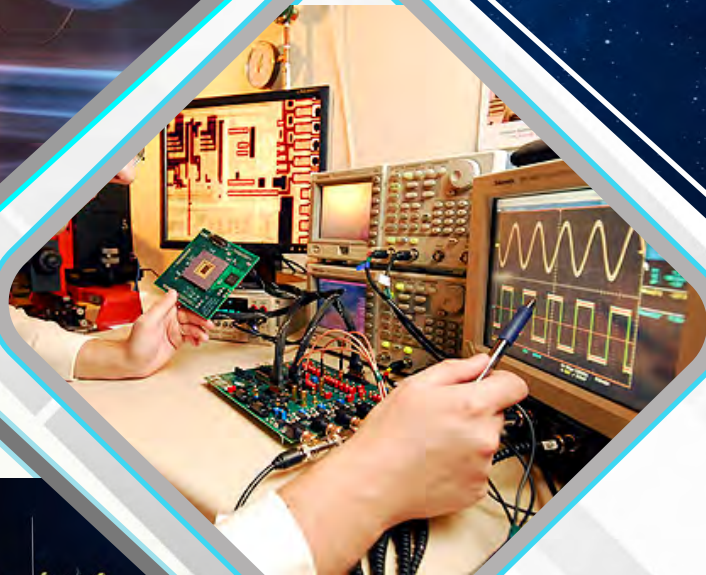


2025

UNDERGRADUATE PROSPECTUS



Institute of Space Technology

VISION

Be a National torchbearer, in the realm of academics, through quality teaching, robust research and outreach – to produce leaders in the field of Space Science and Technology, in line with National aspirations.

MISSION

To provide a conducive environment for the realization of the full potential of faculty and students.

To produce competent, balanced, and creative graduates capable of assuming leadership positions to tackle future national/international technological challenges.

To create awareness of and interest in Space Education at all societal tiers for sustainable national development.





CERTIFICATE



**Management System as per
EN ISO 9001 : 2015**

In accordance with TÜV AUSTRIA procedures, it is hereby certified that

INSTITUTE OF SPACE TECHNOLOGY

**1 - Islamabad Highway
ISLAMABAD, PAKISTAN**

Applies a Quality Management System in line with the above Standard for the following Scope

**PROVISION OF EDUCATIONAL SERVICES IN TEACHING AND LEARNING, WHICH
CONSISTS OF PROGRAM REGISTRATION, EXAMINATION, MONITORING OF STUDENT
PERFORMANCES, RESEARCH AND DEVELOPMENT, TEACHING EVALUATION,
INDUSTRIAL TRAINING AND GRADUATION OF:**

- AERONAUTICS AND ASTRONAUTICS ENGINEERING
- ELECTRICAL ENGINEERING
- MATERIAL SCIENCE ENGINEERING
- MECHANICAL ENGINEERING
- APPLIED MATHEMATICS AND STATISTICS.

Certificate Registration No.: 20001190002033

Valid until: 2022-07-29


Rashid Mehr
CEO
Certification Body
at TÜV AUSTRIA

Lahore, 2019-07-30

This certification was conducted in accordance with TÜV AUSTRIA auditing and certification procedures and is subject to regular surveillance audits.

TÜV AUSTRIA HELLAS
429, Mesogeion Ave.
GR-153 43 Athens, Greece
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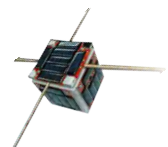


C:\PRK479_A14

Headquarters in Austria bear the responsibility of the Certification decision.

ISO 9001

BUREAU VERITAS
Certification



iCUBE-1
(a project of IST)

"First Cube Sat" by Pakistan
launched on November 21, 2013

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Message of the Vice Chancellor



IST is endowed with an experienced faculty teaching modernized curriculum in well-organized departments with well-equipped labs, utilizing IT enabled learning methodologies. We aim to select motivated students and educate them in fields of their choice in a manner that excites them to excel not only in achieving the curricular objectives, but also in developing entrepreneurial skills aimed to make every student a small business enterprise in him/herself.

We believe that in today's world of shrinking Governments, public sector jobs will become scarcer in future while private sector would grow with the growing economy. As before, our graduates would continue to competitively occupy some slots in our strategic organizations, but most of them would be competing in the local and international business spheres where their competency to design, innovate, develop and produce science & technology services and products would matter. IST shall strive to graduate a socially sensitive, technologically savvy, academically sound and entrepreneurially resilient workforce, which will solve technical problems of the society and industry through innovation while following a scientific approach with resolve and determination.

We are determined to make IST the number one engineering and space sciences university in Pakistan, not only in the various rankings, but more importantly in the eyes of its students, their parents and their employers. We don't believe in cut-throat intake competition, but rather consider every entrant to our university as a trustee. He/she must be helped to discover his/her innate talent and niche capabilities to enable him/her achieve excellence in humanity, education, dedication to work and service to the nation.

In the post AI world, we are aware that teaching methods must change in step with the changing environment. The application of knowledge through generative AI is not the domain of computer science or software development alone, but a disruption in every field of knowledge that must be exploited to the fullest advantage of learning. We are in the process of innovating our learning environment to use AI for adaptive teaching with a student centric approach, rather than the conventional class-centric methodology.

May Allah guide us in making IST a role model institution, a beacon of excellence in technical education and a symbol of national pride.

Aameen!

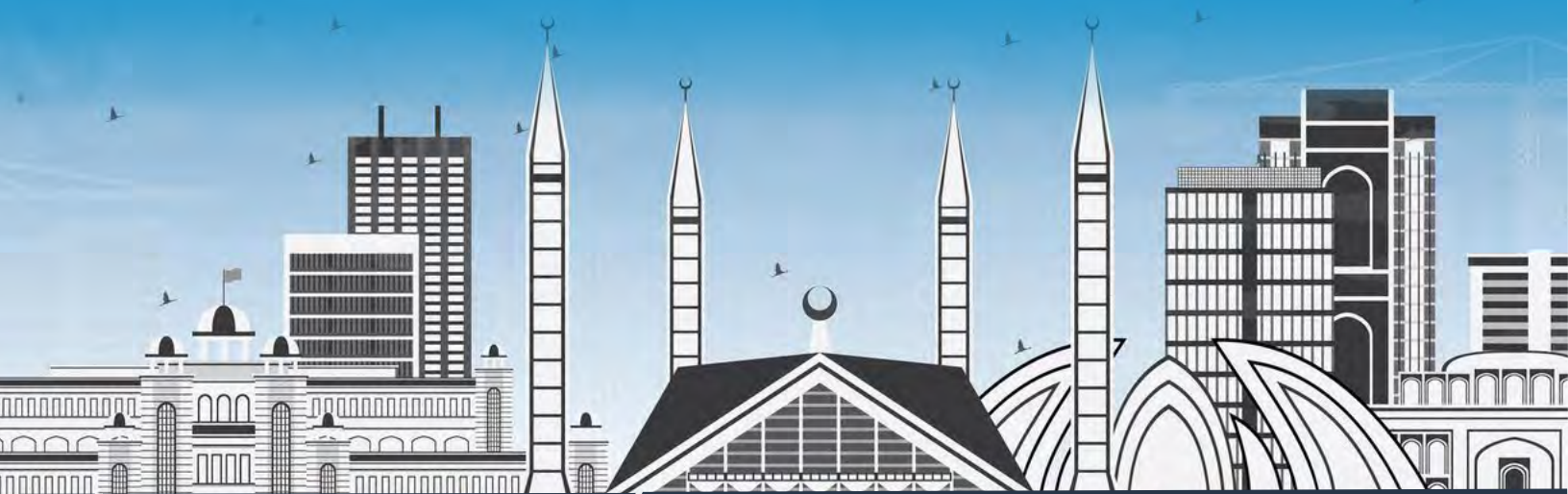
Dr Syed Najeeb Ahmad

Location

Institute of Space Technology, (IST) is located in the federal capital, Islamabad. IST is at 20 minutes drive from the Zero Point of Islamabad and GPO, Rawalpindi and has multiple access through Islamabad Highway and GT Road (see map at the last page of prospectus). This advantageous location affords round the clock accessibility through public and private transportation. Being in Islamabad means that one can visit sights and places depicting the rich cultural heritage and the modern day development of Pakistan.

Combining a rich history, the confluence of many a civilization from the yesteryears and a temperate climate, Islamabad – the capital of Pakistan, is one of the most beautiful cities in South Asia. Wide, tree-lined streets adorn the various sectors and zones of this unique city, making it accessible, spectacular and a vibrant place.

Nestled against the backdrop of Margalla Hills at the northern end of the Potohar Plateau, the city personifies the aspirations and ambitions of a young and dynamic nation that aspires to open doors to a glorious future for its people. The city welcomes new and unique ideas but at the same time, recognizes and cherishes the traditional values and the past history of its people. Apart from the modern amenities, Islamabad is neighbor to quite a few historical sites.



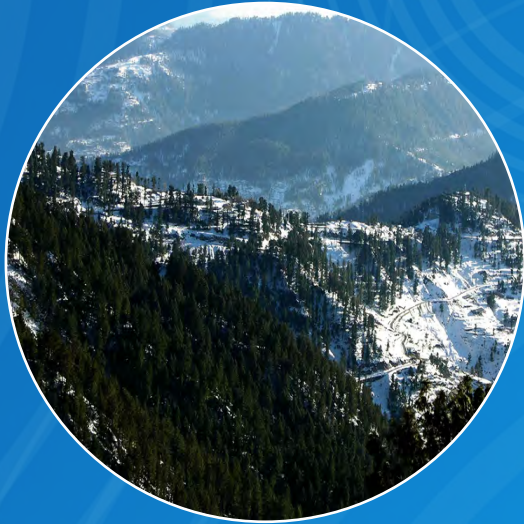
Rawalpindi Rawalpindi, named after Raja Pindi, is a city bustling with life. It is located on the northern most part of the Punjab province, strategically located between the Khyber Pakhtoon Khwa and Azad Jammu & Kashmir. It is also known as the twin city of Islamabad. It is the military headquarters of the Pakistan Armed Forces and once served as the nation's capital while Islamabad was being constructed in 1960s. The city is home to many industries and factories with historical buildings, bazaars, vast parks, chilling winters and hot summers, Rawalpindi has proven its status as a **MUST** visit place.



Wah Gardens Mughal Garden Wah is an elaborate garden dating back to the era of the Mughal Emperor Akbar the Great (1542-1605), located 12 km west of Taxila on G.T Road, in the city of Wah, Punjab, Pakistan. The gardens were developed with magnificent trees and water channels by successive Mughal Emperors. It is a place that must be visited due to its rich history.

Gurudwara Panja Sahib in Hasan Abdal Gurdwara Panja Sahib is situated at Hassan Abdal, 48 km from Islamabad. The town of Hassan Abdal has a particular association with Mughals and Sikhs. This is one of the most holy places of Sikhism because it marks the spot where the founder of the faith, Guru Nanak Dev visited and instilled an important lesson for his adherents. Each year, thousands of faithful Sikhs from all over the globe visit this shrine. The hand print of Guru Nanak is still visible on the sacred rock.





Murree Murree is a popular hill station and a summer resort in Pakistan. It is a delightful place especially for the residents of Islamabad. Its altitude is 2,300 m (7,500 ft) above sea level. Murree is a place for all seasons; in summers it is an ideal place to beat the scorching heat of the twin cities and a beautiful hill station to enjoy snowfall during winters.

Margallah Pass To the North of Islamabad, Margalla lies between the ancient capital of Gandhara (Taxila) and Islamabad. There is an obelisk right on the top of the Pass, built in 1890 in memory of Brig. Gen John Nicholson of the British Army, by his colleagues. A small part of the ancient Shahi (Royal) Road, built by Chandragupta and later developed by the Afghan King Sher Shah Suri in 1540s, can also be seen.



Taxila Situated 35 miles from Islamabad, Taxila was once the seat of Oriental Culture. Most of the archaeological sites of Taxila (600 BC to 500 AD) are located around Taxila Museum. For over one thousand years, when the Buddhist era touched its glory, Taxila remained famous as a centre of learning for Gandhara art of sculpture, architecture, education and Buddhism. Today, Taxila is an archeologist's paradise with over 50 archaeological sites scattered in a radius of 30 kms around Taxila. Also a museum, comprising various sections with rich archaeological finds of Taxila has been established close to the site. It is a popular destination with tourists visiting from all over Pakistan and abroad.



Pharwala Fort beside the Swaan River Pharwala is a historic fort located about 40 km from Rawalpindi in Punjab, Pakistan. It is naturally defended by one side by a small Himalayan range and the other by the Swaan River. It is a Gakhar Fort built in the 15th century on the ruins of a 10th century Hindu Shahi Fort. The fort is situated in the Kahuta area and is open only for Pakistani visitors.

Rawat Fort, built by Gakhars Rawat Fort is located in the Potohar. The fort was built in early 16th century by Gakhars, a tribe of the Potohar Plateau. It is situated at 17 km east of Rawalpindi, on the Grand Trunk Road. The fort was the scene of a battle between the Gakhar chief, Sultan Sarang Khan and Sher Shah Suri in 1546 AD.



Rohtas Fort, Jehlum Rohtas Fort is a garrison fort built by the great Afghan King Sher Shah Suri. This fort is about 4 km in circumference and the first example of successful amalgamation of Pukhtun and Hindu architecture in the Indian Subcontinent. It was built by Harish Chandra of the Solar Dynasty and was named after his son Rohitasva.

Introduction

Indeed, knowledge is increasingly turning into the main currency of the new age of information and technology and a decisive source behind the progress of any country. However, diverse knowledge needs to be considered and reviewed in order to progress in today's age of information. Furthermore, development is not likely without dramatically increasing the role of technical as well as scientific knowledge and, above all, without the acquisition of scientific mindsets. Science and technology is a 'passage oblige' to the progress of any nation in this era of transition and flux. Nevertheless, development of capabilities in the advancement of scientific knowledge is indispensable to meet ever-increasing global challenges.

The recent mega-wave of new scientific knowledge, titled as the 'Knowledge Millennium', has provided new drive for progress. It provides a variety of avenues that could be explored and identified. Scientific and technical knowledge construction is increasing exponentially and is compelling all disciplines to branch into specializations.

In this milieu the Institute of Space Technology, Islamabad, was established in September, 2002 with the focus on the progression of scientific approach and of critical thinking rather than singularly concentrating upon the encyclopedic and academic knowledge. At IST we believe that the new analytical ways of thinking and the new mental approaches are more vital than the new knowledge to attain a significant transition to progress in the society.

The Institute offers undergraduate degrees in Aerospace, Avionics, Electrical, Mechanical, Materials Science & Engineering, Space Science, Computer Science, Artificial Intelligence & Data Science as its core disciplines. The Institute acquired its degree awarding charter in October, 2005.

The faculty of IST with their professional expertise and up-to-date knowledge in their field, industry and applied research experience, is committed to impart the highest quality education with HEC's Foreign Faculty Program, we have notable number of specialized faculty at IST, who have brought home with them years of experience from abroad.

The Institute designs its innovative and career orientated courses to enhance career, ensuring skills and knowledge gain, required by the industry. Equipments such as Subsonic and Supersonic Wind Tunnel have been set up for the up gradation of experiment and research facilities. The aim is to uphold a high quality in education and research in order to consolidate and advance its position among the best Science and Technology Universities in the world.



Programs Offered

The Institute of Space Technology (IST) offers Bachelor of Science degree programs in the following disciplines:

- Aerospace Engineering
- Avionics Engineering
- Electrical Engineering
- Metallurgy & Materials Engineering
- Mechanical Engineering
- Computer Science
- Artificial Intelligence
- Data Science
- Software Engineering
- Computer Engineering
- Mathematics
- Mathematics with AI
- Mathematics with Data Science
- Space Science
- Physics
- Bio-technology
- Remote Sensing & GISc

Campus

Away from congestion, noise and pollution of the city, at 20 minutes drive from Islamabad and Rawalpindi, having multiple accesses through Islamabad Highway and GT Road, IST is located in the Capital Territory of Pakistan. This advantageous location offers round the clock accessibility through public and private transportation.

Spanning over 577 kanals of picturesque expanse of greenery adjacent to DHA, the campus features wide lawns, ample parking spaces and playgrounds. This tranquil environment makes it ideal for situating a seat of higher learning and research.

Academic Block I

Amidst the green spaces a spacious purpose-built, double storied, centrally air conditioned building with a covered area of 5384 sqm, houses administrative and faculty offices, class rooms, lecture theatres, teaching and research laboratories, Information Technology Center, library, conference room, auditorium, faculty lounge and exhibition area.

Academic Blocks II to VII

Academic Blocks II to VI are also available to house additional classes and laboratories. The Blocks are air-conditioned to support a conducive learning environment.

Video Conferencing Facility

A state-of-the-art video conferencing facility is available in the Academic block I. The facility is useful for distance learning and telecasting lectures to and from other universities with similar facilities.

Auditorium

Aesthetically designed, fully air-conditioned auditorium with a capacity of 230 persons is located adjacent to the entrance lobby of the Academic Block-I. An ideal venue for holding national and international conferences, seminars, and workshops, it is equipped with modern audio-visual systems.



Lecture Theaters

All lecture theatres and classrooms are centrally air-conditioned, well-lit and equipped with training aids and multimedia facilities. Lecture theatres can accommodate 60 students, whereas classrooms have a seating capacity of 30 students.

Computer Theatres

Classrooms with individual computers for each student are available for computer based training. The computers are networked to a server and an overhead multimedia projector to enable interactive, hands-on training on computational and professional software learning skills. A computer laboratory housing powerful computers is available for assignments and projects. Also, internet facility is available to students at all times of the day.

Specialized Laboratories

The academic program is supported by laboratories equipped with state-of-the-art equipment. Multiple equipment and instruments are available to ensure hands-on training of each student in the following laboratories:

- Aerodynamics (Subsonic)
- Aerodynamics (Supersonic)
- Aero Workshop/ Project
- Modeling & Simulation
- Propulsion
- Unmanned Aerial Vehicle (UAV)
- Electronics
- Embedded System
- Instrumentation
- Electro-Mechanical System
- Networking/ PCB Fabrication
- Antenna & Microwave
- Communication & Optical
- Information Technology
- Wireless & Signal Processing (WiSP)
- Space Systems Lab (SSL)
- Radar System
- Artificial Intelligence and Computer

Vision (I Vision)

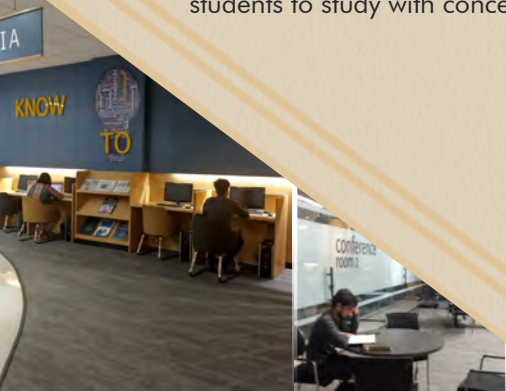
- Avionics System
- Astronomy & Astrophysics
- Geospatial Research and Education Lab (GREL)
- Applied Physics
- Global Navigation Satellite Systems (GNSS)
- Inspection & Testing of Materials
- Polymer
- SEM (Scanning Electron Microscope)
- XRD (X-ray Diffractometer)
- AFM (Atomic Force Microscope) - Centre for Surface Engineering & Tribology
- Heat and Mass Transfer IC Engines
- Mechanics of Machines
- Mechanics of Materials
- Mechanical Vibrations
- Refrigeration & Air Conditioning
- Thermodynamics
- Fluid Mechanics
- Center for Vibration Testing & Condition Monitoring (CVCVM)
- Advanced Manufacturing Facility
- Mechanical Workshop
- Engineering Drawing and Graphics
- Computer Integrated Manufacturing (CIM)
- Metals and Alloys
- Mechanics of Materials
- Ceramics



- Computational Tools in Materials
- Manufacturing and Casting
- Heat treatment and Phase Transformation
- Engineering Mechanics
- Welding
- Composite

Library

The library is integrated with digital technology and electronic information resources. There is an active and continuous development program for the IST library. It has a dynamic collection of books, journals and magazines related to all disciplines which is supplemented by a Xeroxing facility. The core design, furniture and general decor contribute to the formation of an intellectual environment that attracts students to study with concentration.



General Collection: IST library has a collection of more than 13,000 books on all subjects relevant to the courses taught at the institute. Moreover, books on general knowledge, Islam, history, geography and fiction etc are also available.

Reference Section: The reference section has over 840 reference books, handbooks, encyclopedia and dictionaries etc.

Periodicals: IST library is currently subscribing to 17 periodicals to meet the requirements of researchers, faculty and students.

Audio Visual Collection: Audio-visual material is considered an essential medium of instruction. Library has a good collection of educational videos and related audio/visual devices.

Online Resources: To enrich the library collection with the latest online resources available through Internet, professional publications from AIAA, IEEE, ACM and IMechE are accessible.

More than 23,000 journals are available (full text) through HEC Digital Library Program.

Equal Opportunity Institution

IST is an equal opportunity institution and prohibits discrimination on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, marital or family status in all its programs and activities.

Timings	Monday to Friday
Offices	8:00am - 4:00pm
Classes	8:30am - 5:00pm
Computation Facilities	24/7

Medium of Instruction

The medium of instruction at IST is English.

Facilities

Boarding Facility

Boarding facilities will be limited for the students living outside Rawalpindi / Islamabad area. IST managed hostel for female within campus. Students are expected to bring decent coloured bed sheets, pillow covers preferably white. Boarding facility will only be given depending on the availability of rooms.

Messing Services

The messing services are provided by IST Mess Contractor on cash basis.

Dining Timings

Working Days

Breakfast	-	0700 hrs to 0800 hrs
Lunch	-	1200 hrs to 1500 hrs
Dinner	-	2000 hrs to 2230 hrs

Weekends / Holidays

Breakfast	-	0730 hrs to 1000 hrs
Lunch	-	1330 hrs to 1430 hrs
Dinner	-	2030 hrs to 2230 hrs

Quality Assurance Committees

A committee headed by a senior faculty member, administration and students is constituted for check / cater for the standard & quality of Messing Services.

Telephone Facility

Telephone calls can be made through telephone available at reception by using telephone cards.

Laundry Facility

Laundry facility is available at the IST.

Attendant

One attendant in each wing of the hostel would be available for cleaning of rooms and other minor chores.

Regulations-Hostel

- A student shall not occupy a room without due allotment. He shall not transfer or exchange it with any other person without the permission of the warden
- The furniture assigned to a room will not be shifted from it. A resident will be responsible for the articles issued to him / her and shall return them to the hostel authorities when leaving the hostel. He will be responsible for making good any loss or damage to the issued articles
- A resident who breaks or damages any hostel property will have to pay the cost of the article (s) in addition to any disciplinary action that may be taken against him/her
- The residents will be responsible for keeping their room tidy and clean. They will not dispose of litter in the corridor(s) or other parts of the hostel premises.
- Every part of the hostel will be open to the hostel authorities for inspection at any time during day or night
- The residents will not leave lights or fan switched on when the rooms are not in use
- The residents will not keep in the hostel any firearms or other weapons in the hostel even if licensed. Violation of this rule shall render residents liable to expulsion from the hostel



- The residents will not indulge in any immoral activity which is likely to cause nuisance to others
- Any religious ceremony or activity likely to hurt the sentiments of other residents shall not be performed in the hostel
- A room or any part of the hostel premises will not be used as an office for political, religious or sectarian body of the students
- Guests are not allowed to stay overnight without the permission of the Warden / DD (Admin)
- The residents will be responsible for the personal valuable articles or cash left in the rooms. Such as radios, computers, watches, CD players etc
- The residents will not use extra electrical items like heater, air cooler, television or an air conditioner without the written permission of the hostel authority
- The residents are not allowed to gamble or use any intoxicants and narcotics. Violation of this restriction shall render a resident liable to expulsion from the hostel
- The residents will not temper the room door locks nor should they change the fittings
- The residents will meet their guests in the designated area of the hostel only
- The residents will abide by the agreed timing of the outside activities
- The residents will not paste posters, writings and slogans of any kind on wall
- Smoking is strictly prohibited within the premises of the hostel/campus

If a student does not follow the hostel regulations, a fine / ticket will be issued and his hostel allotment may be cancelled.

Computing

Computers are available at IST campus at convenient locations for students for doing assignments and projects. Moreover, internet facility is available to students at any time at campus and in Hostels.

Sports & Games

Students can avail their spare time to enjoy a game of table tennis in the table tennis room or perfect their shoots in the basket ball court. Also, there are numerous indoor games that students can enjoy at leisure.

Gymnasium

For the fitness conscious, a Gymnasium with multiple fitness and exercising equipment is available.



Commuting

Pick and drop facility is available for day scholars from convenient points in Rawalpindi and Islamabad. A weekly shuttle service to city centers is also available for boarders on weekends.

Mosque

The mosque is available adjacent to the academic block for prayers. Namaz-e-taraveeh is also held during the month of Ramadhan.

Tuck Shop

A tuck shop is also available for students and faculty to enjoy meals at economical rates. Quality of food available at the tuck shop is routinely monitored to ensure the quality of food products.

Reproduction Room

A xeroxing, binding, scanning & printing facility is available within the campus which provides services at subsidized rates.

Medical Aid

A health centre is available in the campus which is manned by a qualified nursing staff during the working hours. In case of minor problem, adequate arrangements are available to provide the first aid. However, an ambulance is available round the clock to take serious patients to the hospital.

Trips

Field trips and excursions are arranged for students to learn, interact and absorb from their surroundings. Practical training tours to professional organizations are also arranged to integrate studies and practical application and to bring the perspective employer and students closer.



Department of Student Affairs

Department of Student Affairs (DSA) facilitates students in domains that complements their academics in student life. The major areas of Department of Student Affairs include internships, placements, alumni affairs, student societies' events and activities, sports and annual awards ceremony.

Internships

Department of Student Affairs shares internship opportunities with the students of IST and also encourages them to identify internship opportunities suited to their career aspirations. DSA assists students in securing these additional opportunities so that the students may undertake the much needed industrial exposure during their degree programs.

Placements

IST graduates are consistently recognized for their strong technical acumen and managerial potential, making them highly sought after across public and private sectors. IST facilitate meaningful industry engagement and support successful career transitions of its graduates by conducting on-campus recruitment drives, Annual Job Fair and Open House. These initiatives serve as a dynamic platform connecting students with top employers while highlighting the university's academic and research strengths. Annual Job fair enables student-industry interactions including on-campus interviews of students from our

graduating class. Central to this initiative is the Graduates Book, a professionally curated publication featuring detailed student profiles and project abstracts. It is shared with participating employers to provide a clear snapshot of the talent emerging from IST. Whereas, Open House enables our graduating students to showcase their commercially viable FYPs to the industry experts. These forums offer a chance to enhance IST's institutional brand by fostering collaboration, demonstrating its talent pipeline, and reinforcing its role as a hub of innovation and excellence

Alumni Affairs

Alumni are a benchmark of the success of any institute. Institute of Space Technology has produced graduates with specialized degrees in Aerospace, Communication Systems, Electrical, Mechanical, Materials Science and Engineering, Space Science, Remote Sensing & GIS, Astronomy and Astrophysics, Mathematics and Global Navigation Satellite Systems (GNSS) at undergraduate, post graduate and doctoral level. IST's alumni are currently serving at various nationally & internationally renowned industries and organizations. Prompting an affianced, supportive alumni network is crucial to an institution's success. Alumni reunions are excellent way of promoting networking amongst the alumni, current students and the alma mater. Department of Student Affairs strives to provide the platform

of reunion to its Alumni by managing Alumni Gatherings.

IST Student Societies and Clubs

Academic Societies and Club

1. American Institute of Aeronautics and Astronautics (AIAA) - IST Chapter AIAA is a promising platform that provide incentives for students to undertake hands-on work in the aerospace field. AIAA-IST chapter collaborates with relevant industries



to support students in research findings at the national and international level. Organizing seminars and workshops with other aerospace related institutions and offers students the opportunity to join international associations, allowing students to connect with professionals in the field around the world.

1. American Society of Mechanical Engineers (ASME) – IST Chapter ASME and is a global association that promotes the dissemination of education, knowledge and the respective skills required for the research and development for the discipline of engineering. This society is focused on mechanical

engineering. ASME has over 110,000 members in more than 150 countries worldwide. As a society different



competitions and workshops are hosted so that the students may acquire skills outside the classroom.

3. Institution of Mechanical Engineers (IMEchE) – IST Chapter

Institution of Mechanical Engineers (IMEchE) is a global association that promotes mechanical engineering and its applications in different industries. IMechE has over 120,000



members in as much as 140 countries worldwide. The student chapter of IMECHE at IST strives to provide students with opportunities to get guidance from top professionals in the relevant industries.

4. Institute of Electrical and Electronics Engineers (IEEE) - IST Chapter

IEEE is a non-profit and multi-disciplinary organization with 10 regional setups. Pakistan is part of region 10 and IST affiliates with IEEE Islamabad section. The main objective of this IEEE – IST Chapter is to

facilitate and motivate the students of IST towards technology that will enhance their technical and professional skills in the field of Electrical and Electronic Engineering.



5. Material Advantage Chapter - IST (MAC)

This society provides an opportunity for the young learners to discover their skills and explore new horizons in Materials Science and Engineering. In order to incorporate these qualities in the students, the society arranges multiple activities through its club such as materials research, seminars, workshops etc.

6. American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) – IST Chapter
ASHRAE advances the arts and sciences of heating, ventilation, air conditioning and refrigeration to serve humanity and promote a sustainable world. Students interested in multiple fields including indoor air quality, building design and operation, and environmental control for food processing and industry usually find a sanctuary under the umbrella of this chapter.

7. IST Google Developers Club
Google Developer Student Clubs (GDSCs) are community groups for

university students interested in Google technologies and Tech communities. The club's main purpose is to Connect, Learn and Grow Students. Connect by meeting students interested in developer technologies and technical communities. Learn about various technical topics and gain new skills through hands-on workshops, events, talks, and project-building activities. By joining a GDSC, students grow



their knowledge in a peer-to-peer learning environment and build solutions for local businesses and communities.



8. IST Robotics Society
The objective of IST Robotics Society is to support the development and exchange of scientific knowledge in the fields of robotics and automation. It provides the students a platform to explore and indulge in engineering

knowledge and have hands on experience in the field of robotics, automation and artificial intelligence.



9. IST Space Society (ISS)
Space society aims to create awareness amongst the students of IST and other academic institutions of Pakistan about space, astronomy, aeronautics, space communications and environment through practical & engaging activities. It provides students with the knowledge of new research and technology advancements taking place all over the world in the field of space science and technology.



10. IST Geospatial Society
By connecting Pakistanis with various GIS data and technology providers,

such as ESRI, OSGeo, and others, the Geospatial Society hopes to play a small part in the spread of pure GIS and obtain the resources necessary to give students a better working environment and platform to



use its creativity in GIS. The platform is to educate people about new technologies, provide them with free and useful data to work with, and encourage them to develop geospatial applications.



11. IST Mathematical Society
The goal of the IST Mathematical Society is to promote and advance the discovery, learning and application of mathematics. The IST



Mathematical Society reaches out to and develop new partnerships with the users of mathematics in universities, educators in the school and college systems, as well as other mathematical associations. IST students participated in International Kangaroo Mathematics Contest (IKMC) 2022 secured 1st, 2nd, 3rd, 4th and 5th positions among 37 students in Pakistan. IST stood first in Pakistan with the mentioned accolades.

12. Artificial Intelligence Community of Pakistan (AICP) – IST Chapter
The community is built with the ambition to provide skills, knowledge, and experience in the field of AI to our student community. Our mission is to equip students with the necessary tools and resources to excel in the field of artificial intelligence. The chapter organizes events, workshops and seminars for the students of IST.

13. American Chemical Society – IST Chapter
The American Chemical Society International Chapter at the Institute of Space Technology is dedicated to fostering a vibrant academic and research environment for its members. This esteemed chapter offers its students unparalleled opportunities to engage in specific research endeavors. Additionally, the chapter is committed to the intellectual growth and professional development of its members through workshops and seminars on advance science and engineering.

14. Association for Computing Machinery – IST Chapter

The platform provides students with the opportunity for networking, learning and sharing knowledge related to the field of information technology, computing machinery and computer science. Its mandate is to organize tech oriented workshops, webinars symposiums and field visits.

Extra-Curricular Societies and Clubs

1. IST Green Youth Movement (GYM) Club

Green Youth Movement Club IST Chapter was established in 2021 under the Prime Minister's Youth Program "Clean and Green



Pakistan" aims at tackling climate change and sensitizing the youth to contribute towards environmental conservation and promote eco-friendly behavior among people.



This society assists university administration in formulation, monitoring and implementation of policies pertaining to environment. It also works to create awareness regarding the significance of environmental sustainability of IST and encourages young people to conserve nature by spreading awareness and conducting different activities for environmental protection within campus and outdoor. The GYM club is to make IST a better place where every student of IST is an environmentalist, and knows that their every little action count in making our home planet - Earth close to its nature.

2. IST Entrepreneurial Society (IES)

IST Entrepreneurial society strives to create success in blazing a path of innovation for its members.



Initiating new entrepreneurial ideas and producing employers rather than employees is the core aspect of this society. Students with a mindset of thinking out of the box and are committed to create opportunities for people, are encouraged to be a part of this entrepreneurial setup.

3. IST Literary and Cultural Society

IST Literary and Cultural Society garners and patrons the student



literary, artistic and cultural ambitions. The society promotes creative writings, facilitates publishing of poetry, prose work, and holds meetings with renowned authors and culture-icons who



nourish the participants with their experiences and skills. In addition, society organizes events to revive the esteem of Urdu and regional languages in Pakistan along with the festivity of national heritage of culture. The society organizes Heritage Gala annually to promote



native languages and inter-cultural harmony.

4. IST Debating Society

IST Debating Society aims to provide a platform where the student body can develop and showcase their Oratory and Debating skills. It allows students to master the art of speaking in public domains by engaging them in various activities and competitions. It allows them to indulge into the improvement of their Declamation and Debating skills in



both Urdu and English Language and provides them with the skill-set required to vocally express their opinions on public platforms.

5. IST Arts Society-ArtIST

The society operates with a vision to enhance creativity and talent of the students. The platform helps students to create a balance in their personality and express their imagination through art. It helps



students to explore their innovativeness thereby maintaining a healthy environment.

6. IST Music Society - GOONJ

GOONJ - The Music Society at Institute of Space Technology (IST) is a dynamic platform for students to showcase their talents and explore their love for music. Regularly organizing music events, competitions, and jamming sessions, the society strives to promote and encourage music among students, while also creating opportunities for collaborations and fostering a deeper understanding of different music genres.



7. IST Performing Arts Society - AOIJ

This society aims at promoting the significance of the performing arts in personal development of IST students. The society provides a platform to students to showcase their talents such as acting, script writing, communication and teamwork. Dramas, short plays and skits have always been regular features of the IST Dramatics Society. AOIJ organizes a yearly intra-university dramatics competition, to provide an opportunity to students to

present their acting and performing skills to the audience.

8. IST Youth Club (IYC)

IST Youth Club's mandate is to celebrate/ observe National and International days at IST. IYC aims to promote nationalism and patriotism in students of IST by organizing Pakistan Day, Independence day, Defense Day, Kashmir day, Yum-e-Taqbeer, Iqbal Day, Quaid Day, Labour Day etc.



9. IST Media Club (IMC)

The IST Media Club team prides itself on harboring great talent in many different fields such as photography, videography, graphic designing and content production. Each member of the society possesses a dedicated and innovative spirit towards the work needed for different areas. IST Media Club collaborates with other



societies within IST in addition to organizing their own independent media related events and workshops. The aim is to make each event an unforgettable experience for everyone and to make memories that will last forever. It conducts a Media Fest, an annual event where students are given an opportunity to demonstrate their media related skills.

10. IST Character Building Society (CBS)

IST Character Building Society (CBS) encourages students to develop an environment that supports the students to acquire and practice high moral values and a strong sense of responsibility towards their fellows and society in general. Main objectives of the society are to promote and create awareness of the strong character attributes, moral and ethical values. Also to promote mutual respect and tolerance by



inculcating disciplinary policies of IST pertaining to professional and personal development of the university students.

11. UMEED – IST Social Welfare Society
UMEED, the educational awareness and community building society is

run by the students of Institute of Space Technology and was awarded third prize at the 2016 Yousif Badri Civic Engagement International Competition. UMEED provides continuous material support to fifty rural area government schools and their students. UMEED has undertaken various welfare projects in these schools since its inception in year 2010. IST Student and President of UMEED "IST Social Welfare Society" Ms. Laiba Zahid of Materials Science and Engineering was honored with the "Flood Hero Award" in recognition of team UMEED's efforts to help flood-affected people. The award was presented to her in the Prime Minister's Secretariat on December 5, 2022. UMEED works in the areas of education, health, safe water and disaster mitigation. With efforts increasing each day, UMEED strives to eliminate the hurdles in the path of basic education of the under privileged.



12. IST Islamic Research Society
IST Islamic Research Society promises the development of a friendly environment to promote the teachings of Islam at Institute of Space Technology. It aims to promote the concept of religiosity in the light of Quran and Sunnah. In order to

accomplish its objectives, IST Research Society organizes guest talks, Arabic course, Hadith course and research circles.

- IST Animal Conservation Society
IST Animal Conservation Society aims to build a proper shelter for stray animals and provide animals in and around IST a better healthier life by providing them with food, water, shelter and medical treatment. The society creates awareness among students in IST, to make them more compassionate towards animal welfare.



13. IST Sports Society

To relieve the academic pressure, sports are an integral part of the co-curricular activities at IST. A series of inter-departmental tournaments are held periodically throughout the year to facilitate participation of maximum number of students. IST Sports Society is responsible for conducting and facilitating all sports activities at IST, as well as training students for various intervarsity tournaments and for national level tournaments.

14. IST Tennis Club

Tennis is a sport requiring staunch determination, technique & precision. IST Tennis Club aims to encourage healthy competition amongst students by organizing & conducting

tennis tournaments throughout the academic year, as well as promoting tennis at IST and facilitating students with the right training to excel in the game.

IST Chess Club

IST Chess Club aims at the intellectual development of the students of IST promoting an environment of learning and competition in the beautiful game of chess. Comprising three of the top ranked players of the country, we plan to develop and polish the skills of all newcomers through our influential classes and amazing tournaments. Affiliated with the "Chess Federation of Pakistan" we have the necessary support to succeed in every chess endeavor.



IST Adventure Club

IST Adventure Club aims to promote hands on personal experience through various events and providing a safe yet fun environment. The club aims to bring adventure oriented events and trips to different locations throughout the year. Our events bring students together in challenging activities, encourage teamwork among themselves, and by interacting and appreciating the nature and

beauty of our country.



Sports

Importance of sports in the life of a student is invaluable and goes much further than the basic implied stereotypes. We believe that sports are one of the best ways to develop skills like leadership, team playing and strategy building. IST holds multiple sports competitions among its departments to promote healthy competition among the students. These sports include Football, Cricket, Basketball, Volleyball, Tennis, Badminton, Table Tennis, Tug of war and Futsal. In addition to the interdepartmental sports activities, students are provided ample opportunities for routine sports activities during their free time during and after university hours. Departments are awarded points for winning interdepartmental sports, which contribute to the overall



championship points of the respective departments each year.

Annual Awards Ceremony

Department of Student Affairs holds an annual awards ceremony to acknowledge the accomplishments of students in co-curricular and extra-curricular activities. Students are awarded with medals, trophies and certificates for their extraordinary achievements. These awards are primarily distributed not only to recognize the hard work of the



student but to instill a sense of acknowledgment and accomplishment in the students.

Student Discipline

IST expects its students to uphold the utmost standards of honesty, integrity and discipline. Keeping in perspective the values of IST, a disciplinary committee is set in place which is coordinated by the Department of Student Affairs. In case of violation of student discipline, IST disciplinary committee reserves all rights to take any action against the concerned.

List of General Education Courses

List of Common Non-Engineering / General Education Courses (discipline-wise) that are offered across all departments as part of BS degree requirement.

HUMANITIES & SOCIAL SCIENCE



English

Functional English

The course is designed to equip students with essential language skills needed for effective communication in diverse real-world scenarios. Providing a thorough grounding in the fundamentals of grammar, vocabulary, and sentence structure, it integrates these elements into both simulated and practical communicative tasks to enhance comprehension and expression using English. Students will engage in professional writing, public speaking, and conversational practice, while also examining how language use shapes audience perception. An emphasis on inclusive communication and intercultural awareness is intended to prepare students to interact confidently and responsibly in global settings.

Expository Writing

Building on the foundation of Functional English, this course develops academic writing skills, allowing students

to compose clear, coherent, and well-structured texts in English across a range of academic and professional contexts. It focuses on enhancing analytical and critical thinking abilities through the writing process so that students are able to interpret complex ideas, synthesize information, and articulate well-reasoned arguments. Students will also learn to support their viewpoints with credible sources, while adhering to ethical writing standards.

Technical Writing

This course enables students to develop the skills necessary to produce clear and effective scientific and technical documents. It employs a focus on the basic principles of good writing that scientific and technical writing shares with other forms of writing, and also concurrently provides detailed exposure to the types of documents commonly used in technical fields. The course further situates document-level concerns within a broader discussion of ethical principles and issues relevant to careers in technical communication.

English Composition

This foundational course is designed to develop students' academic writing, and critical thinking. It emphasizes the development of well-structured, coherent, and persuasive writing through advanced instruction in grammar, syntax, paragraphing, and essay organization. Students engage with a variety of academic texts and writing tasks to strengthen their ability to construct logical arguments, synthesize information, and express ideas clearly in both academic and professional settings. The course also introduces citation techniques and the conventions of scholarly writing.

Communication Skills

This course is designed to develop students' proficiency in oral and written communication, essential for academic

success and professional growth. It focuses on enhancing interpersonal skills, public speaking, active listening, academic presentations, and professional writing. Through interactive activities such as group discussions, debates, role-plays, and formal presentations, students learn to communicate ideas effectively and confidently in diverse settings. The course also introduces workplace communication formats including emails, memos, and reports, preparing students for real-world engagement.

CULTURE / STUDY OF RELIGION

Islamic Studies/ Religious Studies

This course aims to contribute to the renaissance of Islamic society by strengthening the foundation of faith and preparing the upcoming generation to face social, ethical, and intellectual challenges confidently. It covers salient aspects of religious scholarly discourse, such as the tenets of faith, Islamic law, interpretation of the divine text, ethics and morality, and the family institution in Islam.

Understanding of Quran I & II

Effective from Fall 2025, these newly introduced compulsory courses aim to develop a deeper understanding of the teachings of the Holy Quran and their practical application in personal and societal life. Spread over two semesters, the courses focus on selected Quranic verses related to ethics, social justice, personal conduct, and the moral framework of an Islamic society. The objective is to foster critical reflection, spiritual awareness, and the application of Quranic principles in both personal and academic spheres.

Pakistan Studies

This course aims to provide an understanding of Pakistan as a nation state founded on distinct ideological origins. It traces key political and constitutional developments, and explores Pakistan's geo-political significance, its role in regional and international organizations, and relations with neighboring countries as well as the wider global community.

Ideology and Constitution of Pakistan

This compulsory undergraduate course is designed to provide students with a foundational understanding of the ideological basis of Pakistan and the evolution of its constitutional framework. It explores the historical context of the Pakistan Movement, key constitutional developments, and the guiding principles that shape the state's political and legal structure. The course aims to instill civic responsibility, national identity, and awareness of constitutional rights and obligations among students across all undergraduate programs.

SOCIAL SCIENCE ELECTIVES

Applied Psychology

This course is designed to introduce undergraduate engineering students to the multidisciplinary field of Psychology. It provides a foundational understanding of the human mind and behavior across key domains, including physiological, organizational, social, and cognitive psychology. Students will actively engage in projects, assignments, and classroom discussions to demonstrate their grasp of core concepts and their applications.

Professional Ethics

This course aims to introduce students to core ideals and principles from various traditional ethical systems and enable them to apply these frameworks to address major ethical challenges and dilemmas in engineering practice within a corporate environment.

Civics and Community Engagement

This course, centered on the scientific study of human interaction, offers students a comprehensive overview of the key concepts, theories, research, and ideas that form the core of sociological knowledge. Its goals are to encourage critical thinking about the social world, foster examination of social issues through a sociological lens, challenge assumptions, and inspire the development of a sociological imagination.



Sociology

This course provides an introduction to the systematic study of human society, social behavior, and cultural patterns. Students explore key sociological concepts, theories, and research methods to understand how individuals interact within groups, institutions, and broader social structures. Topics include socialization, culture, social stratification, gender roles, family, education, deviance, and the impact of globalization. The course emphasizes critical thinking and sociological perspectives for analyzing contemporary social issues, encouraging students to reflect on their role as active members of society.

Occupational Health & Safety

This course introduces students to the principles of occupational health and safety in workplace settings. It covers safe work practices in offices, industrial environments, and construction sites, and teaches students how to identify, prevent, and address safety and health issues in these contexts—as well as in the home.

MANAGEMENT SCIENCE

Entrepreneurship

This course is designed to foster an entrepreneurial spirit and mindset among students, equipping them with the

skills needed to identify opportunities and turn their ideas into successful ventures. It provides the necessary knowledge, skills, and abilities to seize these opportunities and effectively navigate the challenges of starting and managing a business. The course covers various topics crucial to entrepreneurship, including business setup and initiation, market research, opportunity identification, business planning, financial literacy, and team building. The course provides direction for personal growth and professional development, empowering students to pursue innovative ideas, leverage opportunities, and launch successful start-ups.

Project Management

This course offers exposure to the core principles and emerging trends in Engineering Project Management. It provides both foundational knowledge and advanced insights, equipping future engineering professionals with the skills needed to manage complex projects within the constraints of time, budget, and resources. Emphasis is placed on aligning project outcomes with stakeholders' expectations. Students will develop key project management strategies and gain the confidence to address evolving challenges in the field.

Professional Practice

This course explores contemporary and emerging ethical, legal, and professional issues relevant to the modern workforce. Topics include moral reasoning, ethical decision-making, professional codes of conduct, law and morality, equity, justice, and corporate social responsibility. Students examine real-world dilemmas and case studies to understand the role of ethics in professional and societal contexts. By the end of the course, students will be able to demonstrate a clear understanding of their professional responsibilities and moral obligations as future practitioners and active members of society.

Engineering Management

This course introduces students to the principles and practices of management within engineering and technology-driven environments. It covers key topics such as project planning, organizational behavior, decision-

making, leadership, quality management, and resource allocation. Emphasis is placed on the application of management tools and techniques to solve real-world engineering problems. By integrating technical knowledge with managerial skills, the course prepares students to take on leadership roles in multidisciplinary teams and complex project settings.

Human Factor Engineering

This course focuses on the interaction between humans and systems, aiming to optimize human well-being and overall system performance. It introduces the principles of ergonomics, cognitive psychology, biomechanics, and user-centered design as applied to engineering systems, products, and environments. Topics include human capabilities and limitations, safety and risk assessment, human-machine interfaces, workspace design, and usability evaluation. Students learn to design systems that are efficient, safe, and tailored to the needs and behaviors of users in diverse operational settings.

Engineering Economics

This course explores the critical intersection of engineering and economics, emphasizing engineers' pivotal role in business and strategic decision-making for large-scale projects. Students will delve into fundamental economic principles and learn to navigate complex economic landscapes that impact engineering endeavors.

Safety, Health and Environment

This course provides a comprehensive introduction to occupational health, industrial safety, and environmental management. It covers key topics including accident types and prevention, fire safety, hazard analysis, safety inspection procedures, emergency response, and first aid. Students learn the principles of safety management, the legal and economic rationale for workplace safety, and techniques for risk mitigation. The course also addresses environmental concerns such as pollution (air, noise, and industrial waste), their impact on human health, and relevant control technologies. Emphasis is placed on sustainable practices and compliance with international

standards, including relevant ISO certifications related to Safety, Health, and Environment.

SPACE MANAGEMENT

Space Law and Policy

This course introduces students to the legal and regulatory framework governing outer space activities at both international and national levels. It explores foundational treaties such as the Outer Space Treaty, Moon Agreement, and related UN conventions, along with emerging issues in commercial spaceflight, satellite regulation, space debris management, and militarization of space. The course also examines national space policies, licensing frameworks, and the role of international organizations and cooperation in space governance. Students gain insight into the ethical, legal, and strategic dimensions of space exploration, technology development, and space-based services in a rapidly evolving global context.

Space Systems Project Management

This course provides students with a foundational understanding of project management principles as applied to the planning, development, and execution of space systems and missions. It covers key aspects of project lifecycle management, including scope, cost, time, quality, risk, procurement, and stakeholder management, with reference to the Project Management Body of Knowledge (PMBOK) framework. Students will explore the unique challenges of managing multidisciplinary teams, complex technical requirements, regulatory compliance, and risk in space projects. Emphasis is placed on real-world applications, including proposal development, scheduling, budgeting, and performance monitoring in the context of aerospace and space systems engineering.

NATURAL SCIENCE

MATHEMATICS

Calculus (Calculus I & II)

This foundational mathematics course offers a structured and in-depth understanding of calculus, designed to

support the analytical and mathematical needs of science and engineering programs. Calculus introduces fundamental concepts such as functions (single- and multi-valued), inverse functions and their graphs, limits, continuity, derivatives and their applications, L'Hôpital's Rule, infinite series, Taylor and Maclaurin series, and basic integration techniques including arc length and solids of revolution. Calculus I advances these concepts by covering complex conjugates, moduli, power series, multivariable Taylor's theorem, and techniques of integration, including Wallis' formula. Calculus II expands into multivariable and vector calculus, including multiple integrals in cylindrical and spherical coordinates, directional derivatives, Green's theorem, and applications. It also introduces students to Fourier series and transforms, complex variables, analytic functions, Laurent series, Cauchy's theorem, and contour integration. Together, these courses build the mathematical foundation essential for modeling, analysis, and problem-solving in advanced technical fields.

Calculus and Analytical Geometry

This foundational course integrates the core concepts of differential and integral calculus with the principles of analytical geometry, providing students with essential tools for mathematical modeling and problem-solving in engineering and physical sciences. Key topics include limits, continuity, derivatives and their applications, techniques of integration, and an introduction to infinite series. The analytical geometry component covers the study of lines, planes, conic sections, and polar coordinates, as well as the geometry of space using vectors. Emphasis is placed on developing a strong conceptual understanding and the ability to apply mathematical methods to real-world scientific and engineering problems.

Differential Equations

This course introduces the fundamental concepts and solution techniques of ordinary and partial differential equations, which are essential for modeling dynamic systems in science and engineering. Topics include first-

and higher-order differential equations, linear and nonlinear equations, homogeneous and non-homogeneous systems, Laplace transforms, and applications to physical systems. Students also explore series solutions, boundary value problems, and an introduction to partial differential equations. By the end of the course, students gain the skills to formulate, solve, and interpret differential equations in a range of technical and applied contexts.

Linear Algebra

This course provides a foundational understanding of linear algebra and its wide-ranging applications in science, engineering, and computing. Key topics include systems of linear equations, matrix operations, determinants, vector spaces, linear independence, basis and dimension, eigenvalues and eigenvectors, and diagonalization. The course also covers linear transformations and their representations in various coordinate systems. Emphasis is placed on both theoretical understanding and practical problem-solving, with applications in areas such as control systems, computer graphics, data science, and structural analysis.

Numerical Analysis

This course introduces numerical methods for solving mathematical problems that arise in science and engineering when analytical solutions are difficult or impossible to obtain. Topics include error analysis, solutions of nonlinear equations, interpolation, numerical differentiation and integration, and numerical solutions of ordinary differential equations. The course also covers systems of linear equations, matrix factorization, and iterative methods. Emphasis is placed on algorithm development, computational efficiency, and the practical implementation of methods using software tools.

Engineering Mathematics

This course equips students with advanced mathematical tools essential for solving complex engineering problems across disciplines. It covers ordinary and partial differential

equations, linear algebra, complex numbers, Laplace and Fourier transforms, and vector calculus. Additional topics include partial differentiation, multiple integration, directional derivatives, and analysis of irrotational and solenoidal vector fields. The course also explores key theorems such as Gauss's Divergence Theorem, Stokes's Theorem, and Green's Theorem, along with the application of Fourier series, complex variables, and the Cauchy-Riemann equations. Emphasis is placed on analytical reasoning and the application of mathematical methods to model and solve real-world engineering challenges.

Complex Variables and Transforms

This course develops foundational skills in complex variable analysis and their application to solving engineering problems, particularly differential equations using Laplace transforms. Topics include complex numbers and functions, analytic functions, complex integration, power series, Taylor and Laurent series, and residue theorem for contour integration. The course also introduces the Laplace transform, its properties, and its application in solving ordinary differential equations and initial value problems. Emphasis is placed on both theoretical understanding and practical problem-solving relevant to electrical, mechanical, and control systems engineering.

Probability and Statistics

This course provides a foundational understanding of probability theory and statistical methods, essential for data analysis and decision-making in science and engineering. Topics include descriptive statistics, probability concepts, random variables, probability distributions (discrete and continuous), expectation, variance, and the Central Limit Theorem. The course also covers statistical inference, including hypothesis testing, confidence intervals, correlation, regression analysis, and analysis of variance (ANOVA). Emphasis is placed on real-world applications, interpretation of results, and the use of statistical tools for modeling uncertainty and supporting data-driven conclusions.

Quantitative Reasoning I & II

This two-part course sequence is designed to develop students' analytical thinking and problem-solving skills through the application of mathematical reasoning in real-life and academic contexts. Quantitative Reasoning I focuses on foundational topics such as logic, sets, percentages, ratios, proportions, basic algebra, and data interpretation. Quantitative Reasoning II builds upon these concepts with an emphasis on quantitative models, functions, linear and exponential growth, introductory probability, and statistical reasoning.

Discrete Structures

This course introduces the fundamental concepts of discrete mathematics that are essential for computing and information sciences. Topics include logic and propositional calculus, sets, relations, functions, algorithms, mathematical reasoning, and methods of proof. Students also explore combinatorics, recurrence relations, graphs, trees, and Boolean algebra. The course develops analytical thinking and problem-solving skills through applications in computer algorithms, data structures, cryptography, and formal language theory building a strong mathematical foundation for advanced study in computer science and related disciplines.

PHYSICS

Applied Physics

This course provides a comprehensive introduction to the fundamental principles of physics with a focus on real-world applications in engineering and technology. Topics include Newtonian mechanics, motion in two and three dimensions, work and energy, momentum and impulse, rotational dynamics, and equilibrium of rigid bodies. The course also covers fluid mechanics, waves and oscillations, acoustics including the Doppler Effect, and foundational concepts in electromagnetism such as Coulomb's Law, Gauss's Law, Faraday's Law, Maxwell's equations, and electromagnetic waves. Advanced topics include semiconductor physics, modern physics, the theory of relativity, Lorentz transformations, and Einstein's concept of gravity and space-time. Emphasis is placed on

problem-solving, conceptual understanding, and the application of physics principles to engineering systems.

Applied Physics I & II

This two-course sequence provides a strong foundation in classical physics, emphasizing both theoretical concepts and practical applications relevant to engineering and technology.

Applied Physics I focuses on mechanics and motion, covering the nature of science and physics, kinematics in one and two dimensions, Newton's laws of motion, friction, drag, elasticity, uniform circular motion, gravitation, work, energy, momentum, collisions, statics, torque, and rotational motion. Applied Physics II explores thermal physics, waves, and optics. Topics include temperature and heat, specific heat, phase changes, heat transfer mechanisms (conduction, convection, radiation), and the first and second laws of thermodynamics, including Carnot cycles and entropy. The course also covers simple harmonic motion, mechanical waves, acoustics, and sound phenomena such as beats and the Doppler Effect. In optics, students study the nature and propagation of light, reflection, refraction, interference, and diffraction, including applications such as Young's experiment and diffraction gratings.

Together, these courses build essential problem-solving skills and a deep understanding of physical principles applicable across a range of engineering disciplines.

Circuits and Electronics / Electronic Devices and Circuits

This course provides a comprehensive introduction to the analysis and design of electronic circuits and devices. It covers the principles and operation of semiconductor components, including diodes, bipolar junction transistors (BJTs), and field-effect transistors (FETs), along with their applications in rectifiers, amplifiers, and switching circuits. Students also learn circuit analysis techniques involving Ohm's Law, Kirchhoff's laws, Thevenin and Norton theorems, and transient and steady-state analysis of RLC circuits. The course emphasizes practical circuit design, simulation, and troubleshooting, equipping students with foundational knowledge essential for advanced electronics

and embedded systems courses.

Introduction to Space Science

This course provides a foundational overview of space science, exploring the physical principles, celestial phenomena, and technological advancements that shape our understanding of the universe. Topics include the origin and structure of the universe, solar system dynamics, planetary science, space weather, satellite orbits, and basic astrophysics. Students are introduced to key space exploration missions, remote sensing, and the role of space agencies. The course also discusses the impact of space science on modern life, including communication, navigation, and Earth observation. Designed for students from diverse academic backgrounds, the course builds curiosity and interdisciplinary insight into humanity's place in space.

CHEMISTRY

Applied / Engineering Chemistry

This course introduces the fundamental principles of chemistry with an emphasis on their practical applications in avionics, mechanical, and materials engineering. Key topics include atomic and molecular structure, chemical bonding, thermodynamics, chemical kinetics, electrochemistry, and corrosion science. The course also explores materials chemistry, including metallic and composite materials, polymers, lubricants, and fuel



chemistry relevant to propulsion and mechanical systems. Environmental chemistry, water treatment, and green engineering principles are also discussed in the context of sustainability and safety. Students gain essential knowledge to understand material behavior, performance in operational environments, and chemical considerations in design, manufacturing, and maintenance of engineering systems.

COMPUTING ELECTIVES



Applications of ICT

This course introduces students to the effective use of Information and Communication Technology (ICT) in academic, professional, and everyday contexts. It covers fundamental concepts of computing, data management, internet technologies, productivity tools, communication systems, and digital collaboration platforms. Students learn how ICT supports problem-solving, decision-making, and innovation across various disciplines. The course also highlights emerging trends such as cloud computing, cybersecurity, and ethical use of digital resources, equipping students with practical skills for a technology-driven environment.

Computer Systems and Programming

This course provides a foundational understanding of computer systems and programming concepts. It introduces students to the basic architecture and

components of a computer system, including memory, CPU, I/O devices, and data representation. The programming component focuses on problem-solving using a high-level programming language (such as C/C++ or Python), covering variables, control structures, functions, arrays, and file handling. Students learn to design, write, and debug programs while developing logical thinking and algorithmic skills. The course equips students with essential computational knowledge and programming practices for further study in computer science and engineering.

Introduction to Computer Programming

This course introduces students to the foundational concepts of computer programming and computational thinking using a high-level programming language such as C or Python. Core topics include logical expressions, selection control structures (if-else, switch), iterative control structures (loops), and modular programming using functions with proper scope and parameters. Students also work with single and multi-dimensional arrays, user-defined data structures, strings, and pointers. The course focuses on algorithm development, code organization, and debugging skills, enabling students to design efficient and well-structured solutions to computational problems.

Computer-Aided Design (CAD)

This course introduces students to the fundamentals of computer-aided design used in engineering and technical fields. It covers the principles of 2D drafting and 3D modeling using industry-standard CAD software such as AutoCAD or SolidWorks. Students learn to create accurate technical drawings, geometric constructions, assemblies, and annotations in compliance with engineering drawing standards. The course emphasizes spatial visualization, design precision, and the role of CAD in the product development lifecycle. Through hands-on projects, students develop the skills to interpret and produce engineering drawings for manufacturing, construction, and design applications.

AERONAUTICS & ASTRONAUTICS



Aerospace Engineering

The Department of Aeronautics and Astronautics maintains internationally recognized academic programs in Aerospace Engineering.

Aerospace Engineering Program

Aerospace engineering degree program provides graduates with the technical foundation they need to enter the field of Aeronautics & Astronautics. It will prepare them to apply engineering principles, processes and practices to evaluate, analyze, design and develop aerospace systems, and their maintenance. Focused on the field requirements for airborne/space borne platforms, the four-year program encompasses the study of aerodynamics, propulsion, aerospace structures, flight dynamics, guidance navigation and control with application of knowledge during aerospace vehicle design. The program imparts knowledge of basic engineering technology as well as practical knowhow for readiness of engineers to cope up the challenges being faced by organizations in Aerospace industry

Departmental Mission

To serve the community by offering quality education and preparing engineering professionals capable of contributing through sustainable solutions with a focus on research, development, and innovation in Aerospace and allied disciplines

Program Mission Statement

The Aerospace engineering BS program prepares technically strong engineers who can contribute effectively towards the community and related industry through research, entrepreneurship, leadership, and passion for life-long learning

Programs Educational Objectives

The Department of Aeronautics and Astronautics has designed following Educational Objectives for Aerospace Engineering Program through brainstorming

with faculty keeping in view the mission of department, the vision of the institute and the stakeholders' requirements:

- Exhibit knowledge, skills and competence in design and investigation of complex engineering problems using suitable tools.
- Conscious contribution towards ethical, social and environmental responsibilities as an engineer by sustainable solution designing and implementation.
- Demonstrate effective communication skills to reflect purpose clarity in complex situations, either individually or as a part of a team.
- Practice professional management skills and an aptitude for lifelong learning with an aim to maintain balance of life.

Undergraduate Study

The curriculum for undergraduate program in Aerospace leading to the award of Bachelor of Science degrees is approved by Higher Education Commission (HEC) and accredited by Pakistan Engineering Council (PEC)

Program Learning Outcomes

- Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problem
- Engineering Problem Analysis: An ability to identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences
- Design or Development of Solutions: An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental

considerations

iv. Investigation: An ability to conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions

v. Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations

vi. Engineer and Society: An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice

vii. Environment and Sustainability: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development

viii. Ethics: An ability to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice

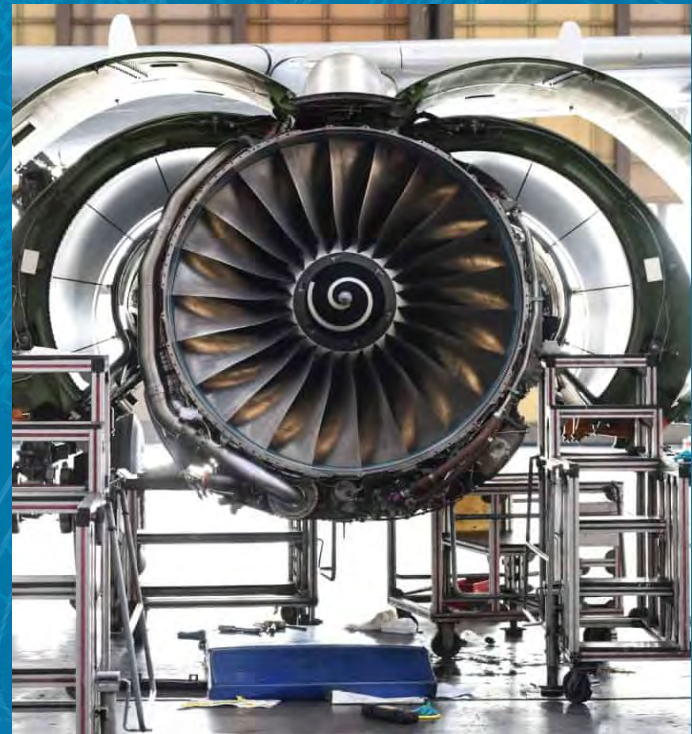
ix. Individual and Team Work: An ability to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings

x. Communication: An ability to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give

and receive clear instructions

xi. Project Management: An ability to demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments

xii. Life Long Learning: An ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change without disturbing the balance of life



Freshman

Semester - 1		
Code	Subject	Cr. Hr.
300312	Functional English	3-0
123201	Calculus	3-0
117401	Applied Physics	3-0
117402	Applied Physics Lab	0-1
111509	Engineering Chemistry	2-0
108470	Introduction to Computer Programming	2-0
108471	Introduction to Computer Programming Lab	0-1
105101	Introduction to Aerospace Engg	2-0
115201	Engineering Drawing	0-1
Total		15-3

Semester - 2		
Code	Subject	Cr. Hr.
	Arts & Humanities Elective	2-0
123204	Linear Algebra	3-0
108101	Circuits & Electronics	3-0
108102	Circuits & Electronics Lab	0-1
109301	Occupational Health and Safety	1-0
114527	Workshop Technology	1-0
114528	Workshop Technology Lab	0-1
205901	Engineering Mechanics-I	3-0
214301	Thermodynamics	3-0
Total		16-2

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
223203	Differential Equations	3-0
300438	Project Management	2-0
305902	Engineering Mechanics-II	3-0
305226	Incompressible Aerodynamics	3-0
205202	Aerodynamics Lab	0-1
205905	Aerospace Materials	3-0
305355	Aerospace Instrumentation	2-0
305356	Aerospace Instrumentation Lab	0-1
Total		16-2

Semester - 4		
Code	Subject	Cr. Hr.
123202	Engineering Mathematics	3-0
323320	Numerical Analysis	2-0
323321	Numerical Analysis Lab	0-1
215223	Computer Aided Drafting	0-1
305903	Mechanics of Materials	3-0
305904	Mechanics of Materials Lab	0-1
305227	Compressible Aerodynamics	3-0
405357	Control Systems	3-0
405358	Control Systems Lab	0-1
Total		14-4

Junior

Semester - 5		
Code	Subject	Cr. Hr.
300130	Expository Writing	3-0
	Social Science Elective	2-0
314305	Heat and Mass Transfer	3-0
314306	Heat and Mass Transfer Lab	0-1
305204	Aero Vehicle Performance	3-0
405906	Aerospace Structures I	3-0
405510	Flight Dynamics & Stability	3-0
Total		17-1

Senior

Semester - 7		
Code	Subject	Cr. Hr.
499901	Design Project I	0-3
123401	Probability in Engineering	2-0
100102	Pakistan Studies	2-0
327127	Artificial Intelligence	2-0
327128	Artificial Intelligence Lab	0-1
405907	Structural Dynamics & Aeroelasticity	3-0
	Engineering Elective III	2-0
	Engineering Elective IV	3-0
Total		14-4

Semester - 6		
Code	Subject	Cr. Hr.
117101	Intro to Space Sciences	1-0
405706	Spacecraft Design	2-0
405707	Spacecraft Design Lab	0-1
405120	Aero Vehicle Design	2-0
405121	Aero Vehicle Design Lab	0-2
405425	Propulsion & Power Systems	3-0
405426	Propulsion & Power Systems Lab	0-1
	Engineering Elective I	3-0
	Engineering Elective II	2-0
	Engineering Elective II Lab	0-1
Total		13-5

Semester - 8		
Code	Subject	Cr. Hr.
499902	Design Project II	0-3
300129	Islamic Studies	2-0
300448	Entrepreneurship	2-0
300133	Civics & Community Engagement	2-0
Total		6-3
Total No of Credit Hours		135

Engineering Electives

Code	Course	Ch
505908	Aerospace Structures-II	3-0
505207	Rotorcraft Dynamics	3-0
405427	Space Propulsion	3-0
405321	Guidance and Navigation of Aerospace Vehicles	3-0
405122	Computational Mechanics	2-0
405123	Computational Mechanics Lab	0-1
405359	Digital System Design	2-0
405360	Digital System Design Lab	0-1
405228	Advance Fluid Mechanics	2-0
405361	Flight Control Systems	2-0
514407	Turbo Machinery	3-0
405502	Spacecraft Dynamics and Control	3-0



Social Science Electives

Code	Course	Ch
300236	Engineering Economics	2
300232	Sociology	2

Courses Description

English Composition

The course is designed to equip students with essential language skills needed for effective communication in diverse real-world scenarios. It builds proficiency in English language usage through a preliminary focus on word choices, grammar, and sentence structure while simultaneously immersing students in communicative situations that activate these concepts to enable nuanced comprehension and expression. The course encompasses a range of practical communication aspects useful in academic and professional spheres, including professional writing, public speaking, and everyday conversation. Additionally, an integral part of the course is fostering an understanding of the impact of language on diverse audiences. Students will also learn to communicate inclusively and display a strong commitment to cultural awareness in their language use to navigate the globalized world with ease and efficacy, thus positively impacting their interactions.

Expository Writing

The course will enhance students' abilities to produce clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, amalgamate information and express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.

Pakistan Studies

To acquaint the students with ideological background of Pakistan, political and constitutional developments in the country, Geo-political significance of Pakistan and its relations with neighboring countries in particular, and world in general in addition to Pakistan's role in regional and international organizations.

Islamic Studies

To acquaint the students with the need for the renaissance of Islamic society by strengthening the foundation of faith upon proofs and not upon blind following and furthermore enabling the upcoming generation to face the social, ethical, religious and intellectual challenges with confidence and will help them in building a strong ethical and intellectual society.

Civics and Community Engagement

The course, as the scientific study of human interaction, aims to provide the students with a survey of the concepts, theories, research, and ideas that comprise the core of body knowledge. The goals of the course are to encourage students to think critically about the social world, examine various issues through a sociological lens, problematize social issues and spark the sociological imagination.

Engineering Economics

Principles of economics, decisions about engineering projects, cost and benefits evaluation of different technical alternatives to determine the most economically viable choices by analyzing the time value of money, comparing different project options, and considering factors like risk and uncertainty

Sociology

Historical Perspective, Society & Community, Social Groups & social Institutions, Social Interaction & Social Norms, Social & Cultural Change, Collective Behavior, Civil Society & Development Discussion on Social Problems of Pakistan.

Professional Ethics

An Overview of Business ethics, Ethical issues in Business, Applying Moral Philosophies to Business Ethics, Moral Philosophy Defined, Moral Philosophy Perspectives, Social Responsibility, An Ethical Decision-Making Framework, How the Organization Influences Ethical Decision Making, The Role of Opportunity and Conflict, Opportunity, Conflict, Development of an Effective Ethics Program, International Business Ethics

Project Management

Introduction to organization, planning and decision aids, project planning techniques, organization structure, human resource management, leadership, total quality management, project management techniques, managing information system, managing operation, PERT, CPM, tools.

Entrepreneurship

Evolution of the concept of entrepreneur; factors affecting entrepreneurial growth. Ingredients for a successful new business, Creativity and source of new business ideas, E-Commerce and business start-up and growth, marketing management: franchising, management systems, role and function of management.

Calculus

Introduction, functions, single & multi valued functions, inverse function and graphs polar coordinates, limit, continuity, indeterminate forms, L'Hopital Rule, infinite series, derivative and its applications, related rates, maxima and minima, Taylor and Maclaurin series comparison, ratio, root and integral tests, absolute series, integration, Wall's formula, application, quadrature, arc length, solid of revolution.

Linear Algebra

System of linear equations and matrices, determinants, Cramer's rule, vectors in 2-D space and 3-D space, eigenvalues, eigenvectors, equilibrium temperature distributions, linear transformations, complex inner product spaces, unitary, normal, and Hermitian matrices, applications of linear algebra.

Differential Equations

First and higher order differential equations, power series method, Laplace transformation, differentiation and integral theorems, system of linear differential equations, partial differential equations, method of separation of variables.

Engineering Mathematics

Partial differentiation, advance vector analysis, directional derivatives, irrational and solenoidal vector fields, multiple integration, Gauss divergence theorem, Stokes's and green theorems, Fourier series, complex variables, Cauchy Riemann equation.

Probability in Engineering

Frequency distribution, Simple and conditional probability, Random variables & mathematical expectation, Distribution (Binomial, Poison, Uniform and Normal distributions) Statistics mainly covers the data collection, presentation, summarization in meaningful manner such as measures of averages and dispersion, and shape of data distribution.

Applied Physics

Vectors, Motion along a straight line, Motion in two and three dimensions, Newton's Laws of Motion, Applying Newton's Laws, Work and Kinetic Energy, Potential Energy and Energy Conservation, Momentum, Impulse and collisions, Rotation of rigid bodies, Dynamics of rotational motion, Newton's Laws of Gravitation, Gravitational Potential Energy, Equilibrium of Bodies, Center of Mass and gravity, Fluid Mechanics, Pascal's Law, Archimedes principle, Waves, Sound Waves, Shock Waves, Doppler Effect, Electromagnetism, Electric Field, Gauss's Law, Electric Potential, Capacitance and Dielectric, Resistance and Electromotive Force, Magnetic Field, Inductance, Solid State Physics

Engineering Chemistry

Extraction of metals, production and applications, corrosion, anodization and thermochemistry that controls the properties and interconnection of processes and defining the behavior of materials, study of polymers, lubricants, paints and coatings, Fuels used in the aerospace industry.



Numerical Analysis

Newton method, regula falsi method, modified newton method, finite differences, method of least square, Lagrange interpolation, numerical differentiation, numerical integration, ordinary and partial differential equations, Runge Kutta method.

Introduction to Computer Programming

Logical Expressions and Selection Control Structures, Loops, Functions, Scope, Single and Multidimensional Arrays, Structures, Strings, etc.

Artificial Intelligence

Introduction (Basic component of AI, Identifying AI systems, branches of AI, etc.); Reasoning and Knowledge

Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, First order Logic); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Constraint Satisfaction Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Learning (Unsupervised learning, Supervised learning, Reinforcement learning); Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems).

Introduction to Aerospace Engineering

Aeronautics: Anatomy of an airplane, standard atmosphere, Aerodynamic forces, lift and drag; Astronautics: Satellite types and orbits; elements of propulsive systems, basic structural elements, systems and materials used for aerospace vehicles-project.



Workshop Technology

Introduction to manufacturing, hand tools, turning, milling, shaping, drilling, grinding, joining and welding processes, manufacturing process planning, CNC lathe and CNC milling, Computer Aided Design and Computer Aided Manufacturing (CAD/CAM), woodworking. Awareness regarding workshop floor safety and health procedure and use of protective equipment with relevance to OSHA standard.



Engineering Drawing

Intro to engineering drawing, concept of lines, orthographic projection, projection of points, projection of lines, solids of revolution, intro to PRO-E, drawing of 2D figures and 3D solids.

Computer Aided Drafting

Intro to engineering drawing, concept of lines, orthographic projection, projection of points, projection of lines, solids of revolution, intro to PRO-E, drawing of 2D figures and 3D solids.

Thermodynamics

Introduction and Basic Concepts, Energy, Energy Transfer and General Energy Analysis, Properties of Pure Substances, Energy Analysis of Closed Systems, Mass and Energy Analysis of Control Volumes, The Second Law of Thermodynamics, Entropy, Exergy-A Measure of Work Potential, Gas Power Cycles.

Engineering Mechanics-I

Fundamental concepts, systems of units, scalars and vectors, Newton's laws, force systems, equilibrium in 2D and 3D, structures, method of joints and sections, center of mass, concentrated loads, shear force and bending moment, friction.



Engineering Mechanics-II

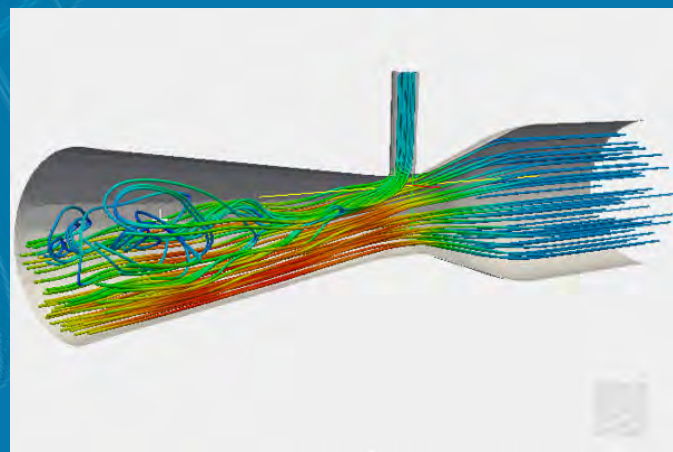
Kinematics of particle motion in various coordinate systems, kinetics of particle using force mass acceleration, work-energy and impulse-momentum, Kinematics of body motion in 2D, Kinetics of rigid bodies, using force-mass acceleration, work-energy and impulse-momentum.

Mechanics of Materials

Stress, strain, Hook's law, statically determinate and indeterminate problems in axial and shear modes, shear force and bending moment diagrams, flexural and shear formula for beams, theory of torsion; thin walled pressure vessel.

Aerospace Materials

General introduction to materials classification and their general properties, atomic and crystal structure, crystal imperfections, mechanical properties/behavior of material, dislocations and failure mechanism, Phase diagram, thermal processing of metals, description of Ferrous and non-ferrous metals & alloys, ceramics, and polymers with emphasis on its aerospace application, composite material and its applications in aerospace, material selection process and salient environmental/societal issues.



Aerospace Instrumentation

Principles and components of a measurement system, statistical data analysis, circuits used for signal conditioning, amplifiers and their configurations, Analog to Digital and Digital to Analog converters, meters, problems associated with electronic measurement systems, Transducers used for measuring different physical quantities like temperature, light, humidity, pressure, vibration, shock, magnetism, ultrasonic, proximity and strain etc. Control of DC motors and stepper motors, aircraft cockpit instruments, IMU/INS, implementation of data acquisition systems and inter-facing with computer using Lab View.

Incompressible Aerodynamics

Aerodynamic forces and moments, fundamental principles and equation fundamentals of in viscid incompressible flow. Bernoulli equation, potential flows over airfoil, thin airfoil theory, flow over finite wings, Prandtl classical, lifting time theory, down wash and induced drag compilation of lift and drag of the airfoil and wing, boundary layer analysis, high lift devices.

Compressible Aerodynamics

Intro to wave theory, normal oblique shock, prandtl Meyer expansion waves, Engine inlet & nozzle design, potential low equations, linear theory, transonic flow supersonic/hypersonic flow.

Aerospace Structures-I

Basic structural elements, construction of parts of an aircraft, wing and fuselage, columns, buckling of plates, energy methods, failure theories, Matrix method of structural analysis

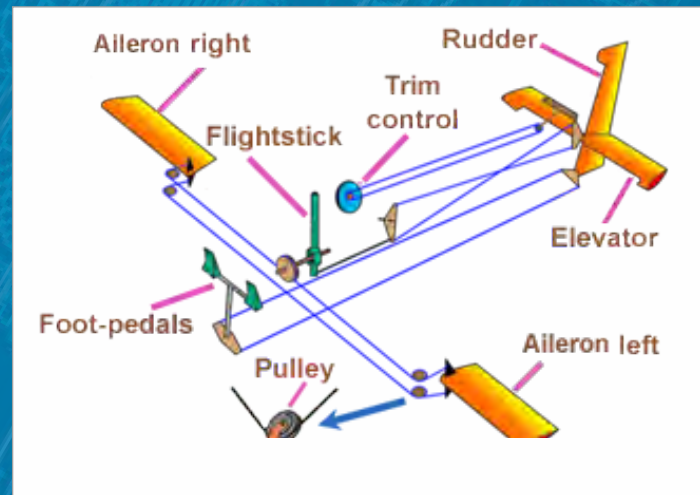
Heat and Mass Transfer

Basics of Heat Transfer: Heat transfer mechanisms, Thermal conductivity & diffusivity, etc. Heat Conduction: Multidimensional heat transfer, Heat generation, heat conduction equation, Boundary and initial conditions, Steady heat conduction in plane walls, cylinders and spheres, Critical radius of insulation, Heat transfer from finned surfaces etc. Convection Heat Transfer: Physical

mechanism, Velocity and thermal boundary layers, Differential equations, External & Internal forced convection, Thermal insulation, Natural & Free convection, etc. Heat Transfer by Radiation: Thermal radiation, Radiation properties, Radiation view factor, View factor relations, Heat exchange between nonblack bodies, Radiation shields, etc. Heat Exchangers: Basic types, Log mean temperature difference method, Heat exchanger effectiveness – NTU method, Selection / Design considerations, etc. Mass Transfer: Fick's law of diffusion, Mass transfer Coefficient, Water vapor migration in buildings, Diffusion in a moving medium, etc.

Aero Vehicle Performance

Performance analysis of air vehicles under steady flight and accelerated conditions, drag polar, power available, power required, endurance, range, climb, ceiling, maximum speed, stalling speed, high lift devices, turning, take-off and landing performance.



Flight Dynamics & Stability

Developing transformation matrices deriving aircrafts governing equation of motion. Mathematically modeling an aircraft. Derive & calculate stability derivation of an aircraft. Aircrafts dynamics stability & response to controls.

Spacecraft Design

This course will not be restricted to satellites and earth orbiting missions but also address the space shuttles, rockets and interplanetary missions. The topics includes spacecraft mission characterization with orbital parameters; space payloads; structural, electrical, thermal and power design of launch vehicles and satellites; attitude control system; mission operations.

Aero Vehicle Design

Analysis of aircraft design with respect to aerodynamics, propulsion, structure, performance and stability. Design specific cost analysis and design optimization.

Control Systems

Open and closed-loop systems, modeling in state space of dynamic systems, mathematical models of mechanical, electrical and electronic systems, stability criteria, control system design by root locus method, control system design by frequency-response, PID Controllers.

Propulsion & Power Systems

Gas turbine cycles, intakes and nozzles, turbojet, turbofan and turbo prop engines, thrust augmentation, centrifugal and axial flow compressors, combustion chambers, turbine, exhaust nozzles.



Structural Dynamics & Aeroelasticity

Structural dynamics and aeroelasticity study, with an emphasis on conventional aircraft. Majorly structural dynamics comprising vibration, modal representation, and dynamic response, (b) static aeroelasticity including divergence, aileron reversal, flight load redistribution and (c) dynamic aeroelasticity including flutter, unsteady aerodynamics, and elastic tailoring.

Senior Design Project

Students undertake an independent project in their senior year. Essential tasks: Project identification, aims and objectives of project, definition of subsystems and requirements, project feasibility, progress presentation, preliminary design, finalization of analysis, design finalization, report preparation, final presentation.

Aerospace Structures II

Stress analysis of elastic structures for aerospace application under different loading conditions, Shear flow distribution in thin-wall structures, wings and fuselage analysis; composite structure for aerospace applications; Aeroelasticity.

Rotorcraft Dynamics

Elementary blade motion; aerodynamics of rotor in motion; helicopter performance; Modeling and analysis techniques for dynamic response, vibration, aeroelastic stability, and aeromechanical stability of rotary-wing vehicles.

Space Propulsion

Propulsion and Thermal Science Space Propulsion Introduction to rocket propulsion fundamentals propellants and nozzle design with detailed insight to chemical and non-chemical propulsion system and advanced concepts in propulsion for space application.

Guidance and Navigation of Aerospace Vehicles

Principles of inertial navigation, theory and applications of GPS, celestial navigation procedures Principles of guidance systems for spacecraft launch vehicles, homing and ballistic missiles. Optimal guidance, Interplanetary transfer guidance with low thrust, Principles of inertial navigation,

theory and applications of the Global Positioning System, Celestial navigation procedures, application of Kalman filtering to recursive navigation theory, Noise Analysis.

Computational Mechanics

Fundamental concepts on solving problems in computational fluid dynamics and computational structural mechanics. The first part of the course would focus on the fundamental computational schemes employed to solve fluid flow while the later part provides a basic approach to finite element methods for learning stress analysis and heat transfer applications.

Digital Systems Design

Analysis of sequential circuits, counters, registers, memories, introduction to microprocessors, low level microprocessor programming, peripheral interface, microcontrollers and their applications.

Flight Control System

Introduction to the design of flight control systems; aircraft stability; cases of stability augmentation system and basic autopilots systems are explained and practiced using design examples in MATLAB/Simulink; design and implementation of navigational autopilots.

Advance Fluid Mechanics

The course focuses on theoretical and computational aspects of fluid mechanics relevant to aerospace engineering. Students will explore topics such as boundary layers, turbulence, and compressible flows and will use CFD tools for design and optimization in aerospace applications. The course will enable students to develop advanced analytical skills to model and solve complex fluid dynamics problems, as well as apply those skills in research projects using computational tools like MATLAB and ANSYS Fluent.

Turbo Machinery

Turbo Machinery Impact of free jets; dimensional analysis and similitude; impulse turbines; reaction turbines; centrifugal pumps; reciprocating pumps; power plants their types and principle of operation.

Spacecraft Dynamics and Control

Introduction to the space, two-body orbital mechanics, orbit determination, time of flight, non-Keplerian motion, rocket performance, orbital maneuvers, interplanetary trajectories, attitude dynamics, attitude control, attitude determination and control hardware.

Circuits and Electronics (MDEE- I)

Current, voltage, resistance, power, energy, resistive circuits, Ohm's law, Kirchoff's current and voltage laws, Thevenin's and Norton's theorem, PN-Junction diode, digital systems and Boolean algebra, analog and digital signals.

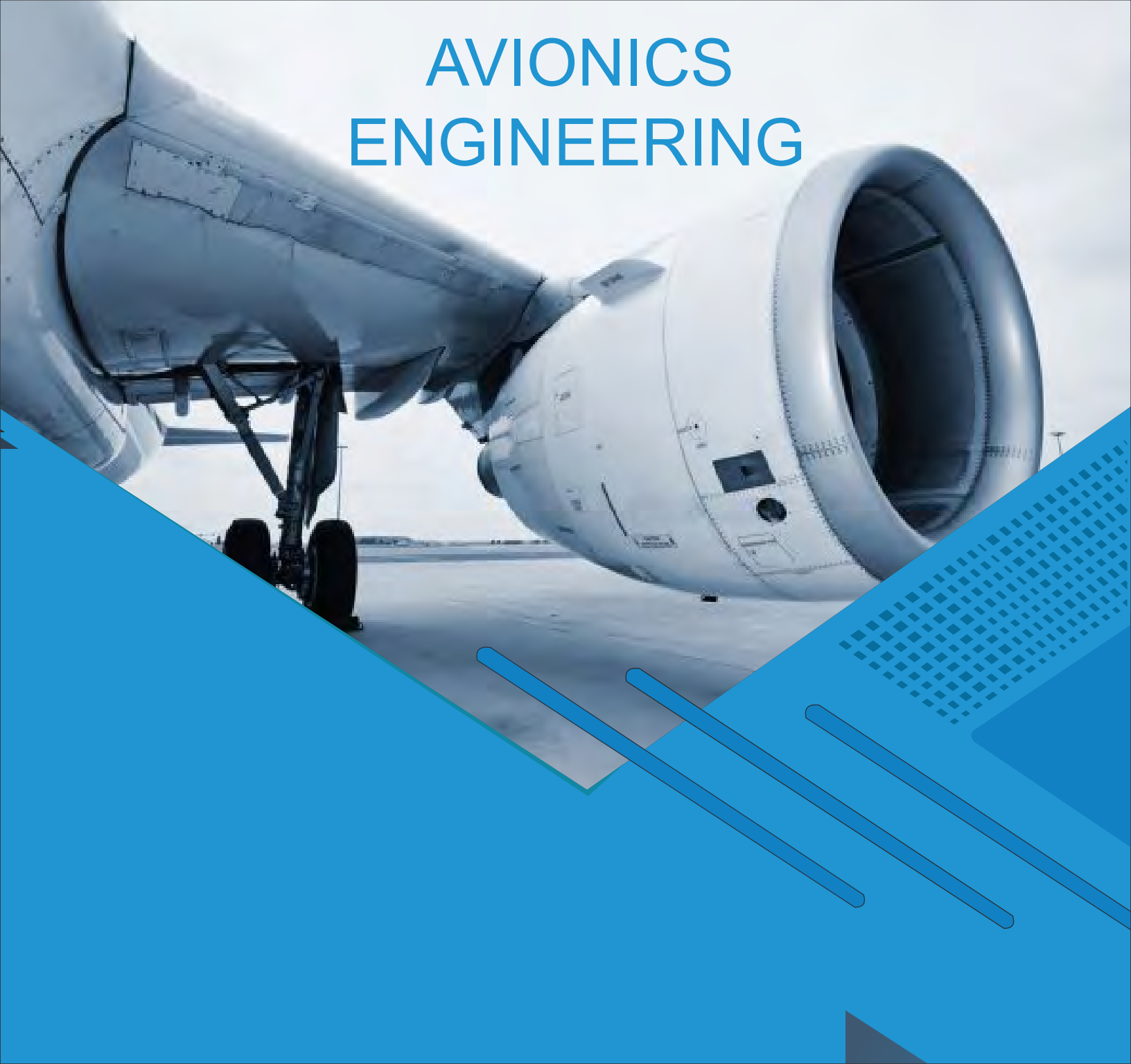
Occupational Health and Safety (MDEE-II)

In-order to avoid lab accidents, Occupational Health and Safety is a very important course for students. Students will learn safety practices, risk assessment, prevention, emergency and first aid, and safety during mechanical and thermal testing. These safety practices will benefit not only themselves but also the protection of the lab, department, institute, and the environment at large.

Intro to Space Sciences (IDEE-I)

This is an introductory course to Space Sciences. The course covers the fundamental concepts of Space Sciences including, Astronomy, Astrophysics, GIS, Remote Sensing, and Environmental Sciences.

AVIONICS ENGINEERING



Department of Avionics Engineering

The Department of Avionics Engineering runs an internationally recognized academic program in Avionics Engineering. The department consists of experienced faculty, well equipped classrooms and state-of-the-art lab facilities.

Avionics Engineering Program

Avionics is one of the key components of Aeronautics and Astronautics that focuses on electrical, electronics and computing aspects of aircraft and spacecraft. Avionics and Aerospace Systems blend together to make the amazing aerial and space vehicles of the modern era a reality. However, the avionics systems not only constitute the on-board electronics systems but a number of ground based systems that help in Air Traffic Management, namely, communication, navigation and surveillance systems. Avionics systems are primarily complex cyber physical systems that comply with ultra-high reliability criteria to meet design requirements of safety critical aviation and space borne systems. Even autonomous surface and marine vehicles use design processes developed for avionics systems. As such, avionics is a broad based applied field and avionics engineers acquire practical knowledge of multiple domains of electrical, computing and aerospace disciplines.

In the Department of Avionics Engineering we are committed to imparting practical knowledge and skills to our students, which makes them a very sought after candidates for a wide range of engineering outfits, both military and commercial. We have state of the art labs equipped with most relevant systems. We boast a faculty that is not only academically highly qualified but also carries vast and varied experience of working in prime aviation and space related organizations. Our hallmark is the personal interaction we maintain with all our students. Owing to their versatile knowledge base, the employment percentage of our graduates is higher than other disciplines

Avionics Engineering Department Mission Statement

The mission of the Avionics Engineering Department is to prepare technically sound engineers and researchers who can contribute effectively towards nation building and societal progress through innovation, research, leadership and entrepreneurship in Avionics Engineering and related technological domains

Avionics Engineering Program Mission Statement

The mission of Avionics Engineering Program is to produce professionally competent and ethical Avionics Engineering graduates who are capable of meeting contemporary and future industrial and technological challenges as team members, team leaders and entrepreneurs.

Programs Educational Objectives

- Our graduates will apply physical, mathematical and engineering sciences to professional practices as an avionics engineer, or when engaged in advanced study
- Our graduates will be cognizant of societal context and ethical responsibility and apply deep working knowledge of technical fundamentals to address society's needs
- Our graduates will function productively on teams as a member or in leadership role and communicate ideas effectively to technical and nontechnical audiences
- Our graduates will be able to develop management skills and an aptitude for life-long learning that enables tackling of emerging and future technological challenges.

Undergraduate Study

The curriculum for undergraduate programs in Avionics Engineering leading to the award of Bachelor of Science degree is approved by Higher Education Commission (HEC). Avionics Engineering program is accredited by Pakistan Engineering Council (PEC).

Program Learning Outcomes

- i. **Engineering Knowledge:** An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problem.
- ii. **Engineering Problem Analysis:** An ability to identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- iii. **Design or Development of Solutions:** An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- iv. **Investigation:** An ability to conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
- v. **Modern Tool Usage:** An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.
- vi. **Engineer and Society:** An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
- vii. **Environment and Sustainability:** An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
- viii. **Ethics:** An ability to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
- ix. **Individual and Team Work:** An ability to function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
- x. **Communication:** An ability to communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- xi. **Project Management:** An ability to demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.
- xii. **Life Long Learning:** An ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change without disturbing the balance of life.

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
123201	Calculus	3-0
105101	Introduction to Aerospace Engineering	2-0
100301	Functional English	3-0
117418	Applied Physics	2-0
117402	Applied Physics Lab	0-1
211502	Engineering Chemistry	2-0
100102	Pakistan Studies	2-0
108443	Intro to Information Technology	2-0
108444	Intro to Information Technology Lab	0-1
Total		16-2

Semester - 2		
Code	Subject	Cr. Hr.
123204	Linear Algebra	3-0
208445	Intro to Computer Programming	2-0
208446	Intro to Computer Programming Lab	0-1
108126	Linear Circuit Analysis	3-0
108127	Linear Circuit Analysis Lab	0-1
223217	Complex Variables and Transforms	3-0
223203	Differential Equations	3-0
100101	Islamic Studies	2-0
Total		16-2

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
115202	Computer-Aided Drafting	0-1
214244	Engineering Mechanics	3-0
114502	Workshop Practice	0-1
208111	Electrical Network Analysis	3-0
208112	Electrical Network Analysis Lab	0-1
208412	Digital Logic Design	3-0
208413	Digital Logic Design Lab	0-1
323301	Numerical Analysis	2-0
214337	Thermodynamics and Propulsion	2-0
Total		15-3

Semester - 4		
Code	Subject	Cr. Hr.
208158	Electronics Devices and Circuits	3-0
208159	Electronics Devices and Circuits Lab	0-1
305224	Applied Aerodynamics	2-0
305225	Applied Aerodynamics Lab	0-1
308431	Digital Systems-Microprocessors & Microcontrollers	2-0
308432	Digital Systems-Microprocessors & Microcontrollers Lab	0-1
208503	Signal and Systems	3-0
208504	Signal and Systems Lab	0-1
308115	Electromagnetic Field Theory	3-0
117101	Occupational Health and Safety	1-0
Total		14-4

Junior

Semester - 5		
Code	Subject	Cr. Hr.
305311	Control Systems	3-0
305312	Control Systems Lab	0-1
123403	Probability in Engineering	3-0
208721	Transmission Lines and Waveguides	2-0
208722	Transmission Lines and Waveguides Lab	0-1
308163	Electronic Circuit Design	3-0
308164	Electronic Circuit Design Lab	0-1
208804	Electrical Machines	2-0
208805	Electrical Machines Lab	0-1
	Expository Writing	3-0
Total		13-4

Senior

Semester - 7		
Code	Subject	Cr. Hr.
499901	Senior Design Project I	0-3
300304	Arts and Humanities Elective	2-0
405805	Avionics System Design	3-0
405803	Avionics System Design Lab	0-1
308723	Microwave Engineering	2-0
308724	Microwave Engineering Lab	0-1
408728	Radar Systems	3-0
408729	Radar Systems Lab	0-1
Total		12-6

Semester - 6		
Code	Subject	Cr. Hr.
305345	Instrumentation and Measurement	2-0
305346	Instrumentation and Measurement Lab	0-1
408447	FPGA based Embedded System Design	2-0
408448	FPGA based Embedded System Design Lab	0-1
308725	Antenna Theory and Design	2-0
308726	Antenna Theory and Design Lab	0-1
308213	Analog and Digital Communication	3-0
308214	Analog and Digital Communication Lab	0-1
405509	Flight Dynamics and Control	3-0
405347	Guidance and Navigation of Aero Vehicles	2-0
Total		14-4

Semester - 8		
Code	Subject	Cr. Hr.
499902	Senior Design Project II	0-3
	Project Management	2-0
	Psychology	2-0
	Civics and Community Engagement	2-0
	Entrepreneurship	2-0
Total		7-3

Total No of Credit Hours

136

Courses Description

Brief course outlines of the taught courses are given below:

Linear Circuit Analysis

The Linear Circuit Analysis is the first course covering the Electric Circuits and Electronics stream. This course



provides the undergraduate students with the foundation of basic laws and theory of basic linear electric circuits using passive elements. The course introduces concepts of charge, current and voltage to be followed with the description of current and voltage sources. An introduction to networks and circuits is accompanied by detailed discussion of Ohm's law and the Kirchhoff's laws. This is followed by circuit analysis techniques using Nodal and Mesh Analysis with particular reference to super-node and super-mesh. A comparison of Nodal and Mesh analysis is also made. The course also covers Circuit Analysis Techniques including linearity and superposition and source transformations; important theorems like Thevenin's, Norton's and Maximum Power Transfer Theorem. The circuit reduction techniques covering Delta-Wye conversion are also covered to allow the students to analyze the simplified circuits. After the

resistive circuit analysis, the study of energy storage elements capacitors and inductors is made. Transient and Steady State analysis of first order RC and RL circuits with unit step forcing function followed by more complex series and parallel RLC circuits are covered.

Electrical Machines

This course examines the basic theory, characteristics, construction operation, and application of rotating electrical machines. It includes the study of direct current motors, direct-current generators, alternators, synchronous motors, polyphase induction motors, and transformers.

Electrical Network Analysis

This is the second course in the two-part sequence of the Electrical Circuit Analysis stream. The course requires basic concepts and knowledge related to circuit analysis and theorems taught in the first course titled Circuit Analysis-I. The course introduces the linear circuits (comprising resistors, capacitors, and inductors) excited by sinusoidal sources. Alternating Current Power Analysis and Poly-phase circuits are introduced next. The concept of complex frequency, Laplace Transforms, and its application to linear circuits and finding transfer functions are covered in the latter part. This is followed by learning about frequency and phase response using Bode plots. The next part of the course introduces the student to magnetically coupled circuits and their analysis, and the last part covers Two-Port network parameters.

Applied Aerodynamics

The aim of this course is to introduce students to the fundamentals and practical aspects of incompressible and compressible flows and the design and operation of flow systems, including pipe networks, automobiles and flight vehicles. The course content includes: flow of inviscid and viscous fluids, laminar and turbulent flow in pipes and boundary layers, losses in pipe systems, lift and drag forces on moving bodies, airfoil theory, incompressible-flow machines, fundamentals of compressible flow, 1-D compressible pipe flow, compressible flow nozzles, Rayleigh flow, Fanno flow,

external compressible flow around bodies including transonic and supersonic vehicles, design considerations and experimental techniques.

Engineering Mechanics

Fundamental concepts, scalars and vectors, Newton's laws, force systems, equilibrium in 2D and 3D, kinematics of particle motion in various coordinate systems, kinetics of particle using force-mass acceleration, work-energy and impulse-momentum, kinematics of body motion in 2D, kinetics of rigid bodies using force-mass acceleration.

Probability in Engineering

Frequency distribution, Simple and conditional probability, Random variables & mathematical expectation, Distribution (Binomial, Poisson, Uniform and Normal distributions).

Workshop Practice

Introduction to manufacturing, hand tools, turning, milling, shaping, drilling, grinding, joining and welding processes, manufacturing process planning, CNC lathe and CNC milling, Computer Aided Design and Computer Aided Manufacturing (CAD/CAM), woodworking.

Instrumentation and Measurements

Principles and components of a measurement system, statistical data analysis, circuits used for signal conditioning, amplifiers and their configurations, Analog to Digital and Digital to Analog converters, meters, problems associated with electronic measurement systems, Transducers used for measuring different physical quantities like temperature, light, humidity, pressure, vibration, shock, magnetism, ultrasonic, proximity and strain etc. Control of DC motors and stepper motors, aircraft cockpit instruments, IMU/INS, implementation of data acquisition systems and interfacing with computer using Lab View

Digital Systems Logic Design & Devices

This course provides a modern introduction to logic design and the basic building blocks used in digital

systems, in particular digital computers. It starts with a discussion of combinational logic: logic gates, minimization techniques, arithmetic circuits, and modern logic devices such as field programmable logic gates, flip-flops, synthesis of sequential circuits and case studies including counters, registers and random access memories.

Signals & Systems

Introduction to Signals & Systems, mathematical representation of Signals & Systems, Sinusoidal signals, Complex exponential signals, discrete and continuous time convolution, LTI systems, Spectral representation of signals, Fourier Series, Fourier transform, Sampling & Aliasing, Conversion of discrete to continuous signals, FIR filters and their frequency response, IIR filter and their frequency response, Laplace transform, z —transform

Electromagnetic Field Theory

The course begins with review of Vector Calculus. Which



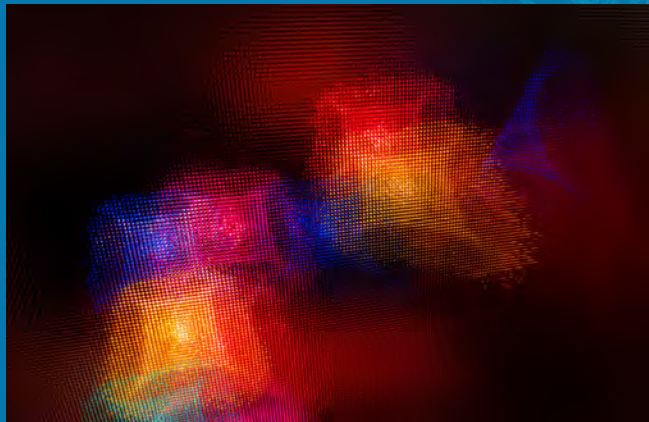
is followed by coverage of key topics of Electrostatics and Magneto statics. The Electrodynamics portion focusing on third and fourth Maxwell equation also forms part of the syllabus. Avionics Engineering students require knowledge of Electromagnetic Compatibility thus the applied examples are oriented as such.

Antenna Theory and Design

Students will know and use standard antenna characterization parameters such as: impedance, far-field radiation pattern, scattering pattern, gain, directivity, bandwidth, beam width, polarization, efficiency, antenna temperature. Understand electromagnetic radiation mechanism and its physics and be able to compute radiation form several common antenna structures. Design simple antennas such as dipoles, micro-strip patches, and waveguide horns to achieve specified performance. Design antenna arrays with required radiation pattern characteristics. Understand self and mutual impedance and the basics of numerical analysis for antennas.

Analog & Digital Communication

Various techniques of modulation and demodulation of

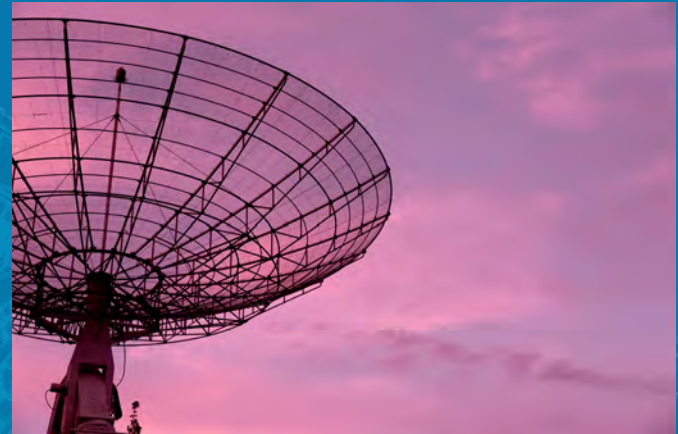


analog signals, Signal-to-noise-ratio (SNR) in analog AM and FM systems, digital transmission methods for analog signals, discrete pulse and carrier wave modulation schemes, Bit-Error-Rate performance of various digital

communication systems, Spread Spectrum communications

Microwave Engineering

The students will be taught fundamentals of Scattering parameters and their utility in design of microwave



devices. Design of passive devices like couplers and dividers is covered. Focus of passive devices design is filter design using insertion loss method. For active devices maximum lectures are devoted to design of Low Noise Amplifier. Salient details of Mixers, oscillators and power amplifiers are also introduced. Final portion is dedicated towards system level design of Receivers and Transmitters

Avionics System Design

The course covers both onboard and Communication/Navigation/Surveillance avionics systems. The students are taught unique feature of Avionics System Design which stem from safety criticality and SwaP-C restrictions. Design methodologies focusing on certification aspects are covered through examples. The final design project based on Model Based Design approach in line with RTCA-DO-331, which is the contemporary methodology world over is followed. System design as per ARP-4761, ARP-4754 is taught and

decomposition of sub-modules into hardware & software complying with RTCA-DO-254 and RTCA-DO-178 practices are inculcated through a semester design project.

Radar Systems

Basic of radar parameters and its functionality, radar range equation and important factors which influence range performance of radar. Concept of probabilistic detection used to analyze the performance of any radar, principle and fundamental applications of CW and FMCW radar, analog/digital MTI, Adaptive MTI and pulse Doppler radar, various tracking radar techniques, sequential lobbing, simultaneous lobbing, conical scan, hybrid functions. Electronically steered phased array antenna and side lobe cancellation, radar performance in wartime environment and electronic warfare, basic principles of electronic support measures, noise jamming, frequency agility, stealth technology and deceptive/expandable ECM.

Electronics Devices and Circuits

Analysis and design of electronic circuits, physical operation of PN junction diodes, Bipolar Junction Transistors (BJTs) and Field Effect Transistors (FETs/MOSFETs) is given, but many interesting and practical circuit applications of these active devices by the end of this course, a student would be thoroughly familiar and comfortable with the active devices and would have also learnt about the basic building blocks of electronic circuits.

Electronic Circuit Design

The objective of the course is to provide students an insight into analysis and design of the electronic devices. The course includes Frequency Response of Amplifiers, Thyristors, and Operational Amplifiers. Basic Op-amp and Special OP-Amps Circuits, Feedback analysis with focus on particular circuit applications of negative feedback and stability problems in feedback amplifiers, Bipolar and MoSFET Analog Integrated Circuits, Design of Active Filters, Tuned Amplifiers, Oscillators and Voltage Regulators.

Transmission Lines & Waveguides

The propagation of plane Electromagnetic Waves in unbounded medium i.e. time-varying fields including Faraday's law of EM induction, displacement current; Maxwell's equations; EM boundary conditions; wave equations; time harmonic fields etc. Applications of the Maxwell's equations to wave propagation in transmission lines, which includes transmission line parameters, SWR, Power, Smith chart and techniques of matching the transmission lines. The rectangular waveguides, which includes Transverse Magnetic (TM) & Transverse Electric (TE) modes, power transmission & attenuation and modes of excitation of a waveguide. Digital System Micro Controller and Microprocessors Computer Architecture, Computer systems Design, Micro Processor/Micro-Controller architecture, Pic-Micro-Controller specification. Memory Organization Parts, Timers, A/D Converter, Serial parts programming. CCP module configuration and programming.

Guidance and Navigation of Aero Vehicles

The course covers different aspects of missile guidance primarily focusing on proportional navigation through a variety of engagement scenarios. Fundamentals of Navigation systems are developed through study of geodetic positioning and navigation frames of reference. Basics of Dead Reckoning and Inertial Navigation Systems are covered. Radio Navigation systems are touched upon to form the basis for dwelling into GNSS based navigation. INS / GNSS integration using kalman filtering is also part of the course. The final phase focuses on Automated Landing aids and Air Traffic Flow aspects with reference to Area Navigation (RNAV), performance based navigation and required navigation performance.

Flight Control Systems

This course provides an introduction to the design of flight control systems. The course starts with an overview of aircraft stability & control, and discusses the cases in which handling qualities of (un-augmented) aircrafts are unsatisfactory and some sort of stability augmentation is required. Stability Augmentation Systems (SAS) and basic autopilots systems are explained and practiced using

design examples in Simulink/MATLAB. Finally, the course concludes with a discussion on the design and implementation of navigational autopilots.

Control System

Classical Control Design Techniques Open and closed loop systems, modeling in state space of dynamic systems, mathematical models of mechanical, electrical and electronic systems, stability criteria, control system design by root locus method, control system design by frequency-response, PID Controllers



FPGA Based Embedded System Design

The course focuses on design and development of digital systems using FPGA as a generic platform. Initial portion focuses on Hardware Description Languages Combination, Sequential logics, Adder, Flip Flops and Digital Integrated Circuit are implemented in FPGA

Engineering Chemistry

This subject introduces the applications of chemistry in aerospace industry. It starts with the extraction of metals, its production and applications. The main objective of engineering chemistry is to know the applications of chemistry in various fields of life, the processes like corrosion, anodization and thermochemistry that



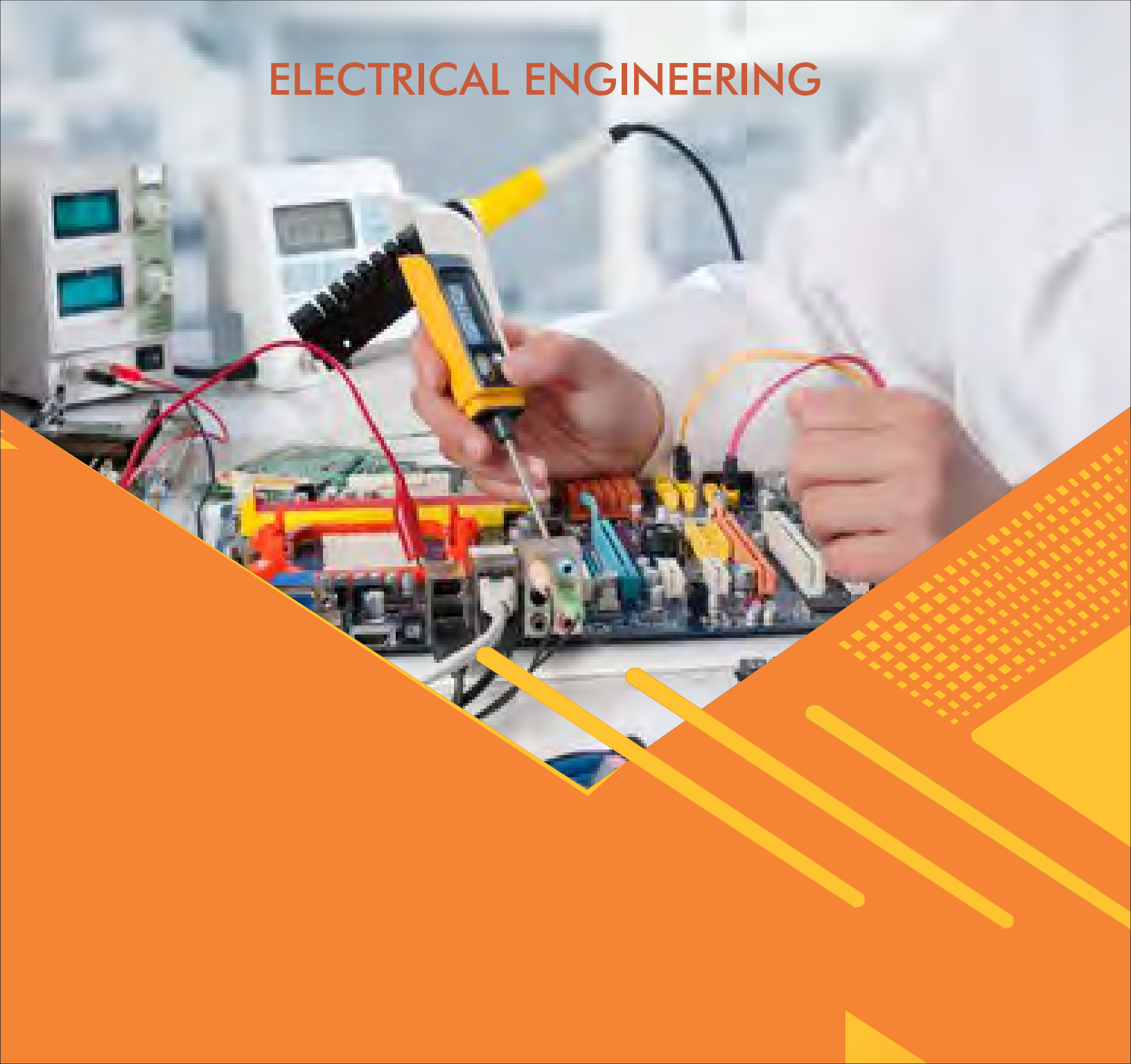
controls the properties and interconnection of processes that define the behavior a material. Study of polymers is also a part of this course which will further help to understand the importance of lubricants, paints and coatings. Fuels that are used in the aerospace industry will be a part of studying this course.

MDEE/IDEE courses

- Thermodynamics and Propulsion
- Aerodynamics

Total 6 credit hours are reserved for 2 Multi-disciplinary Engineering Elective (MDEE) courses and may be divided as per the requirements of courses offered.

ELECTRICAL ENGINEERING



Department of Electrical Engineering

The Department of Electrical Engineering runs an internationally recognized academic program in Electrical Engineering (EE). The Department consists of experienced faculty, well-equipped classrooms and state-of-the-art lab facilities. The department provides continuous academic improvement through consultation with faculty, industry, electronics & communication engineering professionals and students. The focus of these courses is on the design, analysis, development and testing of communication & electronic systems encompassing both wired and wireless technologies. The curriculum is designed to provide all-rounder experience to students in fundamental principles and application of electronics, signal analysis, electromagnetic, antennas, modulation and demodulation methods, digital communications, digital signal processing, coding techniques, wireless technologies, satellite systems, artificial Intelligence (AI) and internet of things (IoT). The curriculum will provide the students with a chance to study a variety of courses over the period of four years.

Mission Statement

To prepare our students for a career with wide ranging opportunities in research, design, development, production, management and solutions related to all fields of Electrical Engineering that encompass the fast growing telecommunication, electronics, computers, wireless & satellite industry.

Program Educational Objectives

The Department of Electrical Engineering has designed the following Educational Objectives for Electrical Engineering program through brainstorming with faculty and keeping in view of Departments' mission, Institute's Vision, and stakeholders' requirements. The following PEOs have been defined in consultation with the Departmental Faculty Members and Industry Advisory

Board (IAB). The graduates of Electrical Engineering program will have the following capabilities/ skills/ attributes four years after their graduation:

- Ability to investigate complex engineering problems using modern techniques and propose effective solutions.
- Manage projects and become effective members of engineering teams through inter-personal skills.
- Demonstrate high moral and ethical values, life-long learning attitude and societal responsibilities.

Program Learning Outcomes

The curriculum for BS student is designed keeping in view the Bachelor of Electrical Engineering Curriculum 2023 provided by Pakistan Engineering Council (PEC) and Higher Education Commission (HEC). The Department of Electrical Engineering has adopted the program learning outcomes that are provided by PEC and HEC and these program learning outcomes are supported by our defined Program Educational Objectives.

- Engineering Knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and engineering specialization to the solution of complex engineering problems.
- Problem Analysis:** Identify, formulate, conduct research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- Design/Development of Solution:** An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

iv. Investigation: Conduct investigation of complex engineering problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

v. Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools, including prediction and modeling, to complex engineering problems, with an understanding of the limitations.

vi. The Engineer and the World: Analyze and evaluate sustainable development impacts to society, the economy, sustainability, health and safety, legal frameworks, and the environment while solving complex engineering problems.

vii. Ethics: Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion.

viii. Individual and Collaborative Team Work: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings.

x. Communication: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, and make effective presentations, taking into account cultural, language, and learning differences.

xi. Project Management and Finance: Demonstrate knowledge and understanding of engineering

management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects in a multidisciplinary environments.

xii. Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadcast context of technological change.



Electrical Engineering

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
300312	Functional English	3-0
	MDEE Elective I	3-0
123820	Calculus and Analytical Geometry	3-0
115201	Engineering Drawing	0-1
109201	Applied Physics	2-0
109202	Applied Physics Lab	0-1
109203	Applications of ICT	2-0
109204	Applications of ICT Lab	0-1
109301	Occupational Health and Safety	1-0
Total		14-3

Semester - 2		
Code	Subject	Cr. Hr.
108126	Linear Circuit Analysis	3-0
108127	Linear Circuit Analysis Lab	0-1
109305	Electrical Workshop Practice	0-1
109205	Differential Equations	3-0
300130	Expository Writing	3-0
109303	Computer Programming	3-0
109304	Computer Programming Lab	0-1
	Social Science Elective I	2-0
Total		14-3

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
	Data Structures and Algorithms	3-0
	Data Structures and Algorithms Lab	0-1
223217	Complex Variables and Transforms	3-0
208111	Electrical Network Analysis	3-0
208112	Electrical Network Analysis Lab	0-1
208412	Digital Logic Design	3-0
208413	Digital Logic Design Lab	0-1
	Islamic Studies	2-0
Total		14-3

Semester - 4		
Code	Subject	Cr. Hr.
	Electronics Devices and Circuits	3-0
	Electronics Devices and Circuits Lab	0-1
208503	Signals and Systems	3-0
208504	Signals and Systems Lab	0-1
	Microprocessors and Interfacing	3-0
	Microprocessors and Interfacing Lab	0-1
300133	Civics and Community Engagement	2-0
123204	Linear Algebra	3-0
Total		14-3

Junior

Senior

Semester - 5		
Code	Subject	Cr. Hr.
	Electrical Machines	3-0
	Electrical Machines Lab	0-1
	Probability and Statistics for Engineers	3-0
	Power Distribution and Utilization	3-0
	Power Distribution and Utilization Lab	0-1
308201	Communication Systems	3-0
308202	Communication Systems Lab	0-1
308115	Electromagnetic Field Theory	3-0
Total		15-3

Semester - 7		
Code	Subject	Cr. Hr.
	Flexible Elective – II	3-0
	Depth Elective – III	3-0
	Depth Elective Lab – III	0-1
	Depth Elective – IV	3-0
	Depth Elective Lab – IV	0-1
	Final Year Design Project-I	0-2
	Project Management	2-0
	Arts & Humanities Elective	2-0
Total		13-4

Semester - 6		
Code	Subject	Cr. Hr.
	Natural Science Elective	3-0
	Depth Elective – I	3-0
	Depth Elective Lab – I	0-1
	Depth Elective – II	3-0
	Depth Elective Lab – II	0-1
	Linear Control Systems	3-0
	Linear Control Systems Lab	0-1
	Flexible Elective – I	3-0
Total		15-3

Semester - 8		
Code	Subject	Cr. Hr.
	Depth Elective – V	3-0
	Depth Elective Lab – V	0-1
	Flexible Elective – III	3-0
	Ideology and Constitution of Pakistan	2-0
	Final Year Design Project-II	0-4
	Entrepreneurship	2-0
Total		10-5
Total No of Credit Hours		136

List of Arts and Humanities Electives (2+0)

- Communication and Presentation Skills
- Beginners Spanish
- Elementary Arabic
- Elementary French
- Elementary Chinese
- History
- Philosophy
- Professional Ethics
- Any other relevant course / language decided by the HEI as pre requirement.

List of Social Science Electives (2+0):

- Sociology for Engineers
- Sociology
- Social Psychology
- Critical Thinking
- Human Resource Management
- Organizational Behavior
- Engineering Law
- Engineering Economics
- Applied Psychology
- Engineering Management
- Financial Management
- Marketing Management
- Leadership and Personal Grooming
- Any other relevant course decided by the HEI as pre requirement.

Proposed Electives for Natural Science (3+0):

- Multivariable Calculus
- Discrete Mathematics
- Numerical Analysis
- Applied Chemistry
- Biology or any related course appropriate for the program

- Any other relevant course decided by the HEI as pre requirement.

Proposed Electives for Multi-disciplinary Domain (MIDEE):

- Applied Mechanics
- Fluid Mechanics
- Thermodynamics Surveying & Leveling
- Bio-Mechanics
- Environmental Engineering
- Software Engineering
- Optimization Techniques
- Any other relevant course decided by the HEI as pre requirement.

Major Based Core (MBC) Depth Electives (Proposed)

Power Stream Depth Core I & II

- Power Generation (Depth Core - I)
- Power System Analysis (Depth Core – II)

Telecom/Communication Stream Depth Core I & II

- Electronic Circuit Design (Depth Core – I)
- Computer Communication Networks (Depth Core – II)

Proposed Electives for Power Stream

- Electrical Power Transmission
- Power System Protection
- Power System Operation & Control
- Electrical Machine Design & Maintenance
- High Voltage Engineering
- Renewable Energy Systems
- FACTS and HVDC Transmission
- Smart Grid
- Power Electronics
- Artificial Intelligence
- Instrumentation and Measurement
- Any other relevant course decided by the HEI as pre requirement.

Proposed Electives for Telecom/Communication Stream

- Digital Communications
- Wireless and Mobile Communications
- Satellite Communications
- Navigation Systems
- Next Generation Networks
- Internet of Things (IoT)
- Wireless Network System
- Telecommunication Standards & Regulations
- Network Management
- Telecommunication Traffic Engineering
- Optical Communications
- Microwave & Radar Systems
- Transmission & Switching System
- Antenna & Wave Propagation
- Any other relevant course decided by the HEI as pre requirement.

Electronics Stream Depth Core I & II

- Electronic Circuit Design (Depth Core -I)
- Power Electronics (Depth Core – II)

Computer Systems Stream Depth Core I & II

- Computer Communication Networks (Depth Core – I)
- Operating Systems (Depth Core – II)

Proposed Electives for Electronics Stream

- Analogue Integrated Electronics
- FPGA Based Digital Design
- VLSI Design
- Optoelectronics
- Digital Control
- Biomedical Instrumentation
- Digital Signal Processing
- RF and Microwave Engineering
- Nanotechnology
- Micro Electromechanical Systems (MEMS)
- Industrial Electronics
- Applied Specific Integrated Circuits (ASIC)
- Design

- Embedded Systems
- Internet of Things (IoT)
- Artificial Intelligence
- Any other relevant course decided by the HEI as pre requirement

Proposed Electives for Computer Systems Stream

- Data Base Systems
- Digital Image Processing
- Data Communication
- Computer Graphics
- Computer Vision
- Image and Video Coding
- Network Protocol and Standards
- Network Security
- Network and System Programming
- Computer Organization
- Computer Architecture
- Digital Systems Design
- Robotics
- Unmanned Aerial Vehicles (UAVs)
- Cloud Computing
- Cyber Security Systems
- Geo-Informatics
- Digital Signal Processing
- Digital Control
- Internet of Things (IoT)
- Embedded Systems
- Artificial Intelligence
- Any other relevant course decided by the HEI as pre requirement

Course Details and Teaching Assessments Approaches

The course details are provided in the Bachelor of Electrical Engineering Curriculum 2023 by HEC and PEC. The course outlines and teaching assessment approaches are given in the curriculum and are meant for guidance

based on typical semester system. Suggested teaching and assessment methods include Lectures (audio/video aids), written assignment/quizzes, Tutorials, Case Studies relevant to engineering disciplines, Community Service, Report Writing, Mid Term/OHT, Presentations, Assignments, Term Projects, Quizzes and Final Year Exam etc.

Engineering Subjects (Mandatory Courses)

Linear Circuit Analysis

Systems of units, Basic quantities, Circuit Elements, Ohm's Law, Kirchhoff's Law, Single-Loop Circuits, Single Node Pair Circuits, Series and Parallel Resistor Combinations, Circuits with Series-Parallel Combination of Resistors, Wye-Delta Transformations, Circuits with Dependent Sources, Nodal Analysis, Loop Analysis, Superposition, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem, Introduction to Capacitors and Inductors, Capacitor and Inductor Circuits, First Order Circuits, Second Order circuits, Sinusoids, Sinusoids and complex Forcing functions, Phasors, Instantaneous Power, Average Power, Max Average Power Transfer, Effective or RMS values.

Probability and Statistics for Engineers

Frequency distribution, measures of central tendency, Fractiles, moments, skewness and Kurtosis, Simple and conditional prob, Random variables & mathematical expectation, PDF & CDF & moment generating functions, Discrete and continuous Prob. Distribution (Binomial, Poisson, Uniform and Normal distributions), Sampling distribution of mean & Estimation, Test of Hypotheses, Regression line & coefficient of correlation.

Signals & Systems

Introduction to Signals & Systems, mathematical representation of Signals & Systems, Sinusoidal Signals, Complex Exponential Signals, Spectral representation of

Signals, Fourier Series, Sampling & Aliasing, Discrete to continuous conversion, FIR filters and their frequency response, IIR filter and their frequency response, z —transform, discrete and continuous time convolution, LTI systems, filters, Fourier transform.

Electronics Devices and Circuits

Semiconductor materials, Doping, PN diode and its applications, Zener diode, Bi-polar junction and field effect transistor and their small signal analysis, Biasing techniques and their uses as amplifiers and switch, Structure, and physical operation of enhancement/depletion type MOSFET

Digital Logic Design

Number systems, Logical Analysis, Combinational Logic, Sequential Logic, Data Processing, manipulation, data storage, logic families and logic design, FPGAs, Hardware description language like VERILOG. Microprocessors and Interfacing Computer Architecture, Computer systems Design, Microprocessor based systems 8-, 16- and 32-bit microprocessor architectures. An overview of low-level microprocessor programming, hardware specifications, memory architectures and interface, I/O Interfaces, Interrupts, Direct Memory Access and DMA-Controlled I/O, Bus Interface, Advanced Microprocessors. Microcontrollers and their applications

Electromagnetic Field Theory

Introduction to electromagnetism, Coordinate Systems, Del Operator, Vector Calculus, Differential length, area, volume, Line surface volume Integrals, Grad, Div, Curl of a vector, Stokes theorem, Electrostatic field, Coulomb's law, Electric Field, Electric Flux, Gauss's law, Electric potential, relation between E and V , Electric dipole, Energy and energy density, Electric field in materials, Properties of materials, Convection conduction currents, Polarization in dielectrics, Dielectric constant and strength, Linear, isotropic, and

homogenous dielectrics, Continuity equation, Boundary conditions, Electrostatic Boundary Value Problems, Poisson's and Laplace's equations, Method of images and related problems, Magneto static fields, forces, materials, and Devices, Biot-Savart's law, Ampere's circuit law, Magnetic vector potentials, Force and torque due to magnetic fields, Magnetization and magnetic materials with classification, Magnetic energy and circuits, Maxwell's Equations and Electromagnetic wave propagation, Faraday's law, Maxwell's equations, Time varying potentials and harmonic fields, Wave propagation, Power and poynting vector, Reflection at normal and oblique incidence, Transmission Lines

Linear Control Systems

Introduction, Element of Control System, Laplace Transform, Block diagram, Block diagram algebra, Signal flow diagram and mason's gain formula, Transient and steady state analysis, Routh's stability Criterion, Effect of PID on system, steady state errors in unity feedback control systems, Root locus Plots, Lead compensation, Lag compensation, Frequency response analysis, PID controller and gain tuning, Nyquist Stability Criterion

Electrical Workshop Practice

Various technical facilities in the workshop including machine shop fitting shop, smith shop, carpentry shop, welding shop and foundry shop. Concepts in electrical safety, safety regulations, earthing concepts, electric shocks and treatment .Electric Wiring: Use of tools used by electricians, wiring regulations, types of cables and electric accessories including switches, plug, circuit breakers, fuses etc. symbols for electrical wiring schematics e.g. switches, lamps, sockets etc., drawing and practice in simple house wiring and testing methods, wiring schemes of two way and three-way circuits and ringing circuits, voltage and current measurement transformer windings (low voltage: 6,9 and 12 volts), motor and generator windings.(concept only).Electronic Circuits: Physical realization of the range of discrete and

integrated semiconductor devices. soldering tools; soldering methods and skills, PCB soldering, PCB making steps: transferring a circuit to PCB etching drilling and soldering component on PCB testing

Electrical Machines

Forces and torques in magnetic field systems. Transformer fundamentals, importance of transformers, types and construction, ideal transformer, theory and operation of real single-phase transformers. D.C. machines fundamentals, simple linear machine. A loop rotating between pole faces, commutation. armature construction, armature reaction, induced voltage and torque equation, construction, power flow and losses, compounded motors, three phase induction motor, production of rotating field and torque, reversal of rotation, construction. synchronous speed, slip and its effect on rotor frequency and voltage, equivalent circuit, power and torque, losses, efficiency and power factor, torque-speed characteristics, starting and speed control, induction generator.

Electrical Network Analysis

Initial Condition Determination, Laplace Transform and Differential Equations, Laplace Transform of Signals Involving Generalized Functions. Convolution. Routh Hurwitz Criterion and Stability. Poles & Zeros. Impedance Function and Network Theorems. Two Port Parameters, Frequency Response, Magnitude and Phase Plots. Fourier Series and Transform. Transient and Steady State Response of Circuits. Sinusoidal/non- Sinusoidal Functions. This course is supplemented with Computer Simulation of Circuits and the study of responses on Computers

Communication Systems

Amplitude Modulation: Baseband and carrier communications, Double Sideband (DSB), Single Sideband (SSB), Vestigial Sideband (VSB), Superheterodyne AM Receiver, Carrier Acquisition, Television. Angle Modulation: Instantaneous frequency,

Bandwidth of FM/PM, Generation of FM/PM, Demodulation of FM/PM. Noise: Mathematical representation, Signal to Noise Ratio, Noise in AM, FM, and PM systems. Pulse Modulation: Sampling and Quantization, Pulse Amplitude Modulation, Pulse Position and Pulse Width Modulation, Quantization Noise, Signal to Quantization Noise Ratio, Pulse code Modulation, Delta Modulation, Frequency Shift Keying, Phase Shift Keying

Applied Thermodynamics

Basic concepts and definitions, processes & cycles of Thermodynamics. Property and definition of State; First Law of Thermodynamics, Work & Heat as energies in transition, Interchangeability of Energy States, Working Fluids and Steady / Unsteady Flow Energy Equations, Perfect and Real Gases; Second Law of Thermodynamics, Reversible and Irreversible Processes, Entropy & Carnot Efficiency, concept of Available Energy.

Engineering Drawing

Intro to engineering drawing, geometric construction techniques, dimensioning, concept of lines, projection methods, orthographic projection, projection of points, projection of lines, solids of revolution, intro to PRO-E, drawing of 2D figures and 3D solids, drawing practice.

VLSI Design

This course covers basic theories & techniques of Digital CMOS VLSI technology, including fundamental concepts and structures of CMOS Fabrication processes, CMOS design rules, static & dynamic logic structures interconnect analysis, and CMOS chip layout, power techniques, design tools and methodologies. This course aims at providing the senior-level under-graduate electronic engineering students an introduction to various VLSI design techniques. This course will also cover major types of FPGAs, including their structure, complexity, and applications in design and development of re-configurable and programmable logic and various entry

techniques especially the use of Hardware Description Language such as Verilog HDL

Digital Signal Processing

This course is designed to assist the student in the design and analysis of discrete time signals and systems. The accompanying lab applies the tools studied in class to real world problems. Main contents include introduction to signal processing, discrete time signals and systems, z-transform, frequency domain analysis of signals and LTI systems, sampling and reconstruction of signals, discrete Fourier transform, fast Fourier transform, implementation of discrete time systems, and design of digital filters.

Artificial Intelligence

The course covers the Introduction, basic component of AI, Identifying AI systems, branches of AI, etc. Reasoning and Knowledge Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, First order Logic); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Co); Uncertainty factoring Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Learning (Unsupervised learning, Supervised learning, Reinforcement learning); Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems).

Internet of Things

The Internet of Things (IoT) is the network of physical objects in which microprocessor and wireless radios are embedded to intelligently serve people in a collaborative manner. In future, IoT is expected to revolutionize many areas of human life i.e., agriculture, healthcare, transportation, manufacturing, engineering etc. This undergraduate course covers the conceptual understanding of IoT fundamentals.

Computer Engineering

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
Ge1xx	Programming Fundamentals	3-0
Ge1xx	Programming Fundamentals Lab	0-1
Cs1xx	Application of Information & Communication Technologies	2-0
Cs1xx	Application of Information & Communication Technologies Lab	0-1
Ge1xx	Functional English	3-0
Ge2xx	Natural Science (Applied Physics)	2-0
Ge2xx	Natural Science (Applied Physics-Lab)	0-1
Ge1xx	Discrete Structures	3-0
	Add Maths-1 (For Pre-Medical)	NC
Total		13-3

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
Cs2xx	Information Security	2-0
Cs2xx	Information Security Lab	0-1
Mt1xx	Multivariable Calculus	3-0
Cs2xx	Data Structures	3-0
Cs2xx	Data Structures Lab	0-1
Cs2xx	Computer Networks	2-0
Cs2xx	Computer Networks Lab	0-1
Cs2xx	Software Engineering	3-0
Mt2xx	Probability & Statistics	3-0
Total		16-3

Semester - 2		
Code	Subject	Cr. Hr.
Cs1xx	Digital Logic Design	2-0
Cs1xx	Digital Logic Design Lab	0-1
Cs1xx	Object Oriented Programming	3-0
Cs1xx	Object Oriented Programming Lab	0-1
Cs1xx	Database Systems	3-0
Cs1xx	Database Systems Lab	0-1
GE1xx	Expository Writing	3-0
Ge1xx	Calculus and Analytic Geometry	3-0
	Add Maths-2 (For Pre-Medical)	NC
Total		14-3

Semester - 4		
Code	Subject	Cr. Hr.
Cs2xx	Comp Organization & Assembly Lang	2-0
Cs2xx	Comp Organization & Assembly Lang Lab	0-1
Cs2xx	Linear Circuit Analysis	3-0
Cs2xx	Electrical Network Analysis	2-0
Cs2xx	Electrical Network Analysis Lab	0-1
Cs2xx	Artificial Intelligence	2-0
Cs2xx	Artificial Intelligence Lab	0-1
Mt1xx	Linear Algebra	3-0
Ge2xx	Islamic Studies	2-0
Total		14-3

Junior

Semester - 5		
Code	Subject	Cr. Hr.
Cs3xx	Operating Systems	2-0
Cs3xx	Operating Systems Lab	0-1
Cs3xx	Electronic Devices & Circuits	2-0
Cs3xx	Electronic Devices & Circuits Lab	0-1
Cs3xx	Computer Architecture	2-0
Cs3xx	Computer Architecture Lab	0-1
Cs3xx	Domain Elective 1	2-0
Cs3xx	Domain Elective 1 Lab	0-1
Cs3xx	Domain Elective 2	2-0
Cs3xx	Domain Elective 2 Lab	0-1
Ge2xx	Introduction to Management	2-0
Total		12-5

Semester - 6		
Code	Subject	Cr. Hr.
Cs3xx	Signals & Systems	2-0
Cs3xx	Signals & Systems Lab	0-1
Cs3xx	Parallel & Distributed Computing	2-0
Cs3xx	Parallel & Distributed Computing Lab	0-1
Cs3xx	Domain Elective 3	2-0
Cs3xx	Domain Elective 3 Lab	0-1
Cs3xx	Domain Elective 4	2-0
Cs3xx	Domain Elective 4 Lab	0-1
Cs3xx	Domain Elective 5	2-0
Cs3xx	Domain Elective 5 Lab	0-1
Cs3xx	Domain Elective 6	2-0
Cs3xx	Domain Elective 6 Lab	0-1
Total		12-6

Senior

Semester - 7		
Code	Subject	Cr. Hr.
Cs4xx	Final Year Project – I	0-2
Cs4xx	Analysis of Algorithms	3-0
Cs4xx	Domain Elective 7	2-0
Cs4xx	Domain Elective 7 Lab	0-1
Ss1xx	Elective Supp Course (e.g. Intro to Marketing)	3-0
En4xx	Technical & Business Writing	3-0
Ge4xx	Entrepreneurship	2-0
Total		13-3

Semester - 8		
Code	Subject	Cr. Hr.
Cs4xx	Final Year Project – II	0-4
Ge4xx	Arts & Humanities (Professional Practices)	2-0
Ge4xx	Ideology and Constitution of Pakistan	2-0
Ge4xx	Civics and Community Engagement	2-0
Total		6-4

Total No of Credit Hours

136

Computer Engineering (Courses Description)

Programming Fundamentals:

Introduction to programming languages, Introduction to C++, C/C++ Programming Basics, Loops and Decisions, Structures, Pointers, Functions, Arrays and Strings.

Application Of Information & Communication Technologies

Introduction to IT, Hardware, Computer Software, Internet and Web, Introduction to Data Communication and Computer Networks, Development, Introduction to Software Engineering

Discrete Structures

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals.

Natural Science (Applied Physics)

Electric Charge, Coulomb's Law, Electric Fields, Electric Potential, Current and Resistance, DC Circuits, Magnetic Fields, Lenz's Law, Faraday's Law, Ampere's Law, Magnetic Properties, AC Circuits, Maxwell's Equations

Object Oriented Programming

Evolution of Object Oriented (OO) programming, OO concepts and principles, problem solving in OO paradigm, OO program design process, classes,

methods, objects and encapsulation, constructors and destructors, operator and function overloading, virtual functions, derived classes, inheritance and polymorphism, I/O and file processing, exception handling

Database System

Basic database concepts, Database approach vs file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub-queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Digital Logical Design

Number systems, Logical Analysis, Combinational Logic, Sequential Logic, Data Processing, manipulation, data storage, logic families and logic design, FPGAs, Hardware description language like VERILOG

Data Structures

Introduction to Data structures and types of data structures, Definition of algorithm, running time of algorithm, examples, role of efficient algorithms, Definition of Recursion, Direct and Indirect Recursion, Examples of Recursive Functions, Linear Queue & Its Features, Linear Queue Implementation, Circular Queue, Linked List & Its Features, Linked List Implementation, Doubly Linked List & its Implementation, Stack & Its Implementation, Postfix Notation Concept, Implementation Of Postfix Notation, Binary Trees, Strictly Binary Tree, Complete Binary Tree, Almost Complete Binary Tree, Binary Tree Applications,

Traversing Trees, Pre-Order Traversing In-Order Traversing, Post-Order Traversing, Bubble Sort, Quick Sort, Binary Sort, Merge Sort, Insertion Sort, Heap, Heap Construction, Heap Sort, Heap Sort Implementation. Hashing & its Implementation, Linear and Binary Search, What Are Graphs, Representation Of Directed Graphs, Graph Vocabulary, Graph Operations (Add Vertex, Add Edge), C++ Implementation, Hashing, dictionaries and hash tables, hashing function, hashing implementation using array and linked list.

Information Security

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Computer Networks

Introduction to Computer Networks, Network Hardware, LAN, MAN, WAN, Inter Networks and the Internet, End Systems, Client and Servers, Connectionless and Connection Oriented Services, The Network Core: Circuit Switching and Packet Switching, Network Access and Physical Media, ISPs and Internet Backbones, Delay and Loss in Packet Switched Networks, Protocol Layering, Design Issues for Layers, Service Models. OSI Reference Model, Principles of Application-Layer Protocols, The Web and HTTP, FTP, DNS, WWW, Electronic Mail, Multimedia, Transport Layer Introduction, Transport Protocols, UDP, TCP/IP, Network Layer Introduction, Routing Algorithms, Congestion and Congestion Control Algorithms, QoS, Tunneling, Inter-network Routing and Addressing,

Introduction to MAC and Channel Allocation, MAC Protocols, Bridges, Spanning Tree, Remote Bridges, Repeaters, Hub, Bridges, Switches, Routers, and Gateways, Introduction to Data Link Layer, Framing, Error Control, Flow Control, Error Detection and Correction

Software Engineering

Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioral models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement.

Computer Organization & Assembly Language

Introduction to microprocessors and computers, System Buses, Internal Memory, External Memory, Input/Output, Interrupts, DMA/IO Channels, Computer Arithmetic, Addressing Modes, CPU Structure and Functions, Control Unit Operations.

Artificial Intelligence

This course will introduce Artificial Neural Networks and Deep Learning. ANN's basic architecture and how they mimic the human brain using simple mathematical models. Many of the important concepts and techniques around brain computing and the major types of ANN will also be introduced. Emphasis is made on the mathematical models, understanding learning laws, selecting activation functions and how to train the networks to solve classification problems. Deep neural

networks have achieved state of the art performance on several computer vision and speech recognition benchmarks. This course will further build on the fundamentals of Neural networks and artificial intelligence and will introduce advanced topics in neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning.

Operating System

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security

Linear Circuit Analysis

Ohms Law, KCL, KVL, Methods of Analysis, Circuit theorem, Capacitors and Inductors, First and Second Order Circuits

Electrical Network Analysis

AC Steady-State Analysis, Steady-State Power Analysis, Magnetically Coupled Networks, Polyphase Circuits, Variable-Frequency Network Performance, The Laplace Transform, Application of the Laplace Transform to Circuit Analysis, Fourier Analysis Techniques and applications, two port network

Electronic Devices And Circuits

Operational Amplifier Construction, op-amp parameters and basic configurations, Op-amp circuits, linear digital ICs, Frequency characteristics of amplifiers and filters, Active Filters, Oscillators

Computer Architecture

This course introduces students to the internal structure, Assembly Language programming principles, and I/O interfaces utilizing microprocessors like MIPS. It covers the computer software programming model and instruction set architecture.

Parallel And Distributed Computing

Introduction, Parallel and Distributed Computing, Parallel and Distributed Architectures, Socket programming, Parallel Performance, Shared Memory and Threads, Parallel Algorithms, Parallel Algorithms, Open MP, Scalable Algorithms, Message Passing, Distributed Systems, Map Reduce, Clusters, Distributed Coordination, Security, Distributed File Systems, Security, Distributed Shared Memory, Peer-to-Peer, Cloud Computing.

Signals & Systems

Introduction to Signals and Systems, Continuous and Discrete Time LTI Systems, Laplace Transform, Fourier Analysis

Analysis Of Algorithms

Proof techniques, Induction, Summations, basic algorithms on numbers, complexity classes, Searching and Sorting, Asymptotic analysis, Divide-and-conquer: merge-sort, closest pair problems, collaborative filtering, Karatsuba algorithm, deterministic Selection, Greedy algorithms: Huffman codes, Minimum Spanning Tree, Interval Scheduling Dynamic programming: Weighted Independent Set in Paths, Weighted Interval Scheduling, Knapsack Problem, Sequence Alignment, Single Source Shortest Paths

(Bellman-Ford Algorithm), BFS, DFS, Topological Sort, Shortest paths, The Class P and NP, Decision, Optimization and Search problems, NP Complete Problems, Reduction, P vs NP Question, Ford Fulkerson Algorithm, Max Flow-Min Cut Algorithm, Edmond Karp Algorithm, Applications, Standard Form, Geometry of LP, Simplex Algorithm, Closest pair in linear-time, Universal and uniform hashing, Randomized Selection, Randomized Quicksort, Minimum Cut algorithm, Easy vs. hard problems, Approximation Algorithm with absolute approximation guarantees, Hardness of Approximation, Relative Approximation Algorithm, Max Cut, Set Cover, Vertex Cover, Parallel machine scheduling, PTAS and FPTAS for Knapsack problem, Approximation algorithms for TSP LP- rounding based Approximation Algorithms.

Note: The elective courses will be offered subject to the availability of specialized faculty and the number of students interested in each course.

COMPUTING



The Department of Computing offers internationally recognized undergraduate and postgraduate programmes in Computer Science (CS), Artificial Intelligence (AI), Data Science (DS) and Software Engineering (SE). The department comprises experienced and foreign-qualified faculty members with access to, well-equipped classrooms and state-of-the-art lab facilities. The department stresses on continuous academic improvement through consultation with faculty members, industry experts, alumni and students.

The focus of the courses in CS programme is on design, analysis, development and testing of computer systems that involve mobile, server and AI technologies. The curriculum of CS is designed to provide an all-rounder experience to students in fundamental principles and applications of computing, algorithm analysis, software design, networking, formal verification methods, digital communications, digital signal processing, coding techniques, image processing, wireless technologies, fiber-optics and database systems.

The Computer Science programme focuses on design and development of software-based platforms and technologies that can help industries to transform themselves with a competitive edge. With courses such as programming, software engineering, operating systems, artificial intelligence, image processing, mobile application development, databases, big data analytics, networks & security and Internet of Things (IoT), the CS program acquaints students with a wide range of practical knowledge.

Artificial Intelligence programme aims to give an in-depth knowledge in computing, mathematics, automated reasoning, statistics and computational modeling. The curriculum focuses on introduction to classical artificial intelligence languages and case studies, knowledge representation and reasoning, artificial neural networks,

machine learning, natural language processing, vision, and symbolic computation. The program also encourages students to take courses in ethics and social responsibility, with the opportunity to participate in long term projects in which artificial intelligence can be applied to solve problems that can change the world for the better — in areas like agriculture, defense, healthcare, governance, transportation, e-commerce, finance, and education.

Data Science program focuses on the basic principles of statistics and computer science, with foundational training in statistical and mathematical aspects of data analysis. This program develops foundations on broad computer science principles, including algorithms, data structures, data management and machine learning. This program will prepare graduates for a career in data analysis - combining foundational statistical concepts with computational principles from computer science.

The curriculum of CS, AI, DS and SE will provide students a chance to study a variety of courses over the period of four years. A conducive environment exists for students to develop expertise in their areas of interest through enrolment in elective courses offered by the department - that will provide the necessary knowledge and the skillset to grab opportunities in leading market firms or as an entrepreneur, as well.

Mission Statement

To prepare our students for a career with wide ranging opportunities in research, design, development, production, management and solutions related to all fields of Computer Science that encompass the fast growing Artificial Intelligence, Data Science, Cyber and Information Security and Computer Networks.

Program Educational Objectives

Computer Science

The Program Educational Objectives (PEOs) of BS (CS) are:

- Apply computing knowledge and skills to compete in the market.
- Initiate projects and manage teams through inter-personal skills.
- Demonstrate high moral and ethical values, life-long learning attitude and societal responsibilities.

Artificial Intelligence

The Program Educational Objectives (PEOs) of BS (AI) are:

- Produce seasoned technologists having solid foundation of computing and strong Artificial Intelligence skills to analyze and solve real world problems of various domains.
- Manage projects and become effective members of teams through inter-personal skills
- Demonstrate high moral and ethical values, life-long learning attitude and societal responsibilities.

Data Science

The Program Educational Objectives (PEOs) of BS (DS) are:

- Apply computing knowledge and skills to propose effective solutions.
- Manage projects and become effective members of teams through inter-personal skills.
- Demonstrate high moral and ethical values, life-long learning attitude and societal responsibilities.

Program Learning Outcomes

The program learning outcomes (PLOs) of BS(AI), BS(CS), BS(DS) and BS(SE) are:

i. **Academic Education:** To prepare graduates as computing professionals

ii. **Knowledge for Solving Computing Problems:** Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models

from defined problems and requirements

iii. **Problem Analysis:** Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

iv. **Design/ Development of Solutions:** Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

v. **Modern Tool Usage:** Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

vi. **Individual and Teamwork:** Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

vii. **Communication:** Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

viii. **Ethics:** Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

ix. **Computing Professionalism and Society:** Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

x. **Life-long Learning:** Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Computer Science

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
	Application of ICT	2-0
	Application of ICT Lab	0-1
	Programming Fundamentals	3-0
	Programming Fundamentals Lab	0-1
	Functional English	3-0
	Calculus and Analytic Geometry	3-0
	Discrete Structures	3-0
	Add Maths-1 (For Pre-Medical)	NC
Total		14-2

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
	Information Security	2-0
	Information Security Lab	0-1
	Data Structures	3-0
	Data Structures Lab	0-1
	Artificial Intelligence	2-0
	Artificial Intelligence Lab	0-1
	Computer Networks	2-0
	Computer Networks Lab	0-1
	Software Engineering	3-0
	Probability & Statistics	3-0
Total		15-4

Semester - 2		
Code	Subject	Cr. Hr.
	Digital Logic Design	2-0
	Digital Logic Design Lab	0-1
	Object Oriented Programming	3-0
	Object Oriented Programming Lab	0-1
	Database Systems	3-0
	Database Systems Lab	0-1
	Multivariate Calculus	3-0
	Linear Algebra	3-0
	Add Maths-2 (For Pre-Medical)	NC
Total		14-3

Semester - 4		
Code	Subject	Cr. Hr.
	Computer Organization & Assembly Language	2-0
	Computer Organization & Assembly Language Lab	0-1
	Theory of Automata	3-0
	Advance Database Management Systems	2-0
	Advance Database Management Systems Lab	0-1
	Applied Physics	2-0
	Applied Physics Lab	0-1
	Expository Writing	3-0
	Islamic Studies	2-0
Total		14-3

Junior

Semester - 5		
Code	Subject	Cr. Hr.
	Operating Systems	2-0
	Operating Systems Lab	0-1
	HCI & Computer Graphics	2-0
	HCI & Computer Graphics-Lab	0-1
	Computer Architecture	2-0
	Computer Architecture Lab	0-1
	Domain Elective 1	2-0
	Domain Elective 1 Lab	0-1
	Domain Elective 2	2-0
	Domain Elective 2 Lab	0-1
	Social Science	2-0
Total		12-5

Semester - 6		
Code	Subject	Cr. Hr.
	Compiler Construction	2-0
	Compiler Construction - Lab	0-1
	Parallel & Distributed Computing	2-0
	Parallel & Distributed Computing - Lab	0-1
	Domain Elective 3	2-0
	Domain Elective 3 Lab	0-1
	Domain Elective 4	2-0
	Domain Elective 4 Lab	0-1
	Domain Elective 5	2-0
	Domain Elective 5 Lab	0-1
	Arts & Humanities (Professional Practices)	2-0
Total		12-5

Senior

Semester - 7		
Code	Subject	Cr. Hr.
	Final Year Project- I	0-6
	Analysis of Algorithms	3-0
	Domain Elective 6	2-0
	Domain Elective 6 Lab	0-1
	Elective Supporting Course	3-0
	Technical & Business Writing	3-0
	Entrepreneurship	2-0
Total		13-7

Semester - 8		
Code	Subject	Cr. Hr.
	Final Year project - II	0-12
	Ideology and Constitution of Pakistan	2-0
	Domain Elective -7	2-0
	Domain Elective -7	0-1
	Civics and Community Engagement	2-0
Total		6-13

Total No of Credit Hours 136

Artificial Intelligence

Freshman

Sophomore

Semester - 1		
Code	Subject	Cr. Hr.
	Programming Fundamentals	3-0
	Programming Fundamentals Lab	0-1
	Application of Information & Communication Technologies	2-0
	Application of Information & Communication Technologies Lab	0-1
	QR 1 (Discrete Structures)	3-0
	QR 2 (Calculus and Analytic Geometry)	3-0
	Functional English	3-0
	Add Maths-1(For Pre-medical)	NC
Total		14-2

Semester - 3		
Code	Subject	Cr. Hr.
	Information Security	2-0
	Information Security Lab	0-1
	Artificial Intelligence	2-0
	Artificial Intelligence Lab	0-1
	Data Structures & Algorithms	3-0
	Data Structures & Algorithms Lab	0-1
	Computer Networks	2-0
	Computer Networks Lab	0-1
	Software Engineering	3-0
	Probability & Statistics	3-0
Total		15-4

Semester - 2		
Code	Subject	Cr. Hr.
	Digital Logic Design	2-0
	Digital Logic Design Lab	0-1
	Object Oriented Programming	3-0
	Object Oriented Programming Lab	0-1
	Database Systems	3-0
	Database Systems Lab	0-1
	Multivariable Calculus	3-0
	Linear Algebra	3-0
	Add Maths-2(For Pre medical)	NC
Total		15-3

Semester - 4		
Code	Subject	Cr. Hr.
	Computer Organization & Assembly Language	2-0
	Computer Organization & Assembly Language Lab	0-1
	Programming for AI	2-0
	Programming for AI-Lab	0-1
	Machine Learning	2-0
	Machine Learning -Lab	0-1
	Natural Science	2-0
	Natural Science Lab	0-1
	Expository Writing	3-0
	Islamic Studies	2-0
Total		13-4

Junior

Semester - 5		
Code	Subject	Cr. Hr.
	Artificial Neural Network & Deep Learning	2-0
	Artificial Neural Network & Deep Learning-Lab	0-1
	Operating Systems	2-0
	Operating Systems Lab	0-1
	Knowledge Representation & Reasoning	2-0
	Knowledge Representation & Reasoning-Lab	0-1
	Domain Elective 1	2-0
	Domain Elective 1 Lab	0-1
	Domain Elective 2	2-0
	Domain Elective 2	0-1
	Social Science	2-0
Total		12-5

Semester - 6		
Code	Subject	Cr. Hr.
	Computer Vision	2-0
	Computer Vision-Lab	0-1
	Parallel and Distributed Computing	2-0
	Parallel and Distributed Computing- Lab	0-1
	Domain Elective 3	2-0
	Domain Elective 3 Lab	0-1
	Domain Elective 4	2-0
	Domain Elective 4 Lab	0-1
	Domain Elective 5	2-0
	Domain Elective 5 Lab	0-1
	Arts & Humanities (Professional Practices)	2-0
Total		12-5

Senior

Semester - 7		
Code	Subject	Cr. Hr.
	Domain Elective – 6	2-0
	Domain Elective – 6 Lab	0-1
	Final Year Project – I	0-6
	Analysis of Algorithms	3-0
	Elective Supporting Course	3-0
	Technical & Business Writing	3-0
	Entrepreneurship	2-0
Total		13-7

Semester - 8		
Code	Subject	Cr. Hr.
	Ideology and Constitution of Pakistan	2-0
	Domain Elective 7	2-0
	Domain Elective 7- Lab	0-1
	Final Year Project – II	0-12
	Civics and Community Engagement	2-0
Total		6-13

Total No of Credit Hours 136

Data Science

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
	Programming Fundamentals	3-0
	Programming Fundamentals Lab	0-1
	Application of Information & Communication Technologies	2-0
	Application of Information & Communication Technologies Lab	0-1
	Discrete Structures	3-0
	Calculus and Analytic Geometry	3-0
	Functional English	3-0
	Add Maths-1 (For Pre-Medical Students)	
Total		14-2

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
	Information Security	2-0
	Information Security Lab	0-1
	Artificial Intelligence	2-0
	Artificial Intelligence Lab	0-1
	Data Structures	3-0
	Data Structures Lab	0-1
	Computer Networks	2-0
	Computer Networks Lab	0-1
	Software Engineering	3-0
	Probability & Statistics	3-0
Total		15-4

Semester - 2		
Code	Subject	Cr. Hr.
	Digital Logic Design	2-0
	Digital Logic Design Lab	0-1
	Object Oriented Programming	3-0
	Object Oriented Programming Lab	0-1
	Database Systems	3-0
	Database Systems Lab	0-1
	Multivariable Calculus	3-0
	Linear Algebra	3-0
	Add Maths-2 (For Pre-Medical Students)	
Total		15-3

Semester - 4		
Code	Subject	Cr. Hr.
	Computer Organization & Assembly Language	2-0
	Computer Organization & Assembly Language Lab	0-1
	Natural Science	2-0
	Natural Science - Lab	0-1
	Introduction to Data Science	2-0
	Introduction to Data Science - Lab	0-1
	Expository Writing	2-0
	Advanced Statistics	0-1
	Advanced Statistics - Lab	3-0
	Islamic Studies	2-0
Total		13-4

Junior

Semester - 5		
Code	Subject	Cr. Hr.
	Operating Systems	2-0
	Operating Systems Lab	0-1
	Data Mining	2-0
	Data Mining - Lab	0-1
	Data Visualization	2-0
	Data Visualization - Lab	0-1
	DS Elective-1	2-0
	DS Elective-1 Lab	0-1
	DS Elective-2	2-0
	DS Elective-2 Lab	0-1
	Social Science	2-0
Total		12-5

Semester - 6		
Code	Subject	Cr. Hr.
	Parallel and Distributed Computing	2-0
	Parallel and Distributed Computing - Lab	0-1
	Data Warehousing & Business Intelligence	2-0
	Data Warehousing & Business Intelligence-Lab	0-1
	DS Elective – 3	2-0
	DS Elective – 3 Lab	0-1
	DS Elective – 4	2-0
	DS Elective – 4 Lab	0-1
	DS Elective – 5	2-0
	DS Elective – 5 Lab	0-1
	Arts and Humanities (Professional Practices)	2-0
Total		12-6

Senior

Semester - 7		
Code	Subject	Cr. Hr.
	Final Year Project – I	0-6
	Analysis of Algorithms	3-0
	DS Elective – 6	2-0
	DS Elective – 6 Lab	0-1
	Elective Supporting Course	3-0
	Technical & Business Writing	3-0
	Entrepreneurship	2-0
Total		13-7

Semester - 8		
Code	Subject	Cr. Hr.
	Final Year Project – II	0-12
	Ideology and Constitution of Pakistan	2-0
	DS Elective - 7	2-0
	DS Elective - 7 Lab	0-1
	Civics and Community Engagement	2-0
Total		6-13

Total No of Credit Hours 136

Software Engineering

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
Ge1xx	Programming Fundamentals	3-0
Ge1xx	Programming Fundamentals Lab	0-1
Cs1xx	Application of Information & Communication Technologies	2-0
Cs1xx	Application of Information & Communication Technologies Lab	0-1
Ge1xx	Functional English	3-0
Ge2xx	Natural Science (Applied Physics)	2-0
Ge2xx	Natural Science (Applied Physics-Lab)	0-1
Ge1xx	Discrete Structures	3-0
	Add Maths-1 (For Pre-Medical)	NC
Total		13-3

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
Cs2xx	Information Security	2-0
Cs2xx	Information Security Lab	0-1
Mt1xx	Multivariable Calculus	3-0
Cs2xx	Data Structures	3-0
Cs2xx	Data Structures Lab	0-1
Cs2xx	Computer Networks	2-0
Cs2xx	Computer Networks Lab	0-1
Cs2xx	Software Engineering	3-0
Mt2xx	Probability & Statistics	3-0
Total		16-3

Semester - 2		
Code	Subject	Cr. Hr.
Cs1xx	Digital Logic Design	2-0
Cs1xx	Digital Logic Design Lab	0-1
Cs1xx	Object Oriented Programming	3-0
Cs1xx	Object Oriented Programming Lab	0-1
Cs1xx	Database Systems	3-0
Cs1xx	Database Systems Lab	0-1
GE1xx	Expository Writing	3-0
Ge1xx	Calculus and Analytic Geometry	3-0
	Add Maths-2 (For Pre-Medical)	NC
Total		14-3

Semester - 4		
Code	Subject	Cr. Hr.
Cs2xx	Comp Organization & Assembly Lang	2-0
Cs2xx	Comp Organization & Assembly Lang Lab	0-1
Cs2xx	Software Design & Architecture	3-0
Cs2xx	Software Construction & Development	2-0
Cs2xx	Software Construction & Development -Lab	0-1
Cs2xx	Artificial Intelligence	2-0
Cs2xx	Artificial Intelligence Lab	0-1
Mt1xx	Linear Algebra	3-0
Ge2xx	Islamic Studies	2-0
Total		14-3

Junior

Semester - 5		
Code	Subject	Cr. Hr.
Cs3xx	Operating Systems	2-0
Cs3xx	Operating Systems Lab	0-1
Cs3xx	Software Quality Engineering	2-0
Cs3xx	Software Quality Engineering Lab	0-1
Cs3xx	Software Requirement Engineering	2-0
Cs3xx	Software Requirement Engineering Lab	0-1
Cs3xx	Domain Elective-1	2-0
Cs3xx	Domain Elective-1-Lab	0-1
Cs3xx	Domain Elective-2	2-0
Cs3xx	Domain Elective-2-Lab	0-1
Ge2xx	Social Science (Example: Psychology)	2-0
Total		12-5

Semester - 6		
Code	Subject	Cr. Hr.
Cs3xx	Software Project Management	2-0
Cs3xx	Software Project Management Lab	0-1
Cs3xx	Parallel & Distributed Computing	2-0
Cs3xx	Parallel & Distributed Computing Lab	0-1
Cs3xx	Domain Elective 3	2-0
Cs3xx	Domain Elective 3 Lab	0-1
Cs3xx	Domain Elective 4	2-0
Cs3xx	Domain Elective 4 Lab	0-1
Cs3xx	Domain Elective 5	2-0
Cs3xx	Domain Elective 5 Lab	0-1
Cs3xx	Domain Elective 6	2-0
Cs3xx	Domain Elective 6 Lab	0-1
Total		12-6

Senior

Semester - 7		
Code	Subject	Cr. Hr.
Cs4xx	Final Year Project – I	0-2
Cs4xx	Analysis of Algorithms	3-0
Cs4xx	Domain Elective 7	2-0
Cs4xx	Domain Elective 7 Lab	0-1
Ss1xx	Elective Supp Course (e.g. Intro to Marketing)	3-0
En4xx	Technical & Business Writing	3-0
Ge4xx	Entrepreneurship	2-0
Total		13-3

Semester - 8		
Code	Subject	Cr. Hr.
Cs4xx	Final Year Project – II	0-4
Ge4xx	Arts & Humanities (Professional Practices)	2-0
Ge4xx	Ideology and Constitution of Pakistan	2-0
Ge4xx	Civics and Community Engagement	2-0
Total		6-4

Total No of Credit Hours

136

Elective Courses BS(AI), BS(CS), BS(DS) and BS(SE)

- Data Warehousing and Data Mining
- Big Data Analytics
- Social Network Analysis
- Mobile Application Development
- Wireless Networks
- Telecommunication Systems
- System Modelling and Simulation
- Concepts of Internet of Things
- Digital Image Processing
- Computer Vision
- Computer Graphics
- Machine Learning
- Distributed Computing
- Mobile Computing
- Parallel Computing
- Object Oriented Software Development
- Software Quality Assurance
- Software Project Management
- Software Design and Testing
- Network Security
- Computer Forensics
- Introduction to Cryptography
- Introduction to Computer Security
- Natural Language Processing
- Speech Processing
- Data Mining
- Advanced Statistics
- Reinforcement Learning
- Theory of Automata
- HCI & Computer Graphics
- Fuzzy Systems
- Swarm Intelligence
- Agent Based Modeling
- Knowledge Based Systems
- Advanced Database Management Systems
- Big Data Analytics
- Artificial Neural Networks & Deep Learning
- Business Process Analysis

- Software Verification and Validation (Testing & QA)
- Object Oriented Analysis & Design
- Computer Architecture
- Theory of Automata
- HCI & Computer Graphics
- Web Technologies
- Advanced Database Management

Core Courses details are as follow:

Programming Fundamentals

Introduction to programming languages, Introduction to C++, C/C++ Programming Basics, Loops and Decisions, Structures, Pointers, Functions, Arrays and Strings.

Object Oriented Programming

Evolution of Object Oriented (OO) programming, OO concepts and principles, problem solving in OO paradigm, OO program design process, classes, methods, objects and encapsulation, constructors and destructors, operator and function overloading, virtual functions, derived classes, inheritance and polymorphism, I/O and file processing, exception handling.

Database Systems

Basic database concepts, Database approach vs file based system, database architecture, three level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub-queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Digital Logic Design

Number systems, Logical Analysis, Combinational Logic, Sequential Logic, Data Processing, manipulation, data storage, logic families and logic design, FPGAs, Hardware

description language like VERILOG.

Data Structures

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals.

Information Security

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Artificial Intelligence

Introduction (Introduction, basic component of AI, Identifying AI systems, branches of AI, etc.); Reasoning and Knowledge Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, First order Logic); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Constraint Satisfaction Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Learning (Unsupervised learning, Supervised learning, Reinforcement learning) ;Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems).

Computer Networks

Introduction to Computer Networks, Network Hardware, LAN, MAN, WAN, Inter Networks and the Internet, End Systems, Client and Servers, Connectionless and Connection Oriented Services, The Network Core: Circuit Switching and Packet Switching, Network Access and Physical Media, ISPs and Internet Backbones, Delay and Loss in Packet Switched Networks, Protocol Layering, Design Issues for Layers, Service Models. OSI Reference Model, Principles of Application-Layer Protocols, The Web and HTTP, FTP, DNS, WWW, Electronic Mail, Multimedia, Transport Layer Introduction, Transport Protocols, UDP, TCP/IP, Network Layer Introduction, Routing Algorithms, Congestion and Congestion Control Algorithms, QoS, Tunnelling, Inter-network Routing and Addressing, Introduction to MAC and Channel Allocation, MAC Protocols, Bridges, Spanning Tree, Remote Bridges, Repeaters, Hub, Bridges, Switches, Routers, and Gateways, Introduction to Data Link Layer, Framing, Error Control, Flow Control, Error Detection and Correction.

Software Engineering

Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioural models, model driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement.

Computer Organization & Assembly Language

Introduction to microprocessors and computers, System Buses, Internal Memory, External Memory, Input/Output, Interrupts, DMA/IO Channels, Computer Arithmetic, Addressing Modes, CPU Structure and Functions, Control

Unit Operations.

Operating Systems

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security.

Analysis of Algorithms

Proof techniques, Induction, Summations, basic algorithms on numbers, complexity classes, Searching and Sorting, Asymptotic analysis, Divide-and-conquer: merge-sort, closest pair problems, collaborative filtering, Karatsuba algorithm, deterministic Selection, Greedy algorithms: Huffman codes, Minimum Spanning Tree, Interval Scheduling Dynamic programming: Weighted Independent Set in Paths, Weighted Interval Scheduling, Knapsack Problem, Sequence Alignment, Single Source Shortest Paths (Bellman-Ford Algorithm), BFS, DFS, Topological Sort, Shortest paths, The Class P and NP, Decision, Optimization and Search problems, NP Complete Problems, Reduction, P vs NP Question, Ford Fulkerson Algorithm, Max Flow-Min Cut Algorithm, Edmond Karp Algorithm, Applications, Standard Form, Geometry of LP, Simplex Algorithm, Closest pair in linear-time, Universal and uniform hashing, Randomized Selection, Randomized Quicksort, Minimum Cut algorithm, Easy vs. hard problems, Approximation Algorithm with absolute approximation guarantees,

Hardness of Approximation, Relative Approximation Algorithm, Max Cut, Set Cover, Vertex Cover, Parallel machine scheduling, PTAS and FPTAS for Knapsack problem, Approximation algorithms for TSP LP- rounding based Approximation Algorithms.

Machine Learning

Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to: a) Present the basic machine learning concepts; b) Present a range of machine learning algorithms along with their strengths and weaknesses; c) Apply machine learning algorithms to solve problems of moderate complexity.

Artificial Neural Networks & Deep Learning

This course will introduce Artificial Neural Networks and Deep Learning. ANN's basic architecture and how they mimic the human brain using simple mathematical models. Many of the important concepts and techniques around brain computing and the major types of ANN will also be introduced. Emphasis is made on the mathematical models, understanding learning laws, selecting activation functions and how to train the networks to solve classification problems. Deep neural networks have achieved state of the art performance on several computer vision and speech recognition benchmarks. This course will further build on the fundamentals of Neural networks and artificial intelligence and will introduce advanced topics in neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning.

Knowledge Representation & Reasoning

Knowledge representation is one of the fundamental areas of Artificial Intelligence. It is the study of how knowledge about the world can be represented and manipulated in an automated way to enable agents to make intelligent decisions. This course will provide an overview of existing knowledge representation frameworks developed within AI including but not limited to

propositional and first-order logic, ontologies, planning, reasoning, and decision making under uncertainty. The assignments component of the course would provide hands-on experience of software like Prolog, Protégé, probabilistic reasoning APIs and tools to support complex decision making. It is expected that after completing this course, students will understand (a) the foundations of Knowledge Representation & Reasoning and (b) which tools and techniques are appropriate for which tasks.

Computer Vision

With a single glance a human interprets the entire scene. How many objects are present in the scene and where they are located. Which person is present in the scene. What will happen next. However, computers lack this capability. We have seen only face detectors so far working in our mobile phones. What is the challenge in understanding the 3D scene, i.e., the identity, the location and the size of the objects present in the scene. In this course we will introduce the basic concepts related to 3D scene modelling from single view and multiple views.

Application of ICT

Introduction to IT, Hardware, Computer Software, Internet and Web, Introduction to Data Communication and Computer Networks, Web Development, and Programming.

Discrete Structures

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals.

Theory of Automata

Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.

Compiler Construction

Introduction to interpreter and compiler. Compiler techniques and methodology; Organization of compilers; Lexical and syntax analysis; Parsing techniques. Types of parsers, top-down parsing, bottom-up parsing, Type checking, Semantic analyser, Object code generation and optimization, detection and recovery from errors.

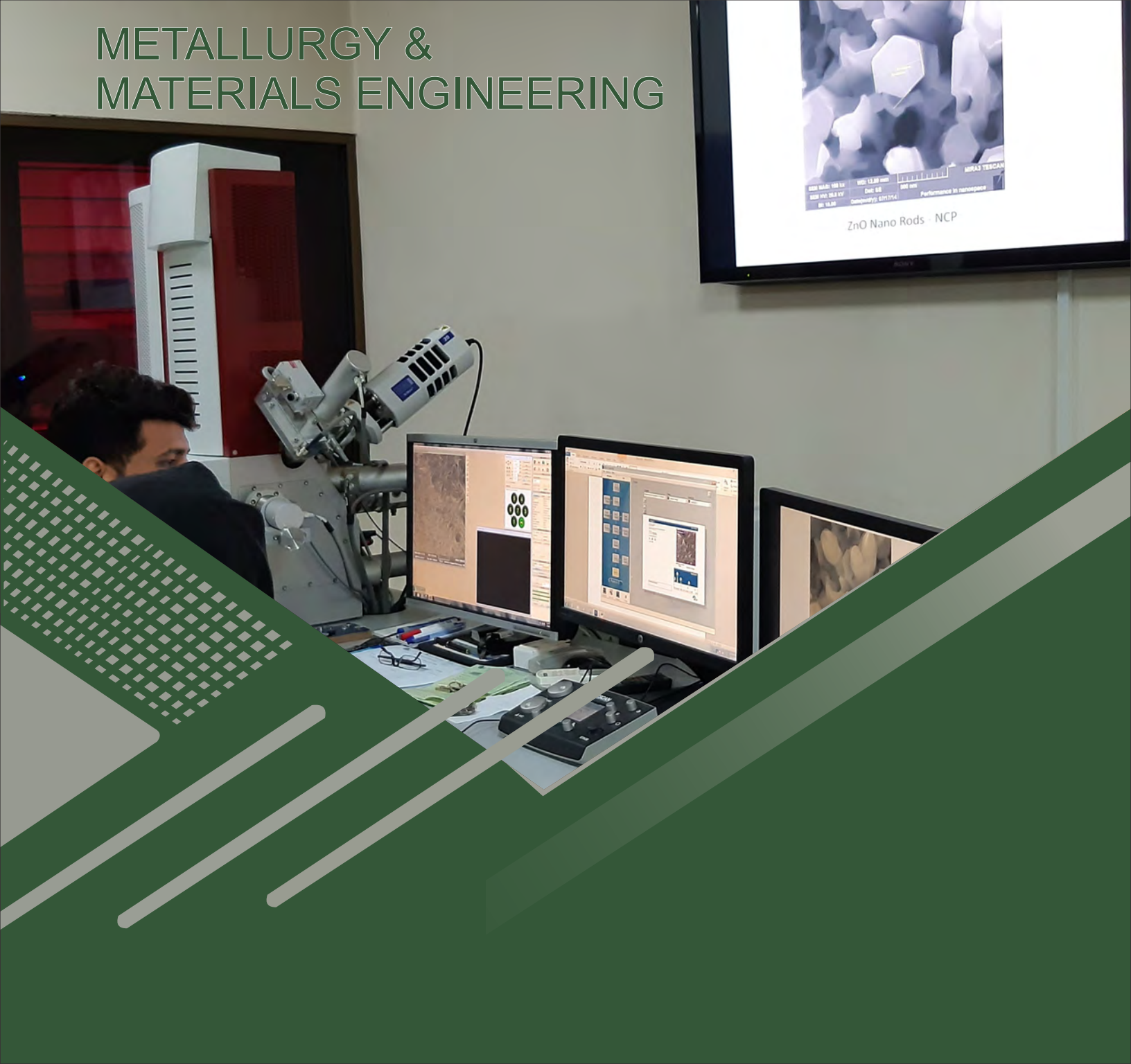
Parallel & Distributed Computing

Introduction, Parallel and Distributed Computing, Parallel and Distributed Architectures, Socket programming, Parallel Performance, Shared Memory and Threads, Parallel Algorithms, Parallel Algorithms, Open MP, Scalable Algorithms, Message Passing, Distributed Systems, Map Reduce, Clusters, Distributed Coordination, Security, Distributed File Systems, Security, Distributed Shared Memory, Peer-to-Peer, Cloud Computing.

Data Mining

Data mining is the process of searching and analyzing a large batch of raw data in order to identify patterns and extract useful information. Companies use data mining software to learn more about their customers. It can help them to develop more effective marketing strategies, increase sales, and decrease costs. Data mining relies on effective data collection, warehousing, and computer processing.

METALLURGY & MATERIALS ENGINEERING



Department of Metallurgy & Materials Engineering

Metallurgy & Materials Engineering play a decisive role in technological development and there is an unavoidable role of a materials engineer in almost all industrial and R & D setups - ranging from aerospace, hydrospace, and bullet trains to automobiles, metallurgical & manufacturing setups, nuclear as well as power plants, chemical and petrochemical industry, pharmaceutical and food processing industry, and many others.

The Department of Metallurgy & Materials Engineering is a hub of research and teaching, supported by state-of-the-art laboratories & equipment.

Courses are designed to impart the fundamental concepts on one hand and their specialized applications in metals and alloys, ceramics, polymers, and composites. Diversification in specialties is the strength of our faculty; energy harvesting and storage, micro/nano electronic devices, optoelectronics, bio-inspired nanostructured materials, coating materials and multifunctional materials, to name a few.

The Department is proud to uphold the tradition of strong linkage with the industry as well as with the R&D organizations, where a good percentage of our graduates serve.

Mission Statement

The Department of Metallurgy & Materials Engineering (M&ME) aims to serve the community by offering quality education and preparing engineering professionals capable of contributing through sustainable solutions with a focus on research, development, and innovation in Metallurgy and Materials Engineering and allied disciplines.

Program Educational Objectives

The M&ME program has the following objectives:

- Graduates would work as competent Metallurgy/Materials Engineers.
- Graduates would take initiatives and provide solutions for technological challenges, keeping in mind economic, environmental, and safety concerns.
- Graduates would be involved in continued professional development, effectively communicate, and will be aware of their ethical responsibilities as team members.



Program Learning Outcomes

The program has twelve learning outcomes. These relate to the aptitude, awareness and performance attributes that a student acquires during his studies and are the following:

i. Engineering Knowledge: Apply knowledge of mathematics, natural science, engineering fundamentals and Engineering specialization to the solution of complex engineering problems.

ii. Problem Analysis: Identify, formulate, conduct research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

iii. Design/Development of Solutions: An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

iv. Investigation: Conduct investigation of complex Engineering problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

v. Tool Usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex Engineering problems, with an understanding of the limitations.

vi. The Engineer and The World: Analyze and evaluate sustainable development impacts to society, the economy, sustainability, health and safety, legal frameworks, and the environment while solving complex engineering problems.

vii. Ethics: Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion.

viii. Individual and Collaborative Team Work: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings.

ix. Communication: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, and make effective presentations, taking into account cultural, language, and learning differences.

x. Project Management and Finance: Demonstrate knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.

xi. Life Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change



Freshman

Semester - 1		
Code	Subject	Cr. Hr.
111101	Introduction to Engineering Materials	3-0
123245	Calculus and Analytical Geometry	3-0
109203	Applications of ICT	2-0
109204	Applications of ICT Lab	0-1
300312	Functional English	3-0
117401	Applied Physics	3-0
300129	Islamic studies	2-0
117101	Introduction to Space Science	1-0
Total		17-1

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
214335	Materials Thermodynamics	3-0
xxxxxx	Statistical Methods	3-0
214203	Mechanics of materials	3-0
411116	Machine learning in Materials Engineering	1-0
411117	Machine learning in Materials Engineering	0-1
211221	Iron and Steel Making	3-0
114502	Workshop practice	0-1
211128	Materials Lab 1	0-1
Total		13-3

Semester - 2		
Code	Subject	Cr. Hr.
123216	Linear algebra & Differential Equations	3-0
	Programming Language	1-1
111510	Materials Chemistry	3-0
111219	Engineering Drawing	0-2
100102	Pakistan Studies	2-0
111220	Non-Ferrous Metallurgy	2-0
100229	Health, Safety and Environment	1-0
108160	Basic Electrical Engineering	2-0
108161	Basic Electrical Engineering Lab	0-1
Total		14-4

Semester - 4		
Code	Subject	Cr. Hr.
xxxxx	Humanities Elective	2-0
211210	Physical Metallurgy	3-0
211118	Mechanical Behavior of Materials	3-0
311408	Ceramics	3-0
211302	Polymers	2-0
300130	Civics and Community Engagement	2-0
211211	Powder Metallurgy	2-0
211184	Materials Lab 2	0-1
Total		17-1

Junior

Semester - 5		
Code	Subject	Cr. Hr.
311106	Inspection and Testing of Materials	3-0
311107	Composite Materials	2-0
411110	Nano Materials	3-0
323301	Numerical Analysis	3-0
311203	Heat Treatment and Phase Transformations	3-0
211185	Materials Lab 3	0-2
Total		14-2

Senior

Semester - 7		
Code	Subject	Cr. Hr.
400412	Business and Entrepreneurship	2-0
311108	Surface Engineering	3-0
	Engineering Elective-I	3-0
300438	Project Management	2-0
300132	Applied psychology	2-0
499901	Project design-I	0-3
311212	Foundry Engineering	2-0
311186	Materials Lab 5	0-1
Total		14-4

Semester - 6		
Code	Subject	Cr. Hr.
311208	Welding and joining	3-0
411113	Materials Characterization Techniques	3-0
311131	Corrosion and Materials Protection	3-0
300130	Expository Writing	3-0
311186	Materials Lab 4	0-2
Total		12-2

Semester - 8		
Code	Subject	Cr. Hr.
411111	Computational Tools in Materials	1-1
xxxxxx	Engineering Elective-II	3-0
xxxxxx	Engineering Elective-III	3-0
411136	Biomaterials	3-0
411112	Electronic, Magnetic and Optical Materials Eng	2-0
411207	Manufacturing processes	2-0
499902	Project design-II	0-3
Total		14-4

Total No of Credit Hours

135

Engineering Subjects (Mandatory Courses)

Probability Methods in Engineering

Functional English* (3-0)

This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking, and everyday conversation, ensuring that students are equipped for both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.

Communication Skills (2-0)

Communication Skills is designed to enhance students abilities to communicate effectively in professional and academic settings. The course covers various aspects of communication including writing, reading, listening, and speaking skills. Students learn techniques for improving vocabulary, writing essays and letters, critical reading, active listening, verbal and non-verbal communication, and presentation strategies. Emphasis is placed on developing effective communication skills essential for job interviews and successful interactions in the workplace.

Expository Writing* (3-0)

Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation of the pre-requisite course, Functional English, this course will enhance students' abilities of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.

Civics and Community Engagement* (2-0)

This course is designed to provide students with fundamental knowledge about civics, citizenship, and community engagement. In this course, the students will learn about the essentials of civil society, government, civic responsibilities, inclusivity, and effective ways to participate in shaping the society which will help them apply theoretical knowledge to the real-world situations to make a positive impact on their communities.

Islamic Studies *(2-0)

This course is designed to provide students with a comprehensive overview of the fundamental aspects of Islam, its beliefs, practices, history and influence on society. It will further familiarize students with a solid foundation in understanding the religion of Islam from an academic and cultural perspective. Through this course, students will have an enhanced understanding of Islam's multifaceted dimensions which will enable them to navigate complex discussions about Islam's historical and contemporary role, fostering empathy, respect, and informed dialogue.

Pakistan Studies (2-0)

This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistani citizens to enable them function in a socially responsible manner.

Applied Psychology (2-0) (Elective)

This course provides an essential foundation in psychological principles tailored to the needs of engineering students. The course explores the scientific and historical contexts of psychology, the biological bases of behavior, and the intricate processes of sensation, perception, learning, memory, cognition, and language. It also covers intelligence, creativity, motivation, emotion, personality, and social psychology, with a focus on practical applications in engineering contexts. Through this course, students will gain insights into human behavior that enhance their professional and interpersonal skills in the field of mechatronics engineering.

Project Management* (2-0)

The primary objective of this course is to get the fair understanding of core issues pertaining to Engineering Project Management. This course is aimed at providing both basic and some advanced exposure to emerging trends in the field of Project Management, so as to enable the engineering professionals of tomorrow to successfully complete sophisticated projects within the constraints of capital, time, and other resources with due regards to stakeholders set of expectations. Engineering students will learn key Project Management skills and strategies and will be able to face emerging challenges.

Business & Entrepreneurship (2-0)

This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge; skills and abilities, enabling them to seize the identified opportunities for initiating ventures and successfully navigating the challenges that come with starting business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business (including requirements for registration and incorporation with regulators such as SECP and others), market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation. Overall, the course is geared towards personal growth and professional development for pursuing innovative ideas, availing opportunities and initiating start-ups.

Calculus (3-0)

Calculus and Analytical Geometry" provides students with a comprehensive understanding of mathematical concepts essential for engineering applications. Topics covered include vectors, functions, limits, continuity, derivatives, integrals, sequences, series, and Taylor series. Emphasis is placed on analytical techniques, problem-solving skills, and their practical applications in engineering.

Differential Equations (3-0)

This course provides students with understanding of convergence test, boundary conditions, linear differential equations, Cauchy's and Legendre's equations, equations of second order, simultaneous equations,, numerical approximation, orthogonal trajectories, partial differential equations, shifting theorems, Heaveside's expansion formula, zeros and poles, Cauchy's-Reimann equations, conformal transformation, counter integration.

Numerical Analysis (3-0)

This course enable the student to understand error analysis, roots of transcendental equations, linear iteration method, Newton method, Regula Falsi method, bisection method, nonlinear simultaneous equations, modified Newton method, finite differences, solution of linear simultaneous equations, Jacobi and LU factorization methods, method of least square, Gregory Newton forward & backward difference formula, Stirling, Lagrange interpolation, divided difference interpolating polynomial, numerical differentiation, numerical integration, ordinary and partial differential equations, Taylor Series method, Heun's Method, Runge Kutta method, solution of one-dimensional heat equation Crank-Nicolson method.

Statistical Methods (3-0)

This course enables the student to understand the concepts of random variables, presentation of data, measurement of central tendency & dispersion, elements of probability & statistics, probability distribution function, probability, correlations.

Applied Physics (2-0)

Applied Physics introduces fundamental principles of physics and their practical applications. Topics include vectors, mechanics, electrostatics, magnetism, semiconductor physics, waves and oscillations, optics and lasers, and modern physics concepts. The course integrates theory with hands-on laboratory sessions to reinforce understanding and application of physical principles in engineering systems.

Material Chemistry (2-0)

This course provides students with an essential foundation in chemistry that is tailored to their field of metallurgical and materials engineering. The course primarily focuses on relevant principles and applications. The students will gain an understanding of the applications of materials chemistry in a wide range of fields, such as metal extraction,

corrosion prevention, polymer synthesis, energy conversion and storage, biomedical devices, electronics and optoelectronics.

Applications of ICT (2-1)

This course is designed to provide students with an exploration of the practical applications of Information and Communication Technologies (ICT) and software tools in various domains. Students will gain hands-on experience with a range of software applications, learning how to leverage ICT to solve daily life problems, enhance productivity and innovate in different fields. Through individual and interactive exercises and discussions, students will develop proficiency in utilizing software for communication, creativity, and more.

Machine Learning in Materials Engineering (1-1)

In recent years, machine learning has revolutionized the way materials are designed, discovered, characterized, and optimized. In this course, students will learn how machine learning techniques can be applied to materials engineering such as predicting material properties, analyzing materials data, and designing materials.

Instrumentation and Control (2-0)

This multi-disciplinary course will cover the principles, techniques, and industrial applications of instrumentation and control systems. The students will learn different measurement systems, industrial automation, and practical applications.

Engineering Drawing (0-2)

This lab course introduces various ways to describe engineering components and assemblies with the help of various forms of drawing and projections. Students will also learn use of software's for drawing as well as development of 2D and 3D models.

Corrosion and Materials Protection (3-0)

This course entails description of corrosion mechanisms, types, and prevention strategies. Starting with the fundamentals of corrosion science, the course progresses to include electrochemical reactions, environmental effects, and degradation processes. Additionally, various corrosion prevention and protection techniques will be explored.

Welding & Joining of Materials (3-0)

This is a specialized course that discusses various methods and techniques used to effectively join different materials. This multidisciplinary course emphasizes the understanding of fundamental principles, practical applications, and advanced trends in joining processes. Starting with traditional joining methods such as welding, brazing, and soldering, students will also learn modern joining processes.

Foundry Engineering (2-0)

This course provides a thorough understanding of the principles, techniques, and applications of various foundry processes. The students will also learn course various foundry processes starting from raw material preparation to finished product inspection.

Electronic, Magnetic, and Optical Materials (2-0)

This course provides a detailed understanding of the basic principles governing the behavior of materials with specific physical properties such as electronic, magnetic, and optical properties. It explores the complex relationships existing between the atomic, electronic and crystal structure of materials and their macroscopic properties. The special emphasis will be on the applications of these materials in different industries.

Biomaterials (3-0)

Biomaterial is an interesting and an emerging field that combines materials science, biology, engineering, and medicine. In this course, students will learn about the development, characterization, and application of

materials used in implants, medical devices, tissue engineering, and drug delivery systems.

Mechanical Behavior of Materials (3-0)

This course builds on the knowledge students already have about the mechanical behavior of engineering materials. Here, the emphasis will be on the elastic and plastic behaviors of different materials as well as on their fracture mechanics. The students will study in detail the mechanisms of elastic and plastic deformation. Additionally, students will learn how different materials may perform in a given situation. As a result, they will be able to select the best material for a particular application.

**Surface Engineering (3-0)**

This course focuses on exploring the surface properties of materials and improving them to enhance material performance. The students will learn various aspects of surface modification, improving appearance, hardness, wear resistance, corrosion resistance, and tribological properties.

Nanomaterials (3-0)

In this course, students will study the behavior of materials at the nanoscale. This multi-disciplinary course integrates principles of physics, chemistry, biology, and engineering to achieve special properties. Emerging applications of nanomaterials will also be discussed.

Basic Electrical Engineering (2-1)

This inter-disciplinary course typically introduces the fundamental principles of electricity and circuits to the undergraduate students of metallurgical and materials engineering. This course also highlights how electrical engineering principles play a crucial role in understanding and manipulating materials for various electrical applications.

Occupational Health and Safety (1-0)

This course introduces the student to the study of workplace occupational health and safety. The student will learn safe work practices in offices, industry and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home.

**Workshop Practice (0-1)**

Workshop Practice is a foundational course designed for undergraduate students pursuing bsc in Metallurgical and Materials Engineering. This course provides hands-on experience and practical skills development in various workshops. The course will provide students with a solid foundation in machining, fitting and fabrication, carpentry, and electrical wiring through extensive practical exercises.

Introduction to Engineering Materials (3-0)

The course introduces the basics of Materials Engineering to the students. The course focuses on types of materials, their scope and role in industrial development. Students will learn about atomic bonding, crystal structures and their relation to properties of materials. The relationship between structure, processing, properties, and applications of various materials will be emphasized.

Materials Thermodynamics (3-0)

In this course, the students will learn the fundamental Laws of thermodynamics and how they influence the behavior of materials at the micro and macro scale. The students will learn the concept of work, heat, enthalpy and entropy. The concept of free energy and equilibrium will be introduced. Solving thermodynamic problems using various laws and rules will be discussed. Application of theories to single-component solutions, multi-component solutions will be highlighted. The role of thermodynamic concepts in electrochemistry will be presented.



Mechanics of Materials (3-0)

This course provides a fundamental understanding of the behavior of solid materials under various types of loading conditions. The students will develop an understanding of the fundamental concepts of mechanics of materials and their applications. The course discusses the principles related to elasticity, plasticity, and the failure of materials, including fracture, fatigue, and creep.

Inspection and Testing of Materials (3-0)

In this course, the students will learn to perform and interpret the results of destructive & non-destructive testing of materials as per renowned international standards. The special emphasis will be on hardness, tensile, compression, torsion, bending, impact, creep, and fatigue testing. Additionally, different non-destructive testing techniques will also be discussed in detail. The students will learn how to ensure the quality of the material to meet the specific industrial requirement.

Physical Metallurgy (3-0)

The course primarily focusses on the knowledge that links the structure of materials with their properties. The role of processing in developing various types of structures will be discussed. This understanding will also help in alloy designing for various applications and interpreting the behavior of materials under different conditions.

Manufacturing Processes (2-0)

The course aims to build theoretical knowledge in students about various manufacturing processes commercially carried out by industries. This knowledge will help in understanding how the properties of the materials affect the selection of specific manufacturing operation to produce the quality product to meet the service conditions.

Iron and Steel Making (3-0)

The course is intended to impart to the students a basic understanding of the contemporary iron and steel making routes, raw materials for iron and steel making and their characterization. The environmental impacts of iron and steelmaking will also be discussed. Additionally, the students will also study the latest developments in this field such as green steel production.

Polymers (2-0)

This course provides an overview of the structure, properties, and applications of polymeric and composite materials. The discussion will consider the needs of society and industry. The students will learn about various properties (such as thermal, rheological, and mechanical), processing and characterization of such materials.

Composite Materials (2-0)

This course provides an overview of the structure, properties, and applications of composite materials. The discussion will consider the needs of society and industry. The students will learn about various properties (such as thermal, rheological, and mechanical), processing and characterization of such materials.

Ceramics (3-0)

This course provides an overview of the structure, properties, manufacturing, and design of traditional and advanced ceramics. Different characterization techniques commonly used to evaluate the performance and properties of ceramics will also be discussed. Additionally, new approaches to enhance fracture toughness of ceramics will be presented.

Materials Characterization Techniques (3-0)

The course deals with studying the structure of materials at both micro and macro level using various types of microscopes and diffraction methods. Various techniques used for the determination of chemical

nature and composition of various materials will be taught. Methods to evaluate various physical and chemical properties of materials will be presented.

Non-Ferrous Metallurgy (2-0)

The course focusses on extraction and production of non-ferrous metals from different ores and scrap. The environmental impacts of non-ferrous metals production will be presented. The course also discusses the general classification, properties, physical metallurgy, and applications of important non-ferrous metals and alloys.

Heat Treatment and Phase Transformations (3-0)

The course presents the principles of thermodynamics and kinetics of phase transformation. These principles are used to understand various types of transformations during different heat treatments. Additionally, the effect of different heat treatment processes on the mechanical properties of the alloys will be presented. The role of composition, time, and temperature of transformation on the evolution of different microstructures will be taught.

Powder Metallurgy (2-0)

This course provides a deep understanding of the principles, processes, materials, and applications involved in the production and utilization of powdered materials. Powder metallurgy (PM) is a manufacturing process that enables the production of complex-shaped components with required properties. This makes PM an important technology in various industries including aerospace, automotive, electronics, biomedical, and other industrial applications.

Computational Tools in Materials Science (1-1)

This course introduces the basic concepts, techniques, and applications of computational methods in materials engineering. The students will learn about different modelling and simulation tools to predict the behavior of materials at different length scales.

Final Year Design Project (FYDP) I & II (6-0)

Project identification, objective of project, subsystems & requirements, project feasibility, presentation, preliminary design, gap analysis, project execution.

Electives Courses

Aerospace Materials (3-0)

This course covers space environments, requirements of materials for aerospace applications, Materials to sustain vacuum, high temperature, high temperature gradients and high energy radiation, Ruggedization and surface modification of aerospace components, Principles of materials selection, Ablative material, non-destructive evaluation (NDE) of aerospace components, Case studies on failure analysis of aerospace components

High Temperature Materials (3-0)

This course covers different high temperature materials and their applications with a focus on the challenges associated with elevated temperature environments. The mechanical and chemical properties of high temperature materials and their design aspects will be discussed.

Nuclear Materials (3-0)

This course starts with a detailed introduction to nuclear energy and the principles of nuclear fission reactions as well as different nuclear fission reactors. Nuclear fuel materials, structural materials, moderators, reflectors, blankets, control elements, coolants, and shielding materials will also be covered in this course. Throughout the course, special attention will be given to understand the effects of radiations on materials mechanical, thermal, and corrosion properties.

Fracture Mechanics and Failure Analysis (3-0)

This course provides an in-depth analysis of fracture mechanics, and covers topics such as fracture and failure mechanisms, testing methods, and failure analysis techniques. Griffith's and Orowan's theories, as

well as linear elastic and elastoplastic fracture mechanics will also be discussed. Students will also learn about the fracture toughness testing of composite materials.

Functional Materials (3-0)

This course explains the structure-property relationship existing in functional materials. Students will learn about a wide range of functional materials and analyze their electrical, thermal, optical, magnetic, and biological properties. The course will conclude with the discussion on challenges associated with the synthesis of functional materials.

Extractive Metallurgy (3-0)

Along with a thorough review of thermodynamic principles of metal extraction, the course offers a detailed explanation of the common extraction methods like hydrometallurgy, electrometallurgy, and pyrometallurgy. The course will especially focus on the extraction of different metals (non-ferrous) from oxide, sulfide, and halide sources. Course will conclude with the discussion on the environmental impacts of different extraction processes and approaches to sustainable production of different metals.

Vacuum and Thin Films Technology (3-0)

This course provides a detailed introduction to thin-film technology, focusing on different deposition techniques and their applications. The course will address the tribological, mechanical and functional properties of different thin film coatings. The discussion on the real-world uses of thin-film materials and deposition methods will conclude the course.

Note: Elective subjects are offered depending upon the availability of faculty and the number of students interested in each course.

Bachelor of Science in Biotechnology

Choosing a career in biotechnology offers a unique interdisciplinary blend of biology, chemistry, mathematics, and physics. The field presents exciting research projects and diverse career opportunities in both the scientific and administrative sectors. Graduates with a biotechnology degree can contribute to building innovative technologies for agriculture, healthcare, medicine, industrial processes, and environmental management. Beyond its intellectual stimulation, a career in biotechnology is financially rewarding. The spectrum of interdisciplinary areas of specialization within the field allows individuals to explore and find fulfilling roles for the betterment of society.

The program of biotechnology is a hub of research and teaching, supported by state-of-the-art laboratories & equipment.

Scope of Biotechnology

The scope of biotechnology extends far beyond traditional boundaries, providing employment possibilities in unexpected industries such as textiles, food, business, and judicial sectors. Graduates from the IST BS Biotechnology find diverse job opportunities. The field has expanded to include roles as forensic science technicians, medical scientists, microbiologists, environmental biotechnologists, geneticists, molecular biotechnologists, epidemiologists, R&D scientists, biochemists, biophysicists, bio-manufacturing specialists, and bioproduction specialists. This broad range of options ensures that individuals can pursue strong-standing careers tailored to their interests and skills. Graduates from the BioSpaceTech Integration Program will be well-equipped for careers in:

- Space agencies and research institutions
- Biotechnology companies

- Astrobiology research
- Healthcare and pharmaceutical industries supporting space exploration.

This interdisciplinary program will prepare students to tackle the challenges of future space exploration by leveraging the principles and applications of biotechnology. It will contribute to the broader goal of advancing human presence in space while also pushing the boundaries of biological sciences.

Future of Biotechnology

Biotechnology stands out as one of the most captivating industries, offering both substantial returns for investors and long-term career prospects. The sector encompasses a wide range of roles, from manufacturing and development to regulatory and commercial release. As the industry evolves, the demand for biotechnologists is set to increase, especially with the ongoing challenges posed by serious diseases and pandemics. The global population exceeding 9 million people necessitates advancements in agricultural technologies, further emphasizing biotechnology's critical role. Beyond its societal impact, biotechnology significantly contributes to the economy, making it a key player in shaping the future. Overall, the field is poised to play a pivotal role in addressing global challenges and driving innovation in the years to come. Engineering program is geared primarily towards industry as well as academia. The program is proud to uphold the tradition of strong linkage with the industry as well as with the R&D organizations, where a good percentage of our graduates serve.

Mission Statement

"The Biotechnology program endeavors to foster future leaders in research, academia, and industry with a specialized undergraduate curriculum. Our focus on cutting-edge research aligns with the evolving needs of society, integrating principles that resonate with space technology, thereby advancing scientific exploration, entrepreneurship, and societal well-being."

Program Educational Objectives

The objectives of the Biotechnology program are to empower our students to engage in critical thinking, rationalize information, and effectively apply acquired knowledge. Our aim is to equip them with the skills to formulate remedial strategies for addressing health, agricultural, industrial, and environmental challenges through the application of biotechnological techniques.

PEO-1: The graduates will contribute competently to the industry related to biotechnology by applying requisite technical skills.

PEO-2: The graduates will demonstrate advancement in their profession by enhancing their knowledge and skills in their relevant field.

PEO-3: The graduates will demonstrate commitment to ethical values and contribute positively towards society.

Program Learning Outcomes

The program has twelve learning outcomes. These relate to the aptitude, awareness and performance attributes that a student acquires during his studies and are the following:

- i. **Knowledge:** An ability to apply fundamental and specialized knowledge of biotechnology to the solution of complex biotechnological problems.
- ii. **Hypothesis Formulation :** An ability to identify,

formulate, research literature, analyze complex biotechnology problems, reaching substantiated conclusions towards formulation of hypothesis using fundamental principles of biotechnology

iii. **Experiment/Process Design:** An ability to design experimental solutions to validate biotechnology Hypothesis and design process while maintaining biotechnology standards, cultural, societal, and environmental considerations

iv. **Investigation:** An ability to investigate complex issues in biotechnology in a methodical way including literature survey, and development of systems, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions

v. **Modern Tool Usage:** An ability to select and apply appropriate techniques, resources, and modern tools, including prediction and modeling, to complex biotechnology activities, with an understanding of the limitations.

vi. **Impact Analysis:** An ability to apply reasoning informed by contextual knowledge to assess societal, legal and cultural issues and the consequent responsibilities relevant to professional biotechnology practice and solution to complex biotechnology problems.

vii. **Management Skills:** An ability to demonstrate management skills and apply biotechnology principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

viii. **Team Work:** An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

ix. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of

biotechnology practice.

x. **Communication:** An ability to communicate effectively, orally as well as in writing, on complex biotechnology activities with the biotechnology community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

xi. **Project Management:** An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

xi. **Life Long Learning:** An ability to recognize the importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
	Pakistan Studies	2-0
	Quantitative Reasoning	3-0
	Space Science	3-0
	Biodiversity	2-1
	Intro to biology and biotechnology	2-1
Total		14-2

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
	Creative writing and critical evaluation	3-0
	Animal biotechnology	3-0
	Organic chemistry	2-1
	Psychology	3-0
	Biochemistry I	2-1
	Molecular biology	2-1
Total		14-4

Semester - 2		
Code	Subject	Cr. Hr.
	Communication skills	3-0
	Religious studies	2-0
	Biostatistics	2-0
	Materials Science	2-1
	Animal husbandry and diversity	3-0
	Cell biology	2-1
Total		12-2

Semester - 4		
Code	Subject	Cr. Hr.
	Technical writing	3-0
	Nanobiotechnology	3-0
	Sociology	3-0
	Analytical Chemistry & Instrumentation	2-1
	Biochemistry II	2-1
	Human genetics	2-1
Total		14-4

Junior

Senior

Semester - 5		
Code	Subject	Cr. Hr.
	Bioinformatics	0-2
	Immunology	3-0
	Cell Signalling and Communication	3-0
	Microbiology and Virology	2-1
	Cell and Tissue Culture	2-1
	Biomaterials	3-0
Total		17-1

Semester - 7		
Code	Subject	Cr. Hr.
	Plant Biotechnology	2-1
	Recombinant DNA Technology	2-0
	Civics and Community Engagement	2-0
	Metabolomics, Proteomics, and Genomics	1-1
	Elective II	3-0
	Elective III	3-0
	FYP-1	0-3
Total		13-3

Semester - 6		
Code	Subject	Cr. Hr.
	Vaccinology	1-1
	Microbial and fermentation Biotechnology	1-1
	Synthetic Biology	3-0
	Health and Food Biotechnology	2-0
	Agriculture Biotechnology	2-0
	Elective I	3-0
	Entrepreneurship	2-0
Total		14-4

Semester - 8		
Code	Subject	Cr. Hr.
	Applications of ICT	3-0
	Industrial biotechnology	2-0
	Principles of Biochemical Engineering	2-0
	Biosafety & bioethics	1-0
	Elective IV	3-0
	Internship	0-3
Total		17-1

Total No of Credit Hours

135

Mandatory Subjects

Cell Biology

Introduction to cell theory, structure, chemical constituents of cell and cell organelles and their functions, separation of cell organelles, Cell membrane, its molecular organization and functional role, The concept of the unit membrane, the fluid mosaic model, membrane receptors and transport mechanisms. Endoplasmic Reticulum. Lysosome, Micro-bodies, Mitochondrial ultra structure and function, Chloroplast ultra structure and the mechanism of photosynthesis, Cell movements, structure and function of cytoskeleton, centriole, cilia and flagella, the mitotic apparatus, The nucleus, structure and function of chromosomes, the cell cycle, mitosis, meiosis.

Introduction to biology and biotechnology

Biotechnology-definition and history; old biotechnology, beginning of modern biotechnology and interdisciplinary pursuit; branches and/or applications of biotechnology in medicine, agriculture, environment, forensic, (food, livestock, fisheries, algae, fungi, etc.); protection of biotechnological products; safety in biotechnology; public perception of biotechnology; biotechnology and ethics; biotechnology and the developing world.

Biodiversity

Introduction to Biodiversity, Biodiversity Patterns and Distribution, Biodiversity Measurement and Assessment, Biodiversity Conservation Strategies, Threats to Biodiversity, Ecosystem Services Provided by Biodiversity, Conservation Biology, Case Studies in Biodiversity Conservation, Biodiversity Monitoring and Citizen Science, Policy and Governance in Biodiversity Conservation, Economic Valuation of Biodiversity.

Organic Chemistry

Introduction to Organic Chemistry Organic chemistry-the chemistry of carbon compounds; the nature of organic chemistry-a historical perspective. Chemical Bonding and

Properties of Organic Molecules Localized and delocalized chemical bonding; concept of hybridization leading to bond angles, bond lengths, bond energies and shape of organic molecules; dipole moment; inductive and field effects; resonance; aromaticity; tautomerism; hyperconjugation; hydrogen bonding; acids and bases; factors affecting the strengths of acids and bases. Classes and Nomenclature of Organic Compounds Classification of organic compounds; development of systematic nomenclature of organic compounds; IUPAC nomenclature of hydrocarbons and heteroatom functional groups. Functional Group Chemistry A brief introduction to the chemistry of hydrocarbons, alkyl halides, alcohols, phenols, ethers, aldehydes, ketones, amines, and carboxylic acids and their derivatives.

Microbiology and Virology

Introduction and scope of Microbiology, Historical foundations of Microbiology, General characteristics of Microbes, methods of Microbiology, bacterial forms and ultrastructure, microbial nutrition, cultivation, reproduction and growth, Metabolic characteristics, symbiotic relationships, taxonomy, classification, nomenclature of microorganism/bacteria. Physical and chemical control of microbes. Role of microbes in industry, agriculture, health, basic research and environment.

Biochemistry-I

Introduction to biochemistry, amino acids and proteins, general functions, classification, primary, secondary, tertiary and quaternary structure, Fibrous and globular proteins, Protein stability, Protein folding. Enzyme nomenclature and classification, co-factors and co-enzymes, general characteristics of enzymatic reactions. Enzyme kinetics. Classification of carbohydrates, structure and functions of mono, oligo and polysaccharides, sugar derivatives, Structural polysaccharides, storage polysaccharides, Structure and function of bacterial cell-walls. Classification, structure, properties and functions of

different types of lipids, fatty acids, triglycerides, glycerophospholipids, sphingolipids, cholesterol, Micelles, bilayers and liposomes. Properties and functions of lipoproteins, Fat and water soluble vitamins, Structural and functional aspects of nucleic acids, Chemical structures of nucleotides, nucleosides and bases.

Biochemistry-II

Amino acid deamination mechanisms, urea cycle and its regulation, biosynthesis and degradation of essential and non-essential amino acids, RNAs and their role in protein synthesis, transcription and translational processes, Chemical nature, synthesis and degradation of purine and pyrimidine nucleotides, Glycolytic pathway and its significance, fermentation, Glycogen breakdown and synthesis pathways. Citric acid cycle, mechanism of electron transport chain, oxidative phosphorylation and regulation of ATP production, gluconeogenesis, pentose phosphate pathway, Properties and functions of lipoproteins, fatty acid oxidation, fatty acid and triglyceride synthesis, Ketone bodies, utilization of cholesterol, Prostaglandins, prostacyclins, thromboxanes and leukotrienes.

Analytical Chemistry & Instrumentation

General methods of fractionation and characterization of proteins and nucleic acids, dialysis, ultrafiltration, lyophilisation, principles and application of visible, UV, IR, mass spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR), flame photometry, atomic absorption, fluorescence spectroscopy, Chromatographic techniques (thin layer, adsorption, partition, ion-exchange, hydrophobic and affinity), Chromatofocusing, native and SDS-PAGE, isoelectric focusing, agarose gel electrophoresis, immunoelectrophoresis. Radioisotopes and their applications in molecular and biomedical sciences, Amino acid analyzer, thermal cycler (PCR), DNA sequencer, Protein/DNA microarray.

Immunology

Body defense mechanisms, the immune system, elements of innate and acquired immunity, antibody structure and function, antigen-antibody interactions, cells of the immune system, monoclonal antibodies, Genetics of antibody structure and diversity, Activation and function of T and B cells and their receptors, Major histocompatibility complex, Complement system, Hypersensitivity, cytokines, Autoimmunity, resistance and immunity to infectious diseases, Immunochemical techniques.

Biostatistics

Definition of statistics, characteristics, importance and limitations, population and samples, Frequency distribution and probabilities, formation of frequency table from raw data, histograms, Applications of probabilities to simple events, Measures of central tendencies and dispersion, Arithmetic mean, median, mode, range, variance and standard deviation, standard error of the mean, mean deviation, semi interquartiles range. Standard distribution (Binomial, poisson and normal distributions, properties and application, Normality), Test of significance (t-test, X²-test, F-test, L.S.D. test, multiple range test), Design of experiment: Brief account of correlation and regression, Computer based statistical software applications.

Recombinant DNA Technology

Introduction and History of Recombinant DNA technology, Basic techniques, gel electrophoresis, Blotting techniques, restriction endonucleases, restriction mapping, vectors and their types, cloning vectors, transformations, Polymerase Chain reaction, Cloning strategies, Site-directed mutagenesis. Sequencing strategies, Application of recombinant DNA Technology (agriculture, health, industry, environment and basic research).

Animal Biotechnology

Introduction and history of transgenic animals, Role of

synthetic peptides/protein in animal health, Use of monoclonal antibodies as a diagnostic/therapeutic agents, Cytokines and their potential therapeutic value, Application to diagnosis of microbial infection and to genotype analysis, The micromanipulations of farm animal embryos, The incorporation of biotechnological techniques in animal breeding strategies, Gene transfer through embryo microinjection, Ethical and social issues in animal biotechnology.

Microbial and Fermentation Biotechnology

Issues and scope of microbial biotechnology, genetically modified microorganisms, microbes as tools for microbiological research, Biotechnological potential of microbes, significance of microorganisms in food production and fermentation, pharmaceutical and other industrial products, Vaccine development and production, biofertilizers, composting, microbiological mining, biofuels, use of microbes in petroleum industry, Microbial role in regulatory mechanism of plant, Significance of microbial biotechnology in economic development of Pakistan.

Proteomic, Genomics and Metabolomics

Structural genomics, Organization and Structure of the Genomes, Genetic Mapping, Transcript Mapping, Structural Variation in the Genomes, Genomics and proteomics, Molecular Biology of Proteins, Posttranslational modifications, Molecular mechanisms of cellular communication/signaling pathways, Protein-Protein Interactions, receptor identification and characterization, Integral Membrane Proteins and Ion Channels, Advance techniques used in proteomics (MS, LCMS/MS, ICAT, iTRAQ). Introduction to Metabolomics, detection, profiling, analysis and engineering. Microarray and RNA interference.

Nanobiotechnology

A brief introduction to Nanotechnology, Interface between Nanotechnology and Bionanotechnology, Manipulating

molecules, Carbon Fullerene, Carbon Nanotubes, Non-Carbon Nanotubes and Fullerene like materials, Quantum Dots and other Nano-particles, Nano-wires, Nano rods and other Nanomaterials, Magnetic Nanoparticles. Natural Biological assembly at Nano-Scale, Nanometric biological assemblies (complexes), Nanobionics and Bio-Inspired Nanotechnology, Applications of biological assemblies in Nanotechnology, Medical, Cosmetics, Agriculture, water and other applications of Nanobionanotechnology, Future prospect of Nanobiotechnology.

Bioinformatics

Introduction to computer hardware and software, computer applications for biotechnologists, Spreadsheet work, Word processing; Graphical and Statistical analysis packages. Biocomputing (Introduction to String Matching Algorithms, Database Search Techniques, Sequence Comparison and Alignment Techniques, Use of Biochemical Scoring Matrices, Introduction to Graph Matching Algorithms, Genome Comparison, Prediction and its Implication). Introduction to Bioinformatics, its Definition and History, Introduction to Data Mining and its Application, Database Hierarchies, Genomic and Proteomic Sequence Database and their Interpretation (UCSC Genome Database, NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc). Bioinformatics Tools: Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip.

Agricultural Biotechnology

The concepts of Plant Molecular Markers, Historical Background of Tissue Culture, Requirements for in-vitro cultures, Role of Phyto-hormones in somatic embryogenesis, Types of Cultures: Tissue culture and regeneration, Cell culture, Haploid Culture, Protoplast

culture. Somaclonal variations as breeding tool, Somatic Hybridization, Commercial application and Issues related to tissue culture, Plant Transformation; Gene Gun Method of Transformation, Agrobacterium-Mediated transformation, Chloroplast Transformation, PEG mediated transformation etc, Field Evaluation and Commercialization, Transgenic crops for Herbicide, Biotic and Abiotic stress resistance, Introduction to Biofertilizers. Biosafety Concerns and Bioethics on GM crops.

Molecular Biology-1

Overview of Molecular Biology, Logic of Molecular Biology, Prokaryotes and Eukaryotes, bacteria, Bacteriophage, yeasts, Animal cell, Animal & plant viruses, Genetic Analysis of Molecular Biology, Macromolecules, chemical structures of the major classes of Macromolecules: Proteins, Nucleic Acids, Polysaccharides, Nucleic Acids, DNA Helix, Form of DNA Helix, Factor that determine structure of DNA, properties of Genetic Material (storage and Transmission of Genetic information by DNA). Transmission of information from parent to progeny, chemical stability of DNA, Ability of DNA to change, DNA Replication, Enzymology of DNA Replication. Events in the Replication Fork, Initiation of synthesis of Leading and lagging strands, Okazaki fragments, importance of 3' 5' and 5' 3' Exonuclease activities of DNA polymerase, Rolling circular Replication, Loop Rolling circular Replication, Difference between Prokaryotic and Eukaryotic Replication, DNA Repair.

Cell and Tissue Culture

Cell and Plant Tissue culture, Introduction, history and importance, Methods of cell and tissue culture, callus culture, organogenesis, somatic embryogenesis, protoplast isolation and fusion, anther and pollen culture Micropropagation, improvement of Plants via Plant cell culture, production of variant plants from selected cells, selection for stress tolerance, production of disease resistant plant material.

Plant Biotechnology

Importance of Biotechnology in Plant improvement, Biotechnology as a tool to supplement conventional systems of Plant improvement, tools of Biotechnology for plant improvement, In Vitro Technology, Micro propagation, Embryo Rescue, Haploid Development, Viral Free Plant material, Somaclonal variation, Recombinant DNA Technology and Genetic Engineering, Gene cloning, GMOs, Incorporation of Novel genes for tolerance against Biotic and Abiotic stresses, Genes for yield and quality improvement, Genes for Insect and disease Resistance. BT crops, herbicide Resistant crops, Ethical issues and public concerns regarding GMOs.

Biosafety and Bioethics

Introduction to Biosafety (Definition, Concept, Uses and abuses of genetic information, Biohazards), Good Laboratory Practices, Risks Related to GMOs, International Rules & regulations for Biosafety & GMOs. Introduction to Bioethics, Ethical issues regarding GMOs, Euthanasia, Issues related to Reproductive & Cloning technologies, Issues to transplants and Eugenics, Patenting, Commercialization and Benefits Sharing, role of National Bioethic committees.

Space Science

Grand tour of the heavens, Astronomy, History, Scale of universe, Big Bang Theory, Beginning of universe, Stellar evolution, Particles, Time scale, Galaxies, Stars, Observational Astronomy, HR diagram, Stellar physics, Calculation of stellar parameters, Sun, Space and biotechnology.

Biomaterials

Introduction to materials used in medicine, trace elements in blood and their importance, surface properties characterization of Bio materials, surface & protein interactions, biological and biochemical properties of proteins, cells & tissues, biocompatibility & host reactions

to bio implants, implementation & degradation of implant materials, sterilization and implants associated infections, testing & bio materials surface coating, elastomers, hydrogels and their applications, Ceramics & bio-glasses, adhesives & sealants, degradable materials application in drug delivery.

Materials Science

Introduction to engineering materials, scope and role in industrial development, Polymers, ceramics and composites in biotechnology their processing, properties and application. Introduction to Materials Science and Biotechnology, Biomaterials, Biocompatibility and Biofunctionality, Nanotechnology and Nanobiotechnology, Tissue Engineering and Regenerative Medicine, Biomedical Devices and Sensors, Biomineralization and Biomimetics, Biofabrication and 3D Bioprinting, Biodegradable Materials and Drug Delivery, Biocompatibility Testing and Regulatory Considerations, Emerging Trends and Future Directions.

Human Genetics

Mendelian Genetics, principle of segregation, monohybrid crosses, dominance, recessiveness, codominance, semidominance, principle of independent assortment, dihybrid and trihybrid ratios, gene interaction, epistasis, multiple alleles, ABO blood type alleles in humans, Rh factor alleles in humans, probability in Mendelian inheritance, structure of chromosomes and Genes, function of DNA and RNA, classes of RNA, DNA as storage of Genetic information, experimental evidence that DNA is genetic material; physical and chemical structure of DNA, Difference between Prokaryotic and Eukaryotic Genetic material, sex determination and differentiation, sex-linked traits, sex anomalies, linkage and crossing over.

Health and Food Biotechnology

Food composition, probiotics, fermented foods, food enzymes, colors and additives; overview of metabolic

engineering of bacteria for food ingredients; techniques used for production of food ingredients by microbes; genetic modification of plant starches for food applications; biotechnological approaches to improve nutritional quality and shelf life of fruits and vegetables; microbial food spoilage and food borne diseases; detection and control of food borne bacterial pathogens; food safety and quality control; international aspects of quality and safety assessment of food derived by modern biotechnology.

Animal Husbandry and Diversity

Introduction to animal husbandry and diversity, importance of breed diversity, management practices in animal husbandry, conservation efforts for animal diversity, benefits of genetic diversity, threats to animal diversity, future directions in animal husbandry, conclusion.

Cell Signalling and Communication

Introduction to cell signaling and communication, types of cell signaling, signaling molecules, components of cell signaling pathways, major signaling pathways a. receptor tyrosine kinase (rtk) pathway b. g protein-coupled receptor (gpcr) pathway c. notch signaling pathway d. wnt signaling pathway, cellular responses to signaling, regulation of signaling pathways, importance of cell signaling in physiology and disease, experimental techniques in studying cell signaling, future directions in cell signaling research, conclusion.

Vaccinology

Introduction to vaccinology, historical overview, types of vaccines, vaccine development process, vaccine administration, vaccine safety and efficacy, public health importance, vaccine-preventable diseases, vaccine technologies, challenges and controversies, global vaccination initiatives, future directions, ethical and legal considerations, conclusion.

Microbial and Fermentation Biotechnology

Introduction, microorganisms in biotechnology, fermentation processes, microbial growth and metabolism, downstream processing, genetic engineering, bioreactor design and operation, applications, challenges and future directions, ethical and social implications, case studies, conclusion.

Synthetic Biology

Introduction to synthetic biology, historical background, principles and methodologies, tools and techniques, genetic components and circuits, applications in biomedicine, industrial applications, environmental applications, ethical and social implications, regulatory considerations, challenges and future directions, case studies, conclusion.

Entrepreneurship

Introduction to entrepreneurship, characteristics of successful entrepreneurs, identifying opportunities, business planning, financing your venture, legal and regulatory considerations, marketing and sales strategies, operations and management, scaling your business, risk management and contingency planning, entrepreneurial mindset and personal development, social and environmental responsibility, exit strategies, entrepreneurship ecosystem, case studies and success stories, conclusion.

Civics and Community Engagement

Introduction to civics and community engagement, understanding civic participation, types of community engagement, importance of civic education, civic institutions and governance, civic participation and democracy, social justice and equity, environmental stewardship, economic empowerment, technology and civic engagement, youth engagement, interfaith and intercommunity dialogue, civic responsibility and ethical engagement, global citizenship, evaluating impact,

conclusion.

Final Year Project & Internship

Project identification and objectives, title defense, literature survey, design and experimental work, progress presentation & final defense presentation, poster, research paper, report in standard format with plagiarism check and internship.

Electives

Radiobiology

Introduction to radiation biology, radiation physics and interactions with matter, biological effects of ionizing radiation, radiobiological dosimetry, principles of radiation therapy, radiobiology of normal tissues, radiobiology of tumors, cellular responses to radiation, molecular mechanisms of radiation damage and repair, radiation carcinogenesis, radiation epidemiology and risk assessment, radiation safety and protection, radiobiological research techniques, ethical and regulatory aspects of radiobiology, recent advances in radiobiology and radiation oncology

Bioelectronics and Biosensors

Introduction to bioelectronics and biosensors, basics of electronics and sensor technology, biological recognition elements, transduction mechanisms in biosensors, types of biosensors (e.g., electrochemical, optical, piezoelectric), fabrication techniques for biosensors, principles of signal processing and amplification, applications of biosensors in healthcare and biotechnology, biosensor integration with microfluidics and lab-on-a-chip systems, emerging trends and future directions in bioelectronics and biosensors
Bioremediation: Introduction to bioremediation, environmental pollution and remediation strategies, microbial diversity and biodegradation pathways, bioremediation microorganisms: bacteria, fungi, and algae, bioremediation techniques: in situ and ex situ methods, bioremediation of contaminated soil,

bioremediation of contaminated water, bioremediation of contaminated air, plant-microbe interactions in phytoremediation, bioremediation case studies and success stories, bioremediation monitoring and assessment methods, genetic engineering approaches in bioremediation, bioremediation regulations and policy, ethical considerations in bioremediation, emerging trends and future directions in bioremediation research.

Pharmaceutical Biotechnology

Introduction to pharmaceutical biotechnology, basics of molecular biology and genetics, recombinant dna technology, gene cloning and expression systems, protein engineering and production, biopharmaceuticals: types and applications, monoclonal antibodies: production and therapeutic applications, vaccines: development and production, gene therapy: principles and applications, cell and tissue engineering in pharmaceuticals, drug delivery systems and nanotechnology, pharmacogenomics and personalized medicine, regulatory affairs in pharmaceutical biotechnology, quality control and assurance in biopharmaceutical manufacturing, ethical and legal considerations in pharmaceutical biotechnology, current trends and future directions in pharmaceutical biotechnology.

Biofuel and Biorefinery

Introduction to Biofuel and Biorefinery, Overview of Renewable Energy Sources, Biomass Resources for Biofuel Production, Biochemical Conversion Processes: Fermentation and Anaerobic Digestion, Thermochemical Conversion Processes: Pyrolysis, Gasification, and Liquefaction, Biofuel Feedstock Production and Supply Chain Management, Biofuel Production Technologies: Biodiesel, Ethanol, Biogas, and Biohydrogen, Biorefinery Concept and Integration of Processes, Valorization of Biomass Byproducts and Waste Streams, Biorefinery Platforms: Lignocellulosic, Algal, and Microbial Biorefineries, Biorefinery Products: Biochemicals, Bio-

based Materials, and Bioenergy, Techno-economic Analysis and Sustainability Assessment of Biorefinery Processes, Policy and Regulatory Frameworks for Biofuel and Biorefinery Industries, Environmental Impacts and Carbon Footprint of Biofuel Production.

Biomechanics

Introduction to biomechanics, human movement analysis, musculoskeletal system: anatomy and physiology, biomechanics of skeletal muscle, biomechanics of bones and joints, biomechanics of tendons and ligaments, biomechanics of the spine, biomechanics of the upper extremity, biomechanics of the lower extremity, sports biomechanics, clinical biomechanics: gait analysis and rehabilitation engineering, biomechanical modeling and simulation, biomechanical instrumentation and measurement techniques, biomechanical data analysis methods, ethical considerations in biomechanics research.

Waste Management

Types and sources of waste, waste generation and composition, waste collection and transportation, waste segregation and recycling, composting and organic waste management, hazardous waste management, landfill management and sanitary engineering, waste-to-energy technologies, circular economy and sustainable waste management practices, policy and regulation in waste management, community engagement and public awareness, waste management economics and cost analysis, emerging trends and innovations in waste management.

Inspection and Testing of Biomaterials

Introduction to biomaterials inspection and testing, types and properties of biomaterials, regulatory standards and quality assurance in biomaterials, mechanical testing of biomaterials, tensile testing, biocompatibility testing of biomaterials, in vitro testing methods, in vivo testing methods.

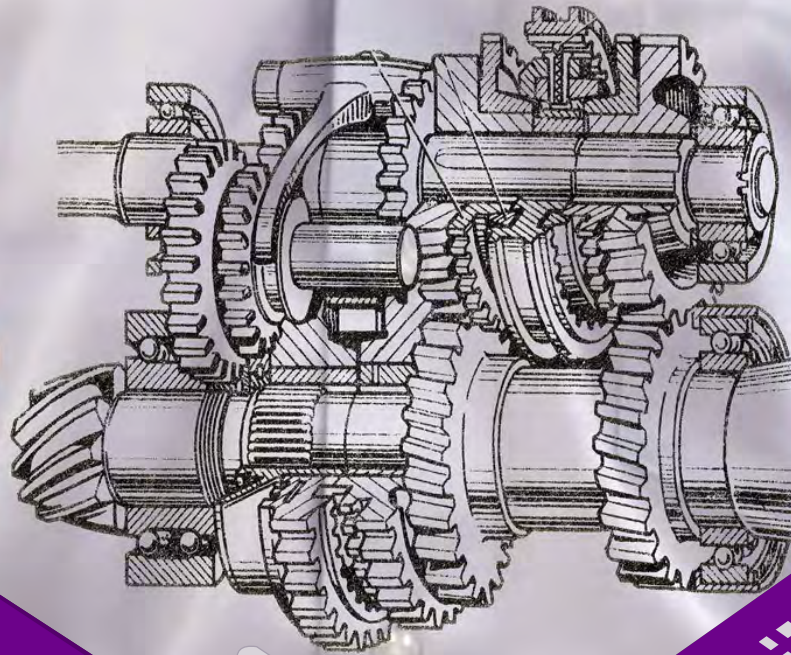
Characterization Techniques of Biomaterials

Characterization techniques in biomaterials testing, microscopic analysis: scanning electron microscopy (SEM), transmission electron microscopy (TEM), spectroscopic analysis: fourier transform infrared spectroscopy (ftir), raman spectroscopy, thermal analysis: differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), surface analysis: x-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM), non-destructive testing techniques in biomaterials inspection, rheological testing techniques, porosity and permeability analysis, particle size analysis, surface area and pore size distribution analysis, biocompatibility testing methods, in vitro cell culture techniques, in vivo animal studies, computational modeling and simulation in biomaterials characterization, data analysis and interpretation

Corrosion Behaviour of Implants

Introduction to biomaterials degradation and corrosion, basics of implant materials and their properties, principles of corrosion, types of corrosion, factors influencing corrosion of implants, electrochemical techniques for corrosion analysis: potentiodynamic polarization, electrochemical impedance spectroscopy (EIS), tafel extrapolation, in vitro and in vivo evaluation of implant degradation, accelerated degradation testing methods, corrosion protection strategies, clinical relevance and performance evaluation of implants, regulatory requirements and standards for implant degradation testing.

MECHANICAL ENGINEERING



Department of Mechanical Engineering

The Department of Mechanical Engineering provides a solid foundation in fundamental sciences, mathematics, and design methodologies related to mechanical structures, fluids, manufacturing, dynamics, AI, machine learning, and thermal systems. Examples of systems and devices that require knowledge of mechanical engineering include engines, ships, trains, aircraft, spacecraft, steam and gas turbines, machine tools, and robots. The curriculum incorporates methodological tools, innovative thinking, communication skills, management techniques, equipping students to work effectively both independently and as part of a team. In their senior year, students are required to apply their theoretical knowledge to real-world problems and gain hands-on engineering experience, which includes problem design, teamwork, communication, time management, and economic analysis. The department encourages students to pursue internships that link academic knowledge with practical work experience. Furthermore, students have opportunities to engage with professional societies such as the American Society of Mechanical Engineers (ASME), the Institution of Mechanical Engineers (IMechE), and the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

The purpose of offering mechanical engineering is to equip students for various exciting industrial opportunities, including aerospace, manufacturing, automotive, chemical, biomedical, nuclear power, robotics, textiles, and more. Mechanical engineers can pursue careers in research and development, production and manufacturing, design, operations and maintenance, and administration.

Vision

To lead in Mechanical Engineering through quality education, research, and innovation, and to be

renowned for producing entrepreneurial and creative graduates capable of addressing contemporary technological and societal challenges with sustainable and inclusive solutions.

Mission Statement

To serve society by offering quality education and preparing engineering professionals capable of providing sustainable solutions through strong intellectual and analytical abilities, innovation, teamwork, and ethical practices in mechanical and allied disciplines.

Program Educational Objectives

The Department of Mechanical Engineering has established and maintained a clear set of educational objectives and expected program outcomes. These objectives relate to all our stakeholders, including students, employers, alumni, and faculty. The department ensures that these objectives and outcomes are achieved through various assessment tools. The educational objectives are outlined below:

PEO-1: Apply mechanical engineering knowledge to identify and provide sustainable solutions that address technical and societal challenges.

PEO-2: Enhance intellectual and analytical abilities to take the initiative or develop innovative ideas for technological and professional growth in mechanical and allied disciplines.

PEO-3: Work effectively and ethically as a team member or leader in a sustainable, multidisciplinary environment while demonstrating strong interpersonal and managerial skills.

Program Learning Outcomes

The Department of Mechanical Engineering has developed program learning outcomes that are aligned

with our defined Program Educational Objectives. These outcomes relate to the skills, awareness, and performance that students acquire as the program progresses.

PLO-1: Engineering Knowledge: Apply knowledge of mathematics, natural science, engineering fundamentals and Engineering specialization to the solution of complex engineering problems.

PLO-2: Problem Analysis: Identify, formulate, conduct research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO-3: Design/Development of Solutions: An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO-4: Investigation: Conduct investigation of complex Engineering problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PLO-5: Tool Usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex Engineering problems, with an understanding of the limitations.

PLO-6: The Engineer and the World: Analyze and evaluate sustainable development impacts to society, the economy, sustainability, health and safety, legal frameworks, and the environment while solving complex engineering problems.

PLO-7: Ethics: Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion.

PLO-8: Individual and Collaborative Team Work:

Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multidisciplinary, face-to-face, remote and distributed settings.

PLO-9: Communication: Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, and make effective presentations, taking into account cultural, language, and learning differences.

PLO-10: Project Management and Finance: Demonstrate knowledge and understanding of engineering management principles and economic decision making and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments.

PLO-11: Lifelong Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change.



Freshman

Semester - 1		
Code	Subject	Cr. Hr.
300129	Islamic Studies	2-0
123245	Calculus & Analytical Geometry	3-0
300312	Functional English	3-0
117418	Applied Physics	2-0
109203	Applications of ICT	2-0
114112	Engineering Drawing and Graphics	1-0
114113	Engineering Drawing and Graphics Lab	0-1
117402	Applied Physics Lab	0-1
114114	Workshop Practice	1-0
114115	Workshop Practice Lab	0-1
109204	Applications of ICT Lab	0-1
Total		14-4

Semester - 2		
Code	Subject	Cr. Hr.
123216	Linear Algebra and Differential Equations	3-0
109302	Electrical Engineering	2-0
114116	Computer Aided Drawing	0-1
114201	Statics	3-0
214341	Thermodynamics-I	3-0
114117	Materials Engineering	2-0
300133	Civics & Community Engagement	2-0
100102	Pakistan Studies	2-0
Total		17-1

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
214118	Dynamics	2-0
214242	Mechanics of Materials-I	3-0
108420	Computer Systems and Programming	2-0
223217	Complex Variables and Transforms	3-0
214420	Fluid Mechanics-I	3-0
215301	Thermodynamics-II	2-0
214238	Engineering Mechanics Lab	0-1
214302	Thermodynamics Lab	0-1
108424	Computer Systems and Programming Lab	0-1
Total		15-3

Semester - 4		
Code	Subject	Cr. Hr.
214119	Measurement and Instrumentation	2-0
214204	Mechanics of Materials-II	3-0
215302	Fluid Mechanics-II	2-0
215401	Machine Design-I	2-0
208103	Electronics Engineering	2-0
208105	Electrical and Electronics Engineering Lab	0-1
300130	Expository Writing	3-0
314402	Fluid Mechanics Lab	0-1
214239	Mechanics of Materials Lab	0-1
Total		14-3

Junior

Semester - 5		
Code	Subject	Cr. Hr.
314514	Manufacturing Processes	3-0
314515	Manufacturing Processes Lab	0-1
315402	Machine Design-II	2-0
315403	Control Engineering	2-0
314305	Heat and Mass Transfer	3-0
309119	Applied AI and Machine Learning	2-0
315404	M&I and Control Lab	0-1
232246	Numerical Analysis	2-0
309120	Applied AI and Machine Learning Lab	0-1
Total		14-3

Senior

Semester - 7		
Code	Subject	Cr. Hr.
414601	Mechanical Vibrations	3-0
414309	Internal Combustion Engines	2-0
	Technical Elective-I	3-0
400235	Arts & Humanities Elective	2-0
414210	Mechanisms and Mechanical Vibrations Lab	0-1
414120	FYDP-I	0-3
414310	Internal Combustion Engines Lab	0-1
Total		10-5

Semester - 6		
Code	Subject	Cr. Hr.
300236	Social Sciences Elective	2-0
315303	Heating, Ventilating and Air Conditioning	3-0
314802	Mechanics of Machines	2-0
314804	Finite Element Methods	2-0
315304	HVAC and H&M Lab	0-1
523411	Maths Elective	3-0
300438	Project Management	2-0
314805	Finite Element Methods Lab	0-1
Total		14-2

Semester - 8		
Code	Subject	Cr. Hr.
414509	Reverse Engineering and Inspection Techniques	2-0
415501	Mechatronics and Robotics Engineering	2-0
-	Technical Elective-II	3-0
400439	Entrepreneurship	2-0
499916	Occupational Health and Safety	1-0
414121	FYDP-II	0-3
414510	Reverse Engineering and Inspection Techniques Lab	0-1
415502	Mechatronics and Robotics Engineering Lab	0-1
Total		10-5

Total No of Credit Hours

136

List of Technical Electives (3-0) or (2-1)

- Intro to Fracture Mechanics
- Stress Analysis
- Engineering Mechanics of Composite Structures
- Power Plants
- Gas Dynamics
- Computational Fluid Dynamics
- Thermo Fluid Application and Design
- Gas Turbines for Propulsion and Power Generation
- Turbomachinery
- Advanced Manufacturing Processes
- Industrial Engineering
- Production Planning and Control
- Intro to Robotics
- Renewable Energy Technology
- Automotive Engineering
- Aerodynamics

List of Mathematics Electives (3-0)

- Applied Statistics
- Probability and Stochastic
- Multivariable Calculus
- Any other relevant course decided by the HEI as per requirement

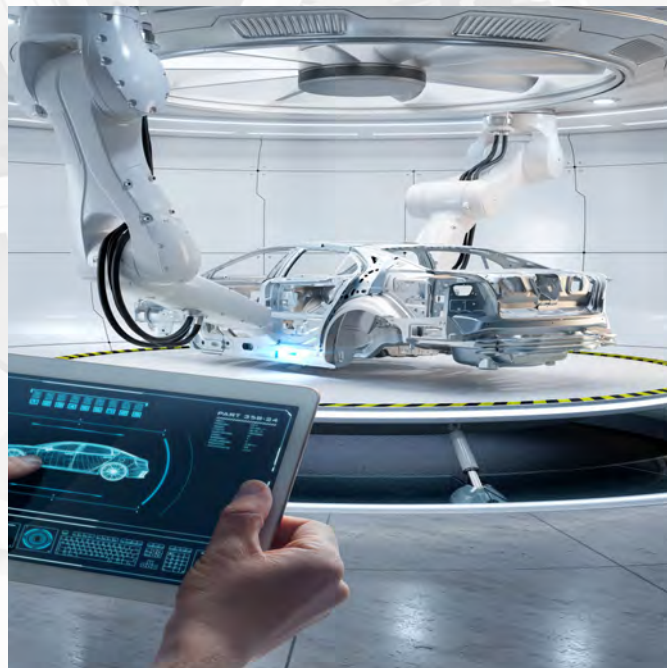
List of Social Science Electives (2-0)

- Sociology for Engineers
- Sociology
- Social Psychology
- Critical Thinking
- Human Resource Management
- Engineering Law
- Engineering Economics
- Applied Psychology
- Engineering Management
- Financial Management
- Marketing Management
- Leadership & Personal Grooming

- Anthropology
- Globalization
- Organizational Behavior
- Total Quality Management
- Operations Research
- Any other relevant course decided by the HEI as per requirement

List of Arts & Humanities Electives (2-0)

- Communication & Presentation Skills
- Beginners Spanish
- Elementary Arabic
- Elementary French
- Elementary Chinese
- Philosophy
- Professional Ethics
- Any other relevant course decided by the HEI as per requirement.



114112 Engineering Drawing and Graphics (1-0)

Fundamentals of Engineering Drawing, Geometric Construction Techniques, Dimensioning, Projection Method, Engineering Curves, Geometric Tolerance, Sectional Views.

114114 Workshop Practice (1-0)

Introduction to workshop technology and its importance, Measurement techniques using Vernier calipers, micrometers, depth gauges, marking gauges, try squares, and bevels, Introduction to woodworking tools, Metal working techniques (filing, drilling, tapping, shearing), Introduction to lathe machine, its parts, and functions, Introduction to a milling machine, its parts, and functions, Introduction to welding processes (arc welding, and gas welding).

114116 Computer Aided Drawing (0-1)

Introduction to CAD, GUI, 2D Sketching, 3D Part Modelling, Assembly, Mechanisms, Drawing.

114201 Statics (3-0)

Mechanics, Basic Concepts, Scalars and Vectors, Problem Solving in Statics, Introduction to forces, External and internal Effects, Principle of Transmissibility, 2-D force Systems, Rectangular Components, 3-D Force Systems, Equilibrium in Two and Three Dimensions, Free-Body Diagrams, Structures, Truss Connections and Supports, Method of Joints, Determining The C.G and Centroid, Composite Bodies and Figures, Friction, Applications of Friction in Machines.

214341 Thermodynamics-I (3-0)

Introduction to First Law of Thermodynamics, Working Fluid, Reversible and Irreversible Processes, Second Law of Thermodynamics, Heat Engine Cycle, Entropy.

114117 Materials Engineering (2-0)

Introduction to Advanced Materials, Atomic Structure and interatomic Bonding, Crystal Structure, Unit Cells, Metallic Crystal Structures, Crystalline and Non-Crystalline

Materials, Polycrystalline Materials, Anisotropy, Imperfection in Materials, Point Defects Due to Vacancies and Impurities, Dislocations, Linear Defects, Interfacial Defects, Mechanical Properties of Materials, Types of Stress and Strain, Elastic Deformation, Stress-Strain Behavior, Materials Failure, Fracture-Fundamentals, Fracture Mechanics, Fatigue Failure, Creep, Phase Diagrams, Phase Transformations, Metal Alloys, Refractory Metals, Heat Treatment, Heat Treatment Processes for Steels, Polymers, Visco-Elastic Deformation, Polymer Structures, Composites, Ceramic Materials.

214118 Dynamics (2-0)

Introduction, Rectilinear Kinematics, Curvilinear Kinematics, Relative Motion, Kinetics of a Particle, force and Acceleration, Principle of Work and Energy, Conservation of Energy, Impulse and Momentum, Planar Kinematics of A Rigid Body, Rigid Body Motion, Relative Motion Analysis, Relative Motion Analysis Using Rotating Axes, Moment of inertia, Planar Kinetic Equation of Motion, Equations of Motion of Rigid Body, General Plane Motion, Work Energy Principle of Rigid Body, Impulse and Momentum of Rigid Body.

214242 Mechanics of Materials-I (3-0)

Stress, Equilibrium of a Deformable Body, Design of Simple Connections, Strain, Mechanical Properties of Materials, The Tension and Compression Test, The Stress-Strain Diagram, Stress-Strain Behavior of Ductile and Brittle Materials, The Shear Stress-Strain Diagram, Axial Load, Saint-Venant's Principle, Torsion, The Torsion formula, Power Transmission, Angle of Twist, Stress Concentration, Bending, Shear and Moment Diagrams, Transverse Shear, Combined Loading.

214420 Fluid Mechanics-I (3-0)

Introduction, Kinematics of Particle, Fluid Mechanics and its Applications, Classification of Fluid Flows, No Slip Condition, Fluid Properties, Hydrostatic and Hydrodynamics. Pressure and Pressure Measurement Devices, Fluid Static, Hydrostatic Static forces on

Submerged Bodies, Buoyancy and Stability, Fluid Kinematics, Lagrangian and Eulerian Description, Flow Pattern and Visualization, Kinematic Description, Vorticity and Rationality, Reynold Transport Theorem, Mass, Energy, Momentum, Conservation of Mass, The Bernoulli Equation, General Energy Equation, Steady Flow Energy Analysis, Newton's Law, Linear Momentum Equation, Dimensional Analysis Homogeneity and Similarity, Buckingham Pi Theorem.

215301 Thermodynamics-II (2-0)

Steam Cycles, Gas Turbine Cycles, Combined Cycles and Boilers, Exergy, Compressible Flows, Mixtures, Rotodynamic Machinery, Otto Cycle and Diesel Cycle.

214204 Mechanics of Materials-II (3-0)

Stress and Strain Transformation, Design of beams and shafts, statically undetermined beams and shafts, buckling of columns, critical loading for columns, designing of columns for eccentric and connecting loads, energy methods, external work and strain energy, elastic strain energy for various types of loading, Castiglione's theorem applied to trusses and beam, Strain gauges, failure theories.

215302 Fluid Mechanics-II (2-0)

Introduction, Fluid Kinematics, Condition of Orthogonality. Fluid Dynamics, Flow in a Pipe, Viscous Flow over Flat Plate, Development of Boundary Layer Theory. Laminar Boundary Layer, Turbulent Boundary Layer, Velocity Profile in Boundary Layer, Drag and Drag Coefficient, Lift and Lift Coefficient. Compressible Flow, Isentropic Flow through Duct, Isentropic Flow through Convergent, Convergent-Divergent Nozzles, Hydraulic Machinery and Equipment, Performance of Hydraulic Turbine, Specific Speed of Turbine, Reciprocating Pump, Air Vessel and Its Effects on The Performance of Reciprocating Pump. Centrifugal Pump, Hydraulic Press, Hydraulic Crane, Hydraulic Accumulator, Hydraulic Intensifier.

215401 Machine Design-I (2-0)

Intro to Mechanical Engineering Design, Fatigue Failure Resulting From Variable Loading, Shaft and Shaft Components, Screws, Fasteners and Design of Nonpermanent Joints, Welding, Bonding and The Design of Permanent Joints, Mechanical Springs, Rolling Contact Bearings, Lubrication and Journal Bearings.

314514 Manufacturing Processes (3-0)

General Overview of Manufacturing Processes, Fundamentals of Metal Casting, Rolling and forging of Metals, Extrusion and Drawing of Metals, Sheet Metal forming and Cutting Processes, Milling Machines and Operations, CNC Lathes and Operations, Operation of Planning and Shaping and Slotting, Grinding Process and Fluids, Design of Jigs and Fixtures, Fundamentals of Cutting Tools, Non-Traditional Cutting Operations, Rapid Prototyping.

315402 Machine Design-II (2-0)

Design and analysis of Gears, Types of Gear, Spur and Helical Gears, Bevel and Worm Gears, Clutches, Brakes, Couplings and Flywheels, Flexible Mechanical Elements, Belt, Ropes, Pulleys, and Various Power Transmission.

314305 Heat and Mass Transfer (3-0)

Basic of Heat Transfer, Fourier's Law, Thermal Conductivity, Thermal Resistance Concept, Multiwall Conduction in Circular Pipes, Multi Layers Circular Pipes, Overall Heat Transfer Coefficient, Circular Thickness of Insulator, Convection Fundamentals, 1-D and 2-D Heat Conduction Equations, Heat Transfer from Extended Surface, Free and forced Convection, Heat Exchanger and their Applications, Mass Transfer, Radiation Heat Transfer.

309119 Applied Artificial Intelligence and Machine Learning (2-0)

Introduction to AI, Reasoning and Knowledge

Representation, State estimation and uncertainty filters, Linear and Logistic Regression, Multiclass Classification and Regularization, Neural Networks, Unsupervised Learning, Bayesian Systems, Reinforcement Learning, Uninformed Search and Informed Search with detailed algorithm examples or space and time complexity.

315303 Heating, Ventilating and Air Conditioning (HVAC) (3-0)

Vapor Compression System: Heat Pump, Refrigerants, H-S and P-H Charts. Vapor Absorption System, Psychometric of Air-Conditioning Processes, Summer Air-Conditioning, Compressors, Reciprocating, Rotary, Screw and Centrifugal Compressors, Condensers and Evaporators.

314802 Mechanics of Machines (2-0)

Introduction, Four Bar Mechanism, Slider Crank Mechanism, Special Purpose Mechanism, Techniques of Mechanism Analysis, Vector Position and Displacement Analysis, Velocity Analysis of Mechanisms, Acceleration Analysis of Mechanisms, Design and Development of Slider Crank Mechanism, Crank Rocker Mechanism, CAM, Governors, Balance of Revolving Masses, Effect on Engine of Reciprocating Mass, Gear Train.

314804 Finite Element Methods (2-0)

Introduction to Finite Element Methods (FEM), Truss Analysis, Variational and Weighted Residual formulations, Shape Functions, Stress Analysis for One and Two-Dimensional Problems of Structures, Beam Analysis, Introduction to Ansys, Simulation of Thin Plate, Simulation of Beams, Dynamic Response in Structures, Simulation On Impact Loading, 2D Plane Stress Analysis of 3D Elastic Solid, Fatigue Analysis, Thermal Analysis, Fluid Flow Analysis.

514122 Nanoengineering and Nanomaterials (3-0)

Overview of Nanotechnology, Historical Perspective, Scale of Nanotechnology, Properties of Nanomaterials,

Fabrication Techniques, Characterization Methods, Nanostructures in Nature, Nanoscale Fabrication Methods, Applications of Nanostructures, Quantum Mechanics and Nanoscale Phenomena, Mechanical Behavior at the Nanoscale, Electrical and Thermal Properties, Nanomaterials in Electronics, Nanotechnology in Medicine, Nanotechnology in Energy and Environment, Environmental Impacts of Nanotechnology, Ethical Issues in Nanotechnology, Regulation and Safety, Current Research in Nanotechnology, Future Trends and Possibilities.

414601 Mechanical Vibrations (3-0)

Introduction to Vibrations, Free Vibratory Systems, Forced Vibratory Systems, Systems with Two Degrees of Freedom, Multi-Degree of Freedom Systems, and Solution Techniques.

414309 Internal Combustion Engines (2-0)

IC Engines Design and Working Principles, Performance Characteristics of SI & CI Engines, Combustion Phases, Knocking Characteristics, Fuel-Air Mixture, Valve Timing Diagrams of SI & CI, Application of Thermodynamic Cycle, Fuel Consumption, Engine Emission, Engine Friction and Lubrication.

414120 FYDP-I (0-3)

Students undertake an independent Project in their Senior Year. Essential Tasks: Project Identification, Aims and Objectives of Project, Definition of Subsystems and Requirements, Project Feasibility, Progress Presentation, Preliminary Design, Finalization of Analysis, Design Finalization, Report Preparation, Final Presentation.

414509 Reverse Engineering and Inspection Techniques (2-0)

Definition, Scope, and Applications of Reverse Engineering, Legal and Ethical Considerations, Overview of Data Acquisition Methods (3D scanning, coordinate measuring), Point Cloud Data Acquisition and

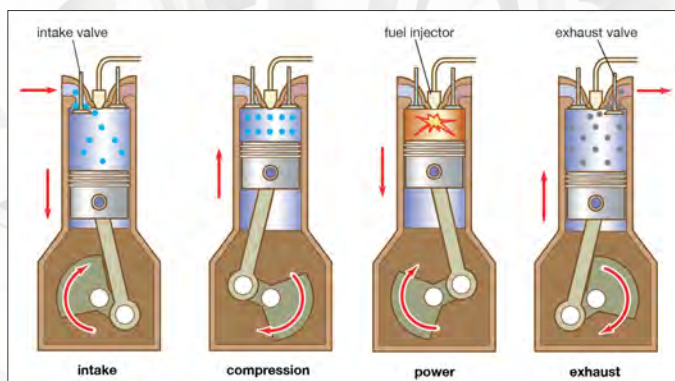
Preprocessing, Registration and Alignment of Multiple Scans, Introduction to Point Cloud Processing Software, CAD Modeling from Point Cloud Data, Feature Recognition and Extraction, Coordinate Measuring Machines (CMM), Optical and Non-contact Inspection Methods, Surface Metrology and Roughness Measurement, Geometric Dimensioning and Tolerancing, Material Characterization Techniques (Destructive and Non-destructive), Metrology Fundamentals and Standards, Reverse Engineering software tools and Functionalities, Integration of Reverse Engineering with Product Development, Reverse Engineering in Industry 4.0, Emerging Technologies in Reverse Engineering, Legal and Ethical Considerations in the Digital Age.

415501 Mechatronics and Robotics Engineering (2-0)

Mechatronics System Design, Data Acquisition, Sensors and Actuators, Introduction to advanced robotics, Spatial Descriptions and Transformations, Forward and Inverse Kinematics, Jacobians and Manipulator Dynamics, Trajectory Generation and Linear Control of Manipulators.

414121 FYDP-II (0-3)

Students undertake an independent Project in their Senior Year. Essential Tasks: Work on the Remaining Tasks of the Project, Regular Meetings with the Supervisors for Progress, Finalization of the Project Work with Concrete



Findings, Report Preparation, Final Presentation, and Demonstration.

Technical Electives

511164 Mechanical Behavior of Materials (3-0)

Elastic and Plastic Deformation, Defects and Imperfections in Single and Polycrystalline Materials, Impact and Fracture Toughness Testing of Materials, Fracture Mechanics, Fatigue, Creep and Stress Rupture of Materials, Materials Selection and Failure Analysis.

514109 Intro to Fracture Mechanics (3-0)

Basic Fracture Mechanics Concepts, Stress Concentrations, Crack Stress and Displacements, Stress Intensity Factor, Crack Growth and Energy Relationships, Crack Tip Plasticity, Crack Growth Prediction Models, Experimental Methods in Fracture and Fatigue.

Stress Analysis (2-0)

Elementary Elasticity and Fracture Mechanics, Strain Measurement Methods and Related Instrumentation, Optical Methods of Stress Analysis, Coating Methods and Application of Statistics; Strain Gauge and Its Application in Stress Analysis.

Engineering Mechanics of Composite Structures (3-0)

Composite Material and Their Constituents, Unidirectional Composites Behavior of Laminated Composite Plates Under Various Loading Conditions, Classical Lamination Theory, Effective Stiffness Properties of Composites, Plates with Moderately Large Deflections.

514312 Power Plants (3-0)

Basics of Thermodynamics, Entropy and Reversibility, Rankine Cycle, Feed Water Heaters, Fossil Fuel Steam Generator, Fire-Tube Boiler, Water-Tube Boiler, Water Circulation, The Steam Drum, Super Heaters and Reheaters, Once Through Boilers, Economizers, Air Preheaters, Gas-Turbine Cycles, Modifications in Brayton Cycle, Cycle Analysis With Variable Properties, Design for

High Temperature, Combined Cycle, Power Plants, Combined Cycle With Multi-Pressure Steam, Wind and Solar Energy, Solar-Thermal Systems, Nuclear Power Plants.

514123 Gas Dynamics (3-0)

Basic Governing Laws of Conservation of Mass, Momentum and Energy, Limitations. Sub-Sonic and Supersonic Gas Flow, Isentropic Flow and Applications. Normal and Oblique Shocks, Prandtl-Meyer Compression and Expansion with Applications. Rayleigh Flow and Fanno Flow, Busemann's Shock Polar Diagram.

515221 Computational Fluid Dynamics (3-0)

Introduction to Computational Fluid Dynamics, Problem Solving Strategy Using CFD, Governing Equations of Fluid Flow, Discretization of Governing Equations, Finite Difference Methods, Introduction to The Finite Volume Methods, Numerical Solution of Governing Equations, Solution Analysis and Accuracy, Introduction to Advanced topics.

Thermo Fluid Applications & Design (3-0)

Types of Design in Thermo Fluid Science, Air Distribution Systems, Liquid Piping Systems, Types of Pumps, Pumps Fundamentals, Pump Performance and System Curves, Fundamentals of Heat Exchanger Design, Application of Heat Exchangers in Systems, Performance Analysis of Power Plant Systems.

Gas Turbines for Propulsion and Power Generation (2-0)

Introduction, Gas Turbine Concepts, Basic Gas Turbine Operations, Gas Generator Fuel Control Systems, Fuel System Design and Applications, Thrust Engine Control and Augmentation Systems, Shaft Power Propulsion Control Systems, Engine inlet and Exhaust Systems, Power Extraction and Starting Systems, Marine Propulsion Systems.

Turbomachinery (3-0)

Turbomachinery for incompressible Fluids, Turbomachinery for Compressible Fluids, Turbines and Compressors, Compressible Aerodynamics, Turbomachine System Discretization, Conservation Law, Euler Turbine Equations, Efficiencies, Turbine Enthalpy-Entropy Diagrams, Turbine Design Parameters, Normalized Velocity Triangles, Turbine Blade Geometry, Special Cases, Losses and off Design Analysis and Turbomachines Condition Monitoring.

Advanced Manufacturing Systems (3-0)

Conventional Machining Operations (Turning, Milling & Drilling), Non-Traditional Cutting Techniques (Ultrasonic Machining, Water-Jet Machining, Electrochemical, Electrical Discharge Machining, Laser Cutting Techniques), Additive Manufacturing, Nano-Manufacturing, Manufacturing Process Planning, Lean & Green Manufacturing, Computer Integrated Manufacturing, Design for Manufacturing and Assembly, Reverse Engineering, Quality Management.

Industrial Engineering (3-0)

Plant Management, Productivity, Work Measurement and Work Sampling, Facilities Planning and Design, Material Handling Systems, Types of Production, Group Technology, Make or Buy Decisions, Inventory Models and Just in Time Technique, Production Planning, Scheduling Problems & Models, Lean Manufacturing, FMS, Process Planning and Analysis, forecasting, Human Factor Engineering Basics.

Production Planning and Control (3-0)

Basics of PPC, Production Management, Mass and Flow Production, Batch Production, Production Design and Development, Aggregate Production Planning, Materials Requirements Planning, Manufacturing Resource Planning, Pull Production, Shop Floor Planning, Master Production Scheduling and Production Control, Capacity Planning.

Intro to Robotics (3-0)

Introduction, Drive Methods, Sensors. Spatial Description and Transformation, Forward Kinematics, Inverse Kinematics Jacobean, Denavit-Hartenberg Coordinate Transformations, force/torque Relations, Trajectory Planning, Dynamics, Position Control, PID Control, Inverse Dynamics Feedforward Control, Nonlinear and Two Parts Control. Open-Loop Manipulators, Closed Loop Linkages, Tendon Driven Robotics Hands. Robotics Applications.

Renewable Energy Technology (3-0)

Types of Renewable Energy: Solar Energy, Wind Energy, Geothermal Energy, Ocean Thermal Energy, Tidal Wave and Geothermal Energy, Biomass Energy, Fuel Cell and Heat Pump Systems, Energy Efficiency Issues and Energy Storage, Renewable and Non-Renewable Energies Used as Hybrid Energy Systems, Modern Renewable Energy Plants, Wind Turbine Design Specifications, Compatible Electric Generators and Major Operational Issues of The Wind Mill for Electric Power Generation, Wind Mills Design Usage for Pumping Water, Biomass Energy Conversion Methods.

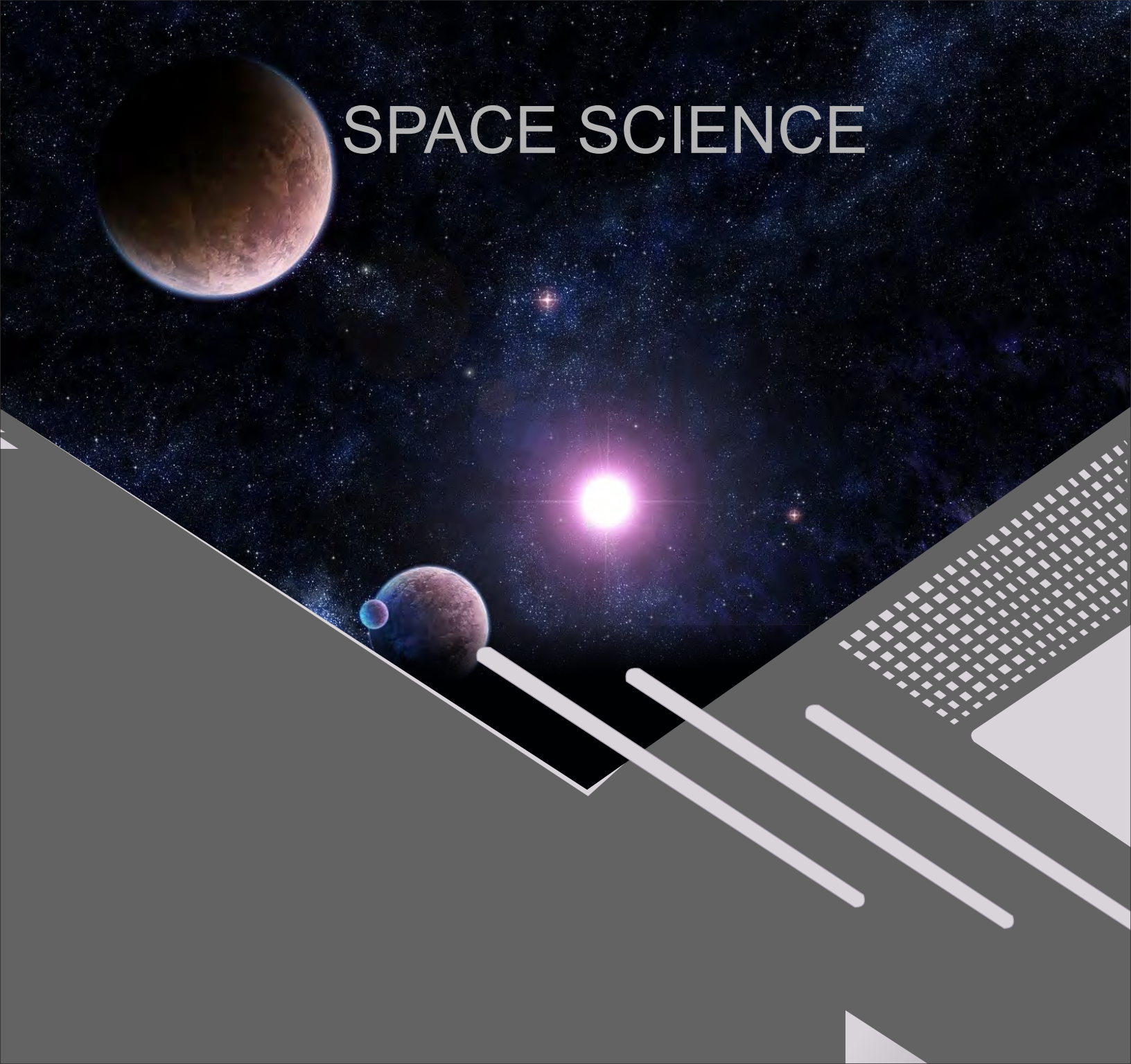
Automotive Engineering (3-0)

Introduction to Automobile, Basic Components of Automobile, Mechanical and Hydraulics Brake System, Petrol and Diesel Engines, Lubricating System, Cooling System, Electrical System, Ignition System, Automotive Air Conditioning.

Aerodynamics (3-0)

Introduction, Aerodynamics of Incompressible Flow, Compressible and Ideal Fluid Flow, Airfoils Theory, Finite Wing Aerodynamics, Blade Element Theory and Aircraft Propellers, Cascade Aerodynamics, Jet Propulsion, Intake and Nozzle Performance, Aircraft Performance Measurement.

SPACE SCIENCE



Department of Space Science

With rapid development in the field of space exploration, the subject of space science has gained tremendous importance. Our knowledge about the universe has further expanded by space observations, and diverse space technologies have become an essential part of our daily life. Manufacturing and operation of spacecraft, analysis of data (both in situ and remote sensed observations) and developing theories with analytic and computational tools are tasks of space science.

Space science as an academic discipline of understanding the universe is no more a heavenly, speculative science. On one hand, it touches the most fundamental philosophical questions, for example, how our world was created and how we come to existence, and on the other hand, it provides the most practical information, for example, that related to the safety of astronauts and spacecraft. Application of space science is not limited to satellite communication and astronomical observations as perceived in the past. The GPS is already embedded in our daily life, and the remote sensing can even provide information on the interior of the earth, to say nothing of its atmosphere and surface. Our department trains students to take part in all those endeavours into space and pioneer the final frontier of the mankind, the universe.

The global space market is experiencing continuous growth since space technology is one of the key fields for national competence and economic growth. The space sector is seeking for young professionals with excellent knowledge in space technology and interdisciplinary skills.

The Space Science department at IST is a multidisciplinary department with the focus on, Astronomy and Astrophysics, Physics, Remote Sensing and Geographical Information Science, Atmospheric and Environmental Science, Meteorology, Earth Sciences

and Astrodynamics. Research laboratories at IST include hi-tech facilities for space and planetary exploration, remote sensing, high-precision positioning and navigation, geospatial information technology, atmospheric measurements, simulations and climate modelling.

Department of Space Science offers the Bachelor of Science Programs in Space Science and Physics. The Master programs are offered in Astronomy and Astrophysics, Remote Sensing and GIS, Environment and Climate Science, Global Navigation Satellite Systems and Physics. It also offers PhD in Astronomy and Astrophysics & Remote Sensing and GIS.

Research Labs and Facilities

The following state-of-the-art laboratories are available for research and experimentation.

- Astronomy and Astrophysics Lab
- Modelling and Simulation Lab
- Global Navigation Satellite Systems Research Lab
- Geospatial Research and Educational Lab
- Earth Observation and Photogrammetry Lab
- Remote Sensing and Geographic Information Science Lab
- Environment and Climate Sciences Lab
- Space Education and Research Lab
- Modern Physics and Research Lab
- Computation Lab
- Applied Physics Lab
- Mechanics, Electricity and Magnetism Lab
- Heat, Waves, Sound and Optics Lab
- IST Observatory

Space Science

The BS Space Science program is especially crafted according to HEC guidelines and following the International trends to enable the graduates for National and International market while equipping them with the solid foundations of Mathematics, Physics, Computation and different domains of Space Sciences. The BS Space Science program offers specialized courses in final year in the domains of Astronomy & Astrophysics, Remote Sensing & Geographical Information Science, Environment & Climate Science and Astrodynamics; all of which have market demand and plenty of opportunities for higher studies.

Remote Sensing & Geographical Information Science:

Remote Sensing (RS) is the science and technology of satellite imaging of the Earth's atmosphere, surface, and oceans, and Geographic Information Science (GISc) refers to the science and technology of geographic data manipulation, analysis, and visualization. Together, the fields of RS & GISc and their associated disciplines have now emerged as “enabling disciplines” in almost every domain. The RS & GISc domain of BS Space Science degree at IST focusses on studying the earth processes and dynamics (e.g., forests, oceans, urban areas, rivers) using optical, radar, and hyperspectral satellite / drone imagery, photogrammetry and terrain estimation, disaster management and mitigation, GIS IT tools expertise and customization, spatial data structures and databases, spatial data visualization, and mobile and Web GIS.

Astronomy and Astrophysics: The Astronomy & Astrophysics is one of the most rapidly expanding fields in the world. Exciting new projects are being developed worldwide to further understand the Universe. In the Astronomy and Astrophysics domain of the BS Space Science program, students are given the necessary physics and mathematics skills they need as well as more advanced concepts and specialized courses providing

essential computational tools for a rewarding career in this domain. It provides a unique opportunity to students to expand their horizon by learning and developing a career in this field.

Environment & Climate Science : The Environment & Climate Science is an interdisciplinary academic field that integrates physical, biological and information sciences (including physics, chemistry, oceanography, physical geography, and atmospheric science) to study environment and to find the possible solution of environmental and climate problems. Environmental studies incorporate more of the social sciences for understanding human relationships, perceptions and policies towards the environment. The Environment & Climate Science domain of BS Space Science degree at IST focuses on Atmospheric Dynamics, Climate Change, hydrological modelling, SMOG, urban air pollution and meteorological process that are occurring at local and regional scale.

Astrodynamics : Astrodynamics is the study of the motion of artificial bodies moving under the influence of gravity from one or more large natural bodies. This includes manoeuvre planning of spacecraft in orbit, methodologies to determine where objects are in space, and spacecraft attitude determination and control. The Astrodynamics domain of BS Space Science degree at IST broadly encompass the basics of orbital mechanics, space weather, space mission design, spacecraft subsystem design, flight dynamics, satellite communication, navigation satellite systems, trajectory optimization and orbit determination.

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
	English Composition	3-0
	Religious Studies	2-0
	Introduction to Space Science	2-0
	Calculus-I	3-0
	Introduction to Computing	2-0
	Introduction to Computing Lab	0-1
	Applied Physics	3-0
	Applied Physics Lab	0-1
Total		17-2

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
	Differential Equations	3-0
	Linear Algebra	3-0
	Modern Physics	3-0
	Introduction to Environmental Sciences	3-0
	Spherical Astronomy	3-0
	Fundamentals of Remote Sensing	2-0
	Fundamentals of Remote Sensing Lab	0-1
Total		16-2

Semester - 2		
Code	Subject	Cr. Hr.
	Communication Skills	3-0
	Calculus-II	3-0
	Computer Programming	2-0
	Computer Programming Lab	0-1
	Electricity & Magnetism	3-0
	Electricity & Magnetism Lab	0-1
	Philosophy of Science	3-0
	Pakistan Studies	2-0
Total		16-2

Semester - 4		
Code	Subject	Cr. Hr.
	Classical Mechanics	3-0
	Numerical Analysis	3-0
	Electromagnetic Waves	3-0
	Astronomy & Astrophysics	3-0
	Astronomy & Astrophysics Lab	0-1
	Fundamentals of GIS	2-0
	Fundamentals of GIS Lab	0-1
Total		18-1

Junior

Semester - 5

Code	Subject	Cr. Hr.
	Digital Image Processing	3-0
	Probability and Statistics	3-0
	Space Flight Dynamics	3-0
	Solar Physics and Space weather	3-0
	Circuits & Electronics	3-0
	Circuits & Electronics lab	0-1
	Meteorology and Atmospheric Sciences	3-0
Total		18-1

Senior

Semester - 7

Code	Subject	Cr. Hr.
	Research Methodology	2-0
	Space Mission Design	3-0
	Special Relativity (E)	3-0
	Quantum Mechanics (E)	3-0
	Applied Remote Sensing (E)	3-0
	WebGIS and Applications (E)	3-0
	Hydroclimatic Modelling (E)	3-0
	Satellite Navigation Systems (E)	3-0
	Spacecraft Attitude Dynamics & Controls (E)	3-0
	Thesis I	0-3
Total		26-3

Semester - 6

Code	Subject	Cr. Hr.
	Mathematical Methods for Space Science	3-0
	Introduction to Spatial Databases	3-0
	Programming with Python	2-0
	Programming with Python Lab	0-1
	Geospatial Analytics	3-0
	Climate System Dynamics	3-0
	Satellite Communications	3-0
	Space Plasma Physics	2-0
Total		19-1

Semester - 8

Code	Subject	Cr. Hr.
	Space Systems Project Management	3-0
	Space Law & Policy	2-0
	Astroparticle Physics (E)	3-0
	Cosmology (E)	3-0
	GIS Customization with Python (E)	3-0
	Photogrammetry (E)	3-0
	Global Warming and Climate Change (E)	3-0
	Guidance & Navigation of Space Vehicles (E)	3-0
	Inertial Navigation Systems (E)	3-0
	Thesis II	0-3
Total		26-3

Total No of Credit Hours

136

Elective Courses

A student may choose an elective course from the list after the approval of program head, research supervisor and HoD. Elective courses will be offered subject to the availability of relevant faculty and a reasonable number of interested students and with the approval of HoD/Dean

1. Astronomy and Astrophysics

- Analysis and Interpretation of Space Data
- Astrophysical & Computational Techniques
- Cosmology
- Geophysics and Space Science
- Gravitational Physics
- High Energy Astrophysics
- Radio Astronomy
- Solar-Terrestrial Physics
- Stellar Astronomy
- Astrobiology and Exoplanets
- Observational Astronomy

2. Remote Sensing & Geographical Information Science

- Analysis and Interpretation of Space Data
- Astrophysical & Computational Techniques
- Cosmology
- Geophysics and Space Science
- Gravitational Physics
- High Energy Astrophysics
- Radio Astronomy
- Solar-Terrestrial Physics
- Stellar Astronomy
- Astrobiology and Exoplanets
- Observational Astronomy

3. Environment and Climate Science

- Analysis and Interpretation of Space Data
- Astrophysical & Computational Techniques
- Cosmology
- Geophysics and Space Science
- Gravitational Physics
- High Energy Astrophysics
- Radio Astronomy
- Solar-Terrestrial Physics
- Stellar Astronomy
- Astrobiology and Exoplanets
- Observational Astronomy

4. Astrodynamics

- Guidance Navigation and Control Systems
- Navigation and Satellite Positioning
- Rocket and Spacecraft Propulsion
- Space Instruments
- Space Materials
- Space Vehicle Systems
- Spacecraft Attitude Dynamics and Control
- Spacecraft Power Systems
- Spacecraft System Design
- Spacecraft Thermal Control
- The Dynamic Earth and Space Geodesy
- Analog and Digital Signal Processing
- Data Communication and Networks
- Radar Technology
- Radio Techniques for Space Exploration
- Satellite Launch Systems

- Software Defined Radio

Details of the Courses are as follow:

Astronomy and Astrophysics

Solar system, Planets and minor objects, planetary data, Nature of radiations from cosmos, Interaction of light with matter, Blackbody Radiations, Telescopes and their types, Telescopes function, Data gathering and handling, H-R diagrams, Dwarf Stars, Red Giant Stars, Supergiant Stars, Brown Dwarf, Nebulae, Formations of Stars in Nebula, Protostars, Stellar structure and evolution, pre-main-sequence and main-sequence stars, Sources of stellar energy, The Sun and solar neutrino puzzle, Stellar magnitudes, Colours and temperatures, Binary stars, Visual, spectroscopic and eclipsing binaries, Variable stars, Novae, Supernovae, Compact stars, White dwarfs and neutron stars, Pulsars, quasars, galaxies and their types, Constituents and formation of solar system, Roche lobe, Exo-planets, Radiative transfer, Stellar Atmosphere, Stellar opacity, Hydrostatic equilibrium, Fundamentals Equations of Stellar structure, Stellar Spot and emissions, Limb darkening, stellar Activity, Distances to Star, Evolution of Stars, Interstellar Dust and Gas, Interstellar Chemistry, Virial theorem in stars formation, Accretion disk of protostars, Hayashi tracks in stellar evolution, Zero Age Main Sequence

Stars (ZAMS), HI and HII regions, open and globular clusters, Pulsating Stars, Stellar Motion, Star Death, Chandrasekhar Limit, Types of Supernovae, white dwarf, Neutron stars, Pulsars, Black Holes, Dark Matter, Dark Energy, Big Bang Theory, accelerating Universe, fate of the Universe

Spherical Astronomy

Introduction, The great and small circles, spherical angle and spherical triangle, applications to the Earth, longitude and latitude, basics of spherical trigonometry, the celestial sphere, horizontal and equatorial systems of coordinates, observer's meridian and diurnal motion, circumpolar stars, right ascension, the equation of time, Elements of spherical Astronomy, The celestial sphere, Parallax, Aberration and Precession, Concepts of geodesy and surveying, Earth's gravity field and the geoid, and measurement techniques applied to Geomatics are examined, Field studies include the use of the level, the total station, and GPS for doing distance and angle measurements, levelling, traversing and topographic surveying, Fundamental understanding of the principles of satellite-based positioning systems and specific knowledge about existing and planned systems (GPS, GNSS, COMPASS, GALELEO) and their applications

Space Plasma Physics

Introduction to Plasmas, Single-Particle Motions, Plasmas as Fluids, Elementary Plasma Waves, Diffusion and Resistivity, Dusty Plasmas Plasma Processing Techniques, Concepts and phenomena by considering applications ranging from fusion energy generation and microwave techniques to space physics and astrophysics

Solar Physics

Magneto-ionic theory, Maxwell's equations, propagation of electromagnetic waves in isotropic medium, constitutive relations for anisotropic medium, polarization, phase and group velocities, solar atmosphere, structure of sun, motion of charged particles in magnetic field, solar

oscillations, convection and rotation, solar wind and heliosphere, solar eruptions. Ionosphere and radio wave propagation, plasma and Alfvén waves, formation of Chapman layers, ion chemistry, Appleton-Hartree equation and its applications in ionosphere, steady-state conductivity of ionosphere, ionospheric phenomena and measurements, auroras, conversion of vertical to oblique incidence, ionogram scaling techniques, use of incoherent data for ionospheric research, HAARP

Electromagnetic Waves

Review of Electromagnetic Theory and Electricity and Magnetism, Maxwell's Equations, Types and Characteristics of Electromagnetic Waves, Propagation of Electromagnetic Waves in Conducting and Non Conducting Media, Time-varying and time-harmonic EM fields, Electrical Properties of Matter, Wave polarization, Electromagnetic theorems and principles, Radiation from structures, Reflection and transmission, Waveguides and cavities, Spectral domain approaches to solve nearly 1-D and 2-D problems, Numerical exercises using computational tools. Fundamental parameters of antennas, Linear and loop antennas, propagation issues, Arrays: linear, planar, circular; finite, infinite, Antenna feeding techniques, Broadband antennas, Aperture antennas, Horn antennas, Micro strip antennas and arrays, Reflector antennas

Circuits and Electronics

Systems of units, Basic quantities, Circuit Elements, Ohm's Law, Kirchhoff's Law, Single-Loop Circuits, Single Node Pair Circuits, Series and Parallel Resistor Combinations, Circuits with Series-Parallel Combination of Resistors, Wye Optoelectronics Overview of Physics fundamentals, Introduction to optics and photonics, Light theory, Electron processes, Light sources, Photon processes, Optical detectors, Photon processes and integration, Applications, Overview of optical fiber and free space communication systems, Complement technologies and future outlook. Analog and Digital Electronics Differential

and Multistage Amplifiers, OpAmps, Frequency response, feedback topologies, Multivibrators, Introduction to analog filters, Logic families and their characteristics, Design and Analysis of analog-digital interfaces in VLSI, Analog-Digital converters, Sample/Hold amplifiers, Introduction and design of VLSI circuits, VLSI hardware description languages, Gate level and Behavioral modeling of digital circuits, Types and applications of ASICs and FPGAs, ASIC and FPGA implementation, Coding Schemes, Analog/ Pulse Modulation Schemes

Mechanics

Vector and scalar triple product, Divergence Theorem, Stokes Theorem, Particle Dynamics: Effect of drag forces on motion: Applications of Newton's Laws, No inertial frames and Pseudo forces, Centrifugal force as an example of pseudo force, Systems of Particles: Two particle systems and generalization to many particle systems: Centre of mass: its position velocity and equation of motion, Calculation of center of mass using integral calculus, Elastics and Inelastic Collisions, Conservation of momentum, Rotational Dynamics: Kinetic project planning techniques, organization structure, human resource management, leadership, total quality management, project management techniques, managing information system, managing operation. Space systems acquisition, program management, test and evaluation processes, Systems engineering methods, lifecycle models, risk management, and trade-off analysis, Acquisition processes and standards, cost estimating, analysis of alternatives, program planning, program management, risk management, schedule/cost management, quality assurance, pricing and procurement, test and evaluation approaches, measures of effectiveness; and measures of uncertainty and confidence

Classical Mechanics

Elementary Principles: Brief survey of Newtonian mechanics of a system of particles, constraints,

D'Alembert's principle, Lagrange's equation and its applications, Variation Principles: Calculus of variation and Hamilton's principle, Derivation of Lagrange's equation from Hamilton's principle, Rutherford scattering, Equation of Motion: Angular momentum, Tensors and dydics, moment of inertia, rigid body problems Bohr's theory (review), Hertz experiment, energy level of electrons, Atomic spectrum, Angular momentum of electrons, vector atom model, orbital angular momentum, Spin quantization, Bohr's Magnetron, X-ray spectrum, (Continuous and discrete) Moseley's law, Pauli Exclusion Principle table and its use in developing the periodic table

Numerical Analysis

Error analysis, Solution of Nonlinear Equations, Linear Iteration, Newton's Method, Secant Method, Regula-Falsi Method, Bisection Method, Simultaneous Nonlinear Equation, Simultaneous Linear Equation, Jacobi method and Gauss Seidel Method, Bairstow's method to find the factors of an nth degree polynomial, Calculus of Finite Differences, Curve Fitting, Interpolation and Interpolating Polynomials, Gregory Newton Forward and Backward Differences Formulae, Lagrange Interpolation, Divided Differences and Divided Differences Interpolating Polynomials, Numerical Differentiation, Numerical Integration, Trapezoidal Rule, Simpson's Rule, Gauss Quadrature, Numerical Solution of Ordinary Differential Equations and Simultaneous Linear Differential Equations, Taylor Series Method, Euler's Method, Modified Euler's Method (Heun's method'), Runge-Kutta Method, Boundary Value Problems

Introduction to Computing

Data types, Variables, System I/O, Logical Operators, Control Structures, Functions, Scope, Lifetime and More on Functions, Single and Multidimensional Arrays, Structures, Unions and Enumerations, Classes and Objects, Strings, Pointers, Dynamic Data and Reference Types, Inheritance, File input and output

Fundamentals of Remote Sensing

Introduction to Remote Sensing, Remote Sensing and its Physical Principles, Electromagnetic Radiation, EM Spectrum, Interaction of Electromagnetic Radiation with Atmosphere and with the Earth's Surface, Atmospheric Windows, Signatures in Remote Sensing, Significance of Multi Spectral Imagery, Resolutions and its meanings, Colors and Human Vision, Color Models, Sensors and their types, satellites: types and functions, space shuttles, ground receiving stations and reception of data, Data Acquisition, Image Processing, Image Interpretation and Analysis, Evolution and application of GIS, data models, data acquisition techniques, data sources in Pakistan, data transformation, visualization of spatial data, map design, data classification, overlay analysis, spatial data quality, Digital Surface Modeling in GIS, Applications of GIS for Land Resource Management, Regional Planning and Land Use Change Analysis, Errors and Uncertainty, Global Positional System, GIS in Pakistan, Future of GIS

Digital Image Processing

Data Sources and Procurement, Data Formats (BSQ, BIL, BIP, GeoTiff, etc.), Image Cleaning, Atmosphere Path Correction, Color Theory and Band Combination, Image Sub-setting, Image scaling factor, Image statistics (Univariate and Multivariate), Image Enhancement Techniques, Contrast Enhancement, Histogram Stretching, Image Filtering, Image Rectification, Registration and Resampling, Image Mosaicing and Color Balancing, Band Ratios, Vegetation Indices, Principal Component Analysis, Classification Schemes, Supervised and Un-Supervised Classification, Field data collection, Accuracy assessment, Digital change detection, DEM/DTM, RS Applications: Landuse and Landcover, Agriculture/Forestry, Geological Phenomenon, Wetlands, Coastal Mapping, Defense Applications, Sea Surface Temperature, and Urban Planning etc

Introduction to Environmental Science

Overview of environmental systems, Environmental factors, Environmental dilemmas, Issues of environment

and sustainable development, Issues of the social environment, Environment and life style, The Global Climate, Energy for Human Use, The Price of Energy Conversion, Transport of Pollutants, Diffusion, Conservation of Mass, Flow in Rivers, Ground Water Flow, Turbulent Diffusion, Examples of Environmental Analysis, The Context of Society, Risk Estimation, Limits on Cheap Resources, Saving, Energy Resources and Nature, Components of Earth System, Hydrologic Cycle, Carbon Cycle, Oxygen in the Earth System, Atmospheric Thermodynamics, Gas Laws, Laws of Thermodynamics, Radiative Transfer, Atmospheric Chemistry, Cloud Microphysics

Meteorology and Atmospheric Sciences

Atmosphere: origin, composition and structure, Radiation; electromagnetic radiation, radiation law, solar radiation and atmosphere, ozone shield, Introduction to weather and climate, Elements of weather and their observation, components of climate systems Atmospheric lapse rates, stability parameters Heat, Gas laws, Humidity, Wind Air masses, Front, Cyclone and Anticyclone, Formation of clouds, weather phenomenon such as Dew, Frost, Fog, Rain, Hailstorm, Duststorm, Thunderstorm, Tropical Cyclones, Frontogenesis General Circulation of Atmosphere, Weather Systems; Monsoon (Frontal Systems), Western disturbance, Pakistan Climatic Classification, Greenhouse effect, Global warming, Climate Change and Climate Variability, Climate Change



Scenarios, Future climate projections, Impact of climate change on Water, Agriculture, Energy sectors, Types of Weather Forecasts, Types weather radars, Weather satellites, Role of Remote Sensing & GIS in weather and climate Monitoring, Heat and Temperature; temperature scale, heat units, transfer of heat, specific heat, windchill, Heat Imbalance, Air Pressure; pressure balance, horizontal variation, highs and lows, Humidity and Stability, Dew, frost, Fog and Clouds, Wind, Planetary Scale circulation, Air masses, Front, Cyclone and Anticyclone

Space Flight Dynamics

Coordinate Systems and Rotation Matrix, Euler Axes and Principle Angle, Euler Angles, Particle Kinematic in a Moving Frame, variable Mass Bodies, Rotation and Translation of a Body, n-Body Problem, Two Body Problem; Geometry of Two Body Trajectories, Lagrange's coefficients, Kepler's Equation for Elliptical Orbit, Position and Velocity in a Hyperbolic Trajectory, Parabolic Escape Trajectory, Celestial Frame and Orbital Elements, Orbit Determination, Motions of Planets and Satellites, Orbit Perturbations, Orbit Maneuvers, Time of Flight in Elliptical, Circular, Parabolic and Hyperbolic orbits, the Hyperbolic Orbit Space Debris, Rocket Propulsion; Rocket Equation and Staging, Optimal Rocket

Satellite Communications

Building Blocks of Communication System Performance Evaluation of Source Coder, Encoder, Decoder and different modulation Schemes Introduction to role of probability in communication systems Brief History of Satellite Communications, Satellite Communications in 2000, Overview of satellite communications Orbital Mechanics, Orbit Perturbations, Orbit Determination, Orbital Effects in Communications Systems Performance Satellite Subsystems, Attitude and Orbit Control Systems, Telemetry, Tracking, Command and Monitoring Power Systems, Communications Subsystems, Satellite Antennas, Equipment Reliability and Space Qualification Satellite



Link Design, Basic Transmission Theory, System Noise Temperature and G/T Ratio, Design of Downlinks, Uplink Design Overview of other state of the art land mobile communication systems, GSM architecture and Cell planning Multiplexing and Modulation Techniques, Digital Transmission, Baseband Transmission of Digital Data, Digital Modulation and Demodulation

Space Mission Design

Fundamentals of systems engineering, identification and problems definition, Synthesis, analysis, and evaluation activities during conceptual and preliminary system design phases, Articulation through examples and case studies, Real-world application of the entire space engineering discipline, Basic mission objectives and principles and practical methods for mission design and operations in depth, Interactive discussions focus on initial requirements definition, operations concept development, architecture trade-offs, payload design, bus sizing, subsystem definition, system manufacturing, verification and operations

Space Law and Policy

The role of international law in the regulation of outer space activities, Government Regulation of Space

Activities, International legal aspects of various space applications, in particular, the international law related to satellite telecommunications, the role therein of various international organizations as well as broadcasting by satellite, navigational services, remote sensing by satellites, space stations, space travel, etc., Certain specific aspects of international law related to international technology transfers, military uses of outer space, trade in space products, satellite telecommunications and launch services, Review and comparison of the international space laws that overlap and are intertwined with international relations, international law, commercial law and the relationship between governmental civilian and defence space activities, An overview to the law important, and as yet, unresolved legal issues that will confront the space community in the years ahead. An overview of domestic and international space policies and strategies, Understanding of the current national security strategy, the military space-related doctrines, domestic laws and policies, and international laws, treaties, and agreements

Employment Prospects

BS Space Science program is crafted to enhance the knowledge breadth while combining the emerging technologies and domains of Astronomy & Astrophysics, Remote Sensing & Geographical Information Science, Environment & Climate Science and Astrodynamics. The integration of wide diversity in curriculum coverage makes this BS Space Science program an attractive choice for the students and opening numerous avenues for their career prospects. Space assets and technologies can be used to support the United Nations Sustainable Development Goals (SPACE for SDGs). Data from Earth-observation satellites play a key role in most of the seventeen SDGs to help monitor targets, plan and track progress, and help countries and organizations make well-informed decisions as they work towards SDG objectives. The wide utility purview of space science

applications in astronomy, agriculture, environmental monitoring, disaster management (floods, earthquakes, landslides, wildfires etc.), weather forecasting, climatology (glacier melting) highlight its broader scope and the graduate of BS space science program can pursue their career in the aforementioned sectors. More specifically, the potential job market for the graduate of BS Space Sciences rests in:

- Space agencies (SUPARCO, ESA, NASA, JAXA)
- Food & Agriculture department
- Forestry and wildlife
- Disaster management authorities (NDMA, NDMRF)
- Meteorology (PMD)
- Academia

Remote Sensing and Geo-Information Science

The Bachelor of Science in Remote Sensing & Geographic Information Systems (BS RS&GIS) at Institute of Space Technology (IST), Islamabad is a future-focused program designed to equip students with advanced geospatial knowledge, hands-on technical skills, and multidisciplinary problem-solving capabilities. This four-year degree is aligned with national needs and global trends, preparing graduates to address challenges in climate change, urban planning, disaster management, environmental sustainability, and beyond.

Offered under the Department of Space Science, the program integrates principles of Remote Sensing, Geo-Informatics, programming, spatial data science, and artificial intelligence with practical applications using cutting-edge tools like UAVs, Hyperspectral imagery, Synthetic Aperture Radar, and cloud-based platforms such as Google Earth Engine.

Our mission is to build a strong academic and practical foundation in geospatial science and technology that directly contributes to Pakistan's national development goals. Through this program, we aim to nurture a new generation of professionals equipped with the technical expertise and critical thinking required to innovate in diverse fields such as natural resource management, precision agriculture, climate and environmental monitoring, hydrology, urban and regional planning, and national security. Emphasizing both theoretical knowledge and applied skills, the program is designed to produce graduates who are not only research-oriented and industry-ready, but also capable of competing at the global level in an era increasingly shaped by big geospatial data, artificial intelligence, and smart technologies. Our graduates will be empowered to drive data-informed decision-making and create impactful geospatial solutions for real-world challenges.

With a balance of theory, practical labs, field experience, and a final-year capstone project, BS RS&GIS at IST is your gateway to transforming Earth data into impactful solutions.

Freshman

Semester - 1

Code	Subject	Cr. Hr.
XXXXXX	Calculus*	3-0
	Functional English*	3-0
	Applications of Information and Communication Technologies*	2-1
	Introduction to GIS	2-1
	Introduction to Physical Geography	3-0
	Introduction to Programming	3-0
Total		16-2

Sophomore

Semester - 3

Code	Subject	Cr. Hr.
XXXXXX	Technical Writing**	2-0
	Islamic Studies	2-0
	Pakistan Studies*	2-0
	Land Surveying	2-1
	Digital Image Processing	2-1
	Global Navigation Satellite System	2-1
	Data Structure and Algorithms	3-0
Total		15-3

Semester - 2

Code	Subject	Cr. Hr.
XXXXXX	Statistics and Probability*	3-0
	Psychology	2-0
	Expository Writing**	3-0
	Introduction to Geology and Geophysics	2-1
	Introduction to Remote Sensing	2-1
	Map work and Projections	2-1
Total		14-3

Semester - 4

Code	Subject	Cr. Hr.
XXXXXX	Civics and Community Engagement*	2-0
	Ideology and Constitution of Pakistan*	2-0
	Entrepreneurship*	2-0
	Active Remote Sensing	2-1
	Photogrammetry	2-1
	Digital Cartography	1-1
	Spatial Data Analysis	2-1
Total		13-4

*The student may Exit with Associate Degree in Remote Sensing and GIS after completion of 04 Semesters in Remote Sensing and GIS four year degree program.

Junior

Semester - 5

Code	Subject	Cr. Hr.
XXXXXX	Meteorology	3-0
	Disaster Management and Risk Assessment	3-0
	Spatial Data Infrastructure and Standardization	3-0
	Mobile Data Acquisition and Mapping	2-1
	GIS Programming and Customization	2-1
Total		13-2

Senior

Semester - 7

Code	Subject	Cr. Hr.
XXXXXX	Web GIS	2-1
	Artificial Intelligence in RS and GIS	2-1
	Spatial Data Modeling	2-1
	Elective-III***	3-0
	Elective-IV***	3-0
	Capstone Project	3-0
Total		15-3

Semester - 6

Code	Subject	Cr. Hr.
XXXXXX	Research Methodology	3-0
	Spatial Decision Support Systems	3-0
	Spatial Databases	2-1
	Hyperspectral Remote Sensing	2-1
	Elective-I***	3-0
	Elective-II***	3-0
Total		16-2

Semester - 8

Code	Subject	Cr. Hr.
XXXXXX	Unmanned Aerial Vehicle and Data Processing	2-1
	Machine Learning in Spatial Data	2-1
	Elective-V***	3-0
	Elective-VI***	3-0
	Capstone Project (Continue)	3-0
Total		13-2

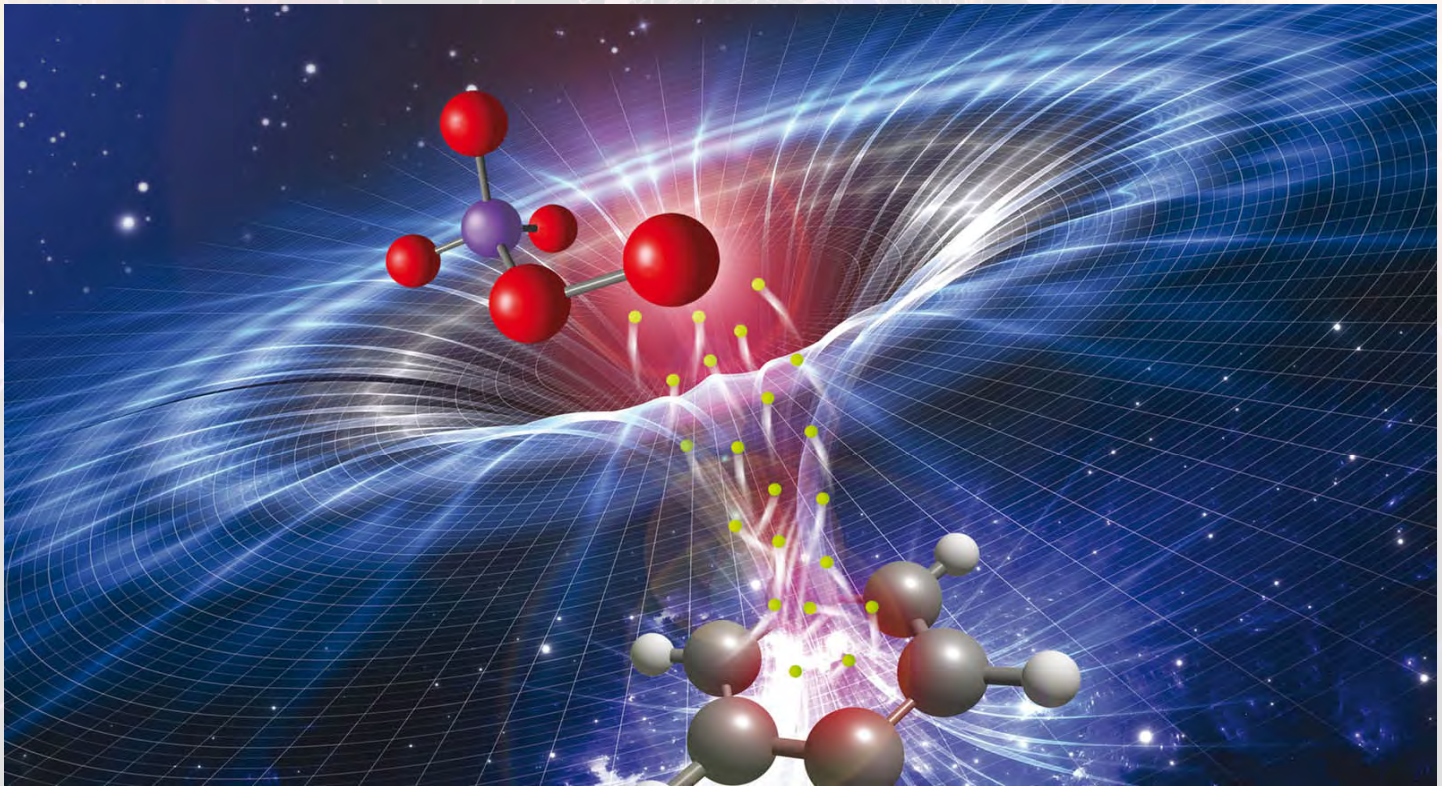
Total No of Credit Hours

133

Physics

Physics investigates the laws of nature and is indispensable not only for understanding of the universe but also for the solution of the technological and ecological problems. As a fundamental of science, Physics continues to be the driving intellectual force in expanding our understanding of the universe, in discovering the scientific basis for new technologies, and in applying these technologies to research. The BS program in Physics is designed to enlighten students with knowledge from all the vast areas of Physics, including Classical Mechanics, Electrodynamics, Statistical Mechanics, Quantum Mechanics, Particle Physics, Plasma Physics, Condensed Matter Physics, Special and General Relativity etc. Alongside a sound basic education

in Physics and Mathematics, BS students would be able to choose attractive, career-oriented study blocks, notably from the fields of Computational Physics, Materials Physics, Environmental Physics, Plasma Physics, High Energy Physics, Electronics and Astronomy & Astrophysics, which is a unique specialization of its kind in Pakistan. The students shall be introduced to the research world by working in the diverse fields under the supervision of capable faculty, where emphasis is placed on teaching and research and preparing the students to become the next great physicists of tomorrow.



Freshman

Semester - 1

Code	Subject	Cr. Hr.
XXXXXX	Mathematical Methods of Physics-I	3-0
	Probability and Statistics	3-0
	Nuclear Physics	3-0
	Quantum Mechanics-I	3-0
	Electronics-II	3-0
	Electronics-II Lab	0-1
Total	Electromagnetic Theory-II	3-0
		18-1

Sophomore

Semester - 3

Code	Subject	Cr. Hr.
XXXXXX	Differential Equations	3-0
	Linear Algebra	3-0
	Modern Physics	3-0
	Modern Physics Lab-I	0-1
	Heat & Thermodynamics	3-0
	Waves & Oscillations	3-0
	Heat, Waves & Sound Lab	0-1
Total		15-2

Semester - 2

Code	Subject	Cr. Hr.
XXXXXX	Communication Skills	3-0
	Calculus-II	3-0
	Computer Programming	2-0
	Computer Programming Lab	0-1
	Electricity & Magnetism	3-0
	Electricity & Magnetism Lab	0-1
	Philosophy of Science	3-0
	Pakistan Studies	2-0
Total		16-2

Semester - 4

Code	Subject	Cr. Hr.
XXXXXX	Classical Mechanics	3-0
	Numerical Analysis	3-0
	Electromagnetic Theory-I	3-0
	Optics	3-0
	Optics Lab	0-1
	Electronics-I	3-0
	Electronics-I Lab	0-1
Total		15-2

Junior

Semester - 5

Code	Subject	Cr. Hr.
XXXXXX	Mathematical Methods of Physics-I	3-0
	Probability and Statistics	3-0
	Nuclear Physics	3-0
	Quantum Mechanics-I	3-0
	Electronics-II	3-0
	Electronics-II Lab	0-1
	Electromagnetic Theory-II	3-0
Total		18-1

Senior

Semester - 7

Code	Subject	Cr. Hr.
XXXXXX	Advanced Experiments in Physics-I	0-1
	Solid State Physics-II	3-0
	General Relativity Elective	3-0
	Materials Physics Elective-I	3-0
	Electronics Elective-I	3-0
	Astronomy & Astrophysics Elective-I	3-0
	Plasma Physics Elective	3-0
	High Energy Physics Elective-I	3-0
	Thesis I	0-3
Total		24-4

Semester - 6

Code	Subject	Cr. Hr.
XXXXXX	Mathematical Methods of Physics-II	3-0
	Technical Writing	3-0
	Computational Physics	2-0
	Computational Physics Lab	0-1
	Quantum Mechanics-II	3-0
	Solid State Physics-I	3-0
	Statistical Physics	3-0
	Modern Physics Lab-II	0-1
Total		17-2

Semester - 8

Code	Subject	Cr. Hr.
XXXXXX	Advanced Experiments in Physics-II	0-1
	Project Management Relativity-II	3-0
	Cosmology Elective	3-0
	Materials Physics Elective-II	3-0
	Electronics Elective-II	3-0
	Astronomy & Astrophysics Elective-II	3-0
	Solar Physics Elective	3-0
	High Energy Physics Elective-II	3-0
	Atmospheric Physics Elective	3-0
	Thesis II	0-3
Total		24-4

Total No of Credit Hours

133

Elective Courses

A student may choose an elective course from the list after the approval of program head, research supervisor and HoD. Elective courses will be offered subject to the availability of relevant faculty and a reasonable number of interested students and with the approval of HoD/Dean

- Plasma Physics
- Methods of Experimental Physics
- Environmental Physics
- Introduction to Quantum Computing
- Quantum Information Theory
- Quantum Field Theory
- Digital Electronics
- Lasers
- Laser Engineering
- Experimental Techniques in Particle and Nuclear Physics
- Electronic Materials and Devices
- Fluid Dynamics
- Introduction to Photonics
- Introduction to Materials Science
- Introduction to Nano Science and Nanotechnologies
- Particle Physics
- Geophysics

Details of the Courses are as follow:

Mechanics

Basic Concepts: Units and Dimensions, SI Units, Changing Units, Scalars and Vectors, Adding Vectors: Graphical as well as Component Method, Multiplying Vectors: Dot and Cross Products. Motion in One, Two and Three Dimensions: Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames. Newton's Laws: Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Gravitational Potential Energy, Escape Velocity,

Kepler's Laws, Satellite Orbits & Energy. Work and Kinetic Energy: Work done by Constant and Variable Forces: Gravitational and Spring Forces, Power, Conservative and Non-conservative Forces, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy. System of Particles: Motion of a System of Particles and Extended Rigid Bodies, Center of Mass and Newton's Laws for a System of Particles, Linear Momentum, Impulse, Momentum & Kinetic Energy in One- and Two-Dimensional Elastic and Inelastic Collisions. Rotational Motion: Rotation about a Fixed Axis, Angular Position, Angular Displacement, Angular Velocity and Angular Acceleration, Rotation under Constant Angular Acceleration, relationship between Linear and Angular Variables, Rotational Inertia, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Work and Rotational Kinetic Energy, Power, Rolling Motion, Angular Momentum for a single Particle and a System of Particles, Conservation of Angular Momentum, Precession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes i.e. for disc, bar and solid sphere. Angular Momentum: Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum. Simple Harmonic Motion (SHM): Amplitude, Phase, Angular Frequency, Velocity and Acceleration in SHM, Linear and Angular Simple Harmonic Oscillators, Energy in SHM, Simple Pendulum, Physical Pendulum, SHM and Uniform Circular Motion, Damped Harmonic Oscillator. Special Theory of Relativity: Inertial and non-inertial frame, Postulates of Relativity, The Lorentz Transformation, Derivation, Assumptions on which inverse transformation is derived, Consequences of Lorentz transformation, Relativity of time, Relativity of length, Relativity of mass, Transformation of velocity, variation of mass with velocity, mass energy relation and its importance, relativistic momentum and Relativistic energy, (Lorentz invariants) $E^2 = c^2 p^2 + m^2 c^4$

Electricity and Magnetism

Electrostatics: Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to a Charge Distribution, Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry. Electric Potential: Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and, Electric Potential Energy. Capacitors and Capacitance: Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in an Electric Field, Dielectrics and Gauss' Law. DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, Semiconductors and Superconductors, Work, Energy, and EMF, Resistances in Series and Parallel, Single and Multi-loop Circuits, Kirchhoff's Rules, RC Circuits, Charging and Discharging of a Capacitor. Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot-Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current carrying Coil as a Magnetic Dipole, Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self-Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction. Alternating Fields and Currents: LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents, Forced Oscillations, Resistive, Capacitive, and Inductive Loads, RLC series Circuit, Power in AC Circuits, Transformers, Gauss' Law for Magnetism, Induced Magnetic Fields, Displacement Current, Spin & Orbital Magnetic Dipole Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis.

Heat and Thermodynamics

Basic Concepts and Definitions in Thermodynamics: Thermodynamic system, Surrounding and Boundaries, Type of systems, Macroscopic and microscopic description of system, Properties and state of the substance: Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium. Processes and Cycles: Isothermal, Isobaric and Isochoric, Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics, The state of the system at Equilibrium. Heat and Temperature: Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts, Internal energy of an ideal gas: Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state. Thermodynamics: First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion, Reversible and irreversible processes, Second law of thermodynamics, Carnot theorem and Carnot engine, Heat engine, Refrigerators, Calculation of efficiency of heat engines, Thermodynamic temperature scale: Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamics, Entropy and Probability, Thermodynamic Functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule-Thomson effect and its equations. Thermoelectricity: Thermocouple, Seaback's effect, Peltier's effect, Thomson effect. Introduction to Statistical Mechanics: Statistical distribution and mean values, Mean free path and microscopic calculations of mean free path. Distribution of Molecular Speeds, Distribution of Energies, Maxwell distribution, Maxwell Boltzmann energy distribution, Internal energy of an ideal gas, Brownian Motion Legvaian equation, Qualitative description.

Waves and Oscillations

Simple and Damped Simple Harmonic Oscillation: Mass-Spring System, Simple Harmonic Oscillator Equation,

Complex Number Notation, LC Circuit, Simple Pendulum, Quality Factor, LCR Circuit. Forced Damped Harmonic Oscillation: Steady-State Behavior, Driven LCR Circuit, Transient Oscillator Response, Resonance Coupled Oscillations: Two Spring-Coupled Masses, Two Coupled LC Circuits, Three Spring Coupled Masses, Normal Modes, Atomic and Lattice Vibrations. Transverse Waves: Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity Longitudinal Waves: Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas. Traveling Waves: Standing Waves in a Finite Continuous Medium, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Transmission Lines, Reflection and Transmission at Boundaries, Electromagnetic Waves Wave Pulses: Fourier Series and Fourier Transforms, Bandwidth, Heisenberg's Uncertainty Principle. Multi-Dimensional Waves: Plane Waves, Three-Dimensional Wave Equation, Laws of Geometric Optics, Waveguides, Cylindrical Waves. Interference and Diffraction of Waves: Double-Slit Interference, Single-Slit Diffraction.

Modern Physics

Motivation for Non--Classical Physics: Quantum interference, blackbody radiation and ultraviolet catastrophe, Planck's quantization. Wave-Particle Duality: Photoelectric effect, Compton effect, production and properties of X-rays, diffraction of X-rays, concept of matter waves, de Broglie relationship, electrons are waves, electron diffraction, particulate nature of matter, contributions of Faraday (atoms exist), Thomson (electron exists), Rutherford (nucleus exists) and Bohr (quantization of energies inside an atom), wave packets and wave groups, dispersion, Heisenberg uncertainty principle, direct confirmation of quantization through Franck-Hertz experiment and spectroscopy, working of electron microscopes. Quantum Mechanics in One Dimension: The concept of a wavefunction, time independent Schrodinger equation and interpretation of the equation, solving the Schrodinger equation for a free particle, for a particle

inside an infinite box, relationship between confinement and quantization, working of a CCD camera. Quantum Mechanical Tunneling: Concept of tunneling, reflection and transmission of wave functions from barriers, applications: radioactivity, scanning tunneling microscope, decay of black holes. Quantum Mechanics in Three Dimensions: The Hydrogen atom, orbitals, angular momentum and its quantization, orbital magnetism, Zeeman effect, concept of spin, Pauli's exclusion principle, building of the periodic table, magnetic resonance and MRI, why is iron magnetic? White dwarfs, and neutron stars. From Atoms to Molecules and Solids: Ionic bonds, covalent bonds, hydrogen bonds, molecular orbitals, how crystals are different from amorphous solids? Why and how do metals conduct electricity? Bands in solids, semiconductors, introduction to LED's and lasers, introducing grapheme. Nuclear Structure: Size and structure of nucleus, nuclear forces, radioactivity and nuclear reactions, radiocarbon dating

Optics

Propagation of Light & Image Formation: Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface, Thin Lenses, Newtonian Equation for a Thin Lens. Matrix Methods in Paraxial Optics: Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points of an Optical System with examples, Optical Instruments including Simple Magnifiers, Telescopes and Microscopes, Chromatic and Monochromatic Aberrations, Spherical Aberrations, Coma, Distortion, Stops, Pupils, Windows. Superposition & Interference: Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple-Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range. Polarization: Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction. Fraunhofer Diffraction: From a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings. Fresnel Diffraction: Zone Plates,

Rectangular Apertures, Cornu's Spiral. Coherence & Holography: Temporal Coherence, Spatial Coherence, Holography of a Point object and an Extended Object. Laser Basics: Stimulated Emission, Population Inversion, Resonators, Threshold and Gain, Multi-layered Dielectric Films.

Mathematical Methods of Physics-I

Partial Differential Equations: Introduction to important PDEs in Physics (wave equation, diffusion equation, Poisson's equation, Schrodinger's equation), general form of solution, general and particular solutions (first order, inhomogeneous, second order), characteristics and existence of solutions, uniqueness of solutions, separation of variables in Cartesian coordinates, superposition of separated solutions, separation of variables in curvilinear coordinates, integral transform methods, Green's functions. Complex Analysis: Review (polar form of complex numbers and de Moivre's theorem, complex logarithms and powers), functions of a complex variable, Cauchy-Riemann conditions, power series in a complex variable and analytic continuation with examples, multi-valued functions and branch cuts, singularities and zeroes of complex functions, complex integration, Cauchy's theorem, Cauchy's integral formula, Laurent series and residues, residue integration theorem, definite integrals using contour integration.

Electromagnetic Theory-I

The Dirac Delta Function: Review of vector calculus using example of Dirac Delta function, the divergence of r/r^2 , the one-dimensional and the three-dimensional Dirac delta functions. The theory of vector fields: the Helmholtz theorem, potentials. Electrostatics: The electric field: introduction, Coulomb's law, the electric field, continuous charge distributions. Divergence and curl of electrostatic fields: field lines, flux and Gauss's law, the divergence of E , applications of Gauss's law, the curl of E . Electric potential: introduction to potential, comments on potential, Poisson's equation and Laplace's equation, the potential of a

localized charge distribution, summary, electrostatics boundary conditions, Work and energy in electrostatics: the work done to move a charge, the energy of a point charge distribution, the energy of a continuous charge distribution, comments on electrostatic energy. Conductors: basic properties, induced charges, surface charge and the force on a conductor, capacitors. Special Techniques: Laplace's equation: introduction, Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems. The Method of Images: The classic image problem, induced surface charge, force and energy, other image problems. Multi-pole Expansion: Approximate potential at large, the monopole and dipole terms, origin of coordinates in multi-pole, expansions, the electric field of a dipole. Electric Fields in Matter: Polarization: Dielectrics, induced dipoles, alignment of polar molecules, polarization, The field of a polarized object: bound charges, physical interpretation of bound charges, and the field inside a dielectric. The electric displacement: Gauss's law in the presence of dielectrics, a deceptive parallel, boundary conditions. Linear Dielectrics: susceptibility, permittivity, dielectric constant, boundary value problems with linear dielectrics, energy in dielectric systems, forces on dielectrics. Magneto statics: The Lorentz Force law: magnetic fields, magnetic forces, currents. The Biot-Savart Law: steady currents, the magnetic field of a steady current. The divergence and curl of B : straight-line currents, the divergence and curl of B , applications of Ampere's law, comparison of magneto statics and electrostatics. Magnetic Vector Potential: the vector potential, summary, magnetic boundary conditions, multipole expansion of the vector potential. Magnetic Fields in Matter: Magnetization, diamagnets, paramagnets, ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization. The Field of a Magnetized Object: bound currents, physical interpretation of bound currents, and the magnetic field inside matter. The auxiliary field H : Ampere's law in magnetized materials, a deceptive

parallel, boundary conditions. Linear and nonlinear media: magnetic susceptibility and permeability, ferromagnetism.

Classical Mechanics

Review of Newtonian Mechanics: Frame of reference, orthogonal transformations, angular velocity and angular acceleration, Newton's laws of motion, Galilean transformation, conservation laws, systems of particles, motion under a constant force, motions under variable force, time-varying mass system. The Lagrange Formulation of Mechanics and Hamilton Dynamics: Generalized co-ordinates and constraints, D'Alembert's principle and Lagrange's Equations, Hamilton's principle, integrals of motion, non-conservative system and generalized potential, Lagrange's multiplier method, the Hamiltonian of a dynamical system, canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem. Central Force Motion: The two-body problem, effective potential and classification of orbits, Kepler's laws, stability of circular orbits, hyperbolic orbits and Rutherford scattering, center of mass coordinate system, scattering cross-sections. Motion in Non- inertial Systems: Accelerated translational co -ordinate system, dynamics in rotating co-ordinate system, motion of a particle near the surface of the earth. The Motion of Rigid Bodies: The Euler angles, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, motion of a torque-free symmetrical top, stability of rotational motion.

Electronics-I

The Semiconductor Diode: Metals, insulators and semiconductors, Conduction in Silicon and Germanium, the forbidden energy gap, n and p type semiconductors, the junction diode, diode voltage-current equation, Zener diodes, light emitting diodes, photodiodes, capacitance effects in the pn junction. The Diode as Rectifier and Switch: The ideal diode model, the half wave rectifier, the full wave rectifier, the bridge rectifier, measurement of

ripple factor in the rectifier circuit, the capacitor filter, the π filter, the π -R filter, the voltage doubling rectifier circuit, rectifying AC voltmeters, diode wave clippers, diode clippers. Circuit Theory and Analysis: Superposition theorem, Thevenin's Theorem, Norton's Theorem, Model for circuit, one port and two-port network, Hybrid parameter equivalent circuit, Power in decibels. The Junction Transistor as an Amplifier: Transistor voltage and current designations, the junction transistors, the volt-ampere curve of a transistor, the current amplification factors, the load line and Q point, the basic transistor amplifiers, the common emitter amplifier, the trans-conductance gm, performance of a CE amplifier, relation between A_i and A_v , the CB amplifier, the CC amplifier, comparison of amplifier performance. DC Bias for the Transistor: Choice of Q point, variation of Q point, fixed transistor bias, the four-resistor bias circuit, design of a voltage feedback bias circuit, Common emitter, common collector, common base biasing. Field Effect Transistor: What is /field effect transistor, JFET: Static characteristics of JFET, Metal oxide semiconductor Field Effect Transistor (MOSFET of IGFET): enhancement and depletion mode, FET biasing techniques, Common drain, common source and common gate, fixed bias and self-bias configurations, Universal JFET bias curve, Darlington pair. Operational Amplifiers: The integrated amplifier, the differential amplifier, common mode rejection ratio, the operational amplifier, summing operation, integration operation, comparator, milli-voltmeter

Mathematical Methods of Physics-II

Group Theory and Representations for finite groups: Transformations, groups definitions and examples, subgroups and Cayley's theorem, cosets and Lagrange's theorem, conjugate classes, invariant subgroups, factor groups, homomorphism, direct products, mappings, linear operators, matrix representations, similarity transformation and equivalent matrix representations, group representations, equivalent representations and characters, construction of representations and addition of

representations, invariance of functions and operators, unitary spaces and Hermitian matrices, operators: adjoint, self-adjoint, unitary, Hilbert space, reducibility of representations, Schur's lemmas, orthogonality relations, group algebra, expansion of functions in basis of irreducible representations, Kronecker product, symmetrized and anti-symmetrized representations, adjoint and complex-conjugate representations, real representations, Clebsch-Gordan series and coefficients, applications of these ideas to classification of spectral terms, perturbation theory and coupled systems. Tensor Analysis: Vector calculus (differentiation, integration, space curves, multi-variable vectors, surfaces, scalar and vector fields, gradient, divergence and curl, cylindrical and spherical coordinates, general curvilinear coordinates), change of basis, Cartesian tensor as a geometrical object, order/rank of a tensor, tensor algebra, quotient law, pseudotensors, Kronecker delta and Levi-Civita, dual tensors, physical applications, integral theorems for tensors, non-Cartesian tensors, general coordinate transformations and tensors, relative tensors, Christoffel symbols, covariant differentiation, vector operators in tensor form, absolute derivatives along curves, geodesics.

Quantum Mechanics-I

Waves and Particles: Introduction to the fundamental ideas of quantum. Mechanics: Electromagnetic waves and photon, material particles and matter waves, quantum description of a particle, wave packets, particle in a time-independent scalar potential, order of magnitude of the wavelength associated with material particles, constraints imposed by uncertainty relations, one-dimensional Gaussian wave packet: Spreading of the wave packet, stationary states of a particle in one-dimensional square potential, behavior of a wave packet at a potential step. The Mathematical Tools of Quantum Mechanics: One-particle wave function space, state space, Dirac notation, representations in the state space, observable, representations, review of some useful properties of linear operators, unitary operators, study of the $\{|r\rangle\}$ and

$\{| \rangle\}$ representations, some general properties of two observable, Q and P , whose commutator is equal to $i\hbar$, the two-dimensional infinite well. The Postulates of Quantum Mechanics: Statement of the postulates and their physical interpretation, the physical implications of the Schrodinger equation, the superposition principle, particle in an infinite potential well, study of the probability current in some special case, root-mean-square deviations of two conjugate observables, the density and evolution operators, Schrodinger and Heisenberg pictures, Gauge invariance, bound states of a particle in a potential well of arbitrary shape, unbound states of a particle in the presence of a potential well or barrier of arbitrary shape, quantum properties of a particle in a one-dimensional periodic structure. Application of The Postulates to Simple Cases: Spin $\frac{1}{2}$ And Two-Level.

Quantum Systems: Spin $\frac{1}{2}$ particles, quantization of the angular momentum, illustration of the postulates in the case of a spin $\frac{1}{2}$, general study of two-level systems, Pauli matrices, diagonalization of a 2×2 hermitian matrix, System of two spin $\frac{1}{2}$ particles, Spin $\frac{1}{2}$ density matrix, Spin $\frac{1}{2}$ particle in a static magnetic field and a rotating field, Magnetic resonance.

The One - Dimensional Harmonic Oscillator: Importance of the harmonic oscillator in physics, eigenvalues and eigenstates of the Hamiltonian, mean value and root-mean-square deviations of X and P in state $|\phi\rangle$, Some examples of harmonic oscillators, study of the n stationary states in the $\{|r\rangle\}$ representation, Hermite polynomials, solving the Eigenvalues of the harmonic oscillators by the polynomial method, study of the stationary states in the $\{| \rangle\}$ representation, isotropic three-dimensional harmonic oscillator, charged harmonic oscillator placed in a uniform electric field, coherent states, Normal. vibrational modes of coupled harmonic oscillators, vibrational modes of an infinite linear chain of coupled harmonic oscillators, phonons, one-dimensional harmonic oscillator in thermodynamics equilibrium at a temperature T . General Properties of Angular Momentum in Quantum Mechanics: Concept of angular momentum in quantum mechanics,

commutation relations, application to orbital angular momentum, spherical harmonics, rotation operators, rotation of diatomic molecules, angular momentum of stationary states of a two-dimensional harmonic oscillator, charged particle in a magnetic field and Landau levels. Particle in a Central Potential: The Hydrogen atom, Stationary states of a particle in a central potential, motion of the center of mass and relative motion for a system of two interacting particles, Hydrogen atom, Hydrogen-like systems, A solvable example of a central potential: the isotropic three-dimensional harmonic oscillator, probability currents associated with the stationary states of the hydrogen atom, The hydrogen atom placed in a uniform magnetic field, para-magnetism and diamagnetism, Zeeman effect, study of some atomic orbitals, vibrational-rotational levels of diatomic molecules.

Electromagnetic Theory-II

Electrodynamics: Electromotive force: Ohm's law, electromotive force, motional emf, electromagnetic induction: Faraday's law, the induced electric field, inductance, energy in magnetic fields, Maxwell's equations: electrodynamics before Maxwell, how Maxwell fixed Ampere's law, Maxwell's equations, magnetic charges, Maxwell's equations in matter, boundary conditions. Conservation Laws: Charge and energy: the continuity equation, Poynting's theorem, momentum: Newton's third law in electrodynamics, Maxwell's stress tensor, conservation of momentum, angular momentum. Electromagnetic Waves: Waves in one dimension: the wave equation, sinusoidal waves, boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum: the wave equation for E and B , monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter: propagation in linear media, reflection and transmission at normal incidence, reflection and transmission at oblique incidence, absorption and dispersion: electromagnetic waves in conductors, reflection at a conducting surface, the frequency dependence of permittivity, guided waves: wave

guides, the waves in a rectangular wave guide, the coaxial transmission line. Potentials and Fields: The potential formulation: scalar and vector potentials, gauge transformations, Coulomb gauge and Lorentz gauge, continuous distributions: retarded potentials, Jefimenko's equations, point charges: Lienard-Wiechert potentials, the field of a moving point charge. Radiation, Dipole Radiation: What is radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, point charges: power radiated by a point charge, radiation reaction, the physical basis of the radiation reaction. Electrodynamics and Relativity: The special theory of relativity: Einstein's postulates, the geometry of relativity, the Lorentz transformations, the structure of space-time, relativistic mechanics: proper time and proper velocity, relativistic energy and momentum, relativistic kinematics, relativistic dynamics, relativistic electrodynamics: magnetism as a relativistic phenomenon, how the field transform, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Electronics-II

Amplifiers and their Frequency Response: Cascade amplifier, The Amplifier pass band, The frequency plot, Low frequency plot, Low frequency limit, The un-bypassed emitter resistor, high frequency equivalent circuit, The Miller Effect, high frequency limit of transistor, bandwidth of a cascade amplifier. Feedback: Positive and Negative feedback, Principle of feedback amplifier, stabilization of gain by negative feedback, Bandwidth improvement with negative feedback, Reduction of nonlinear distortion, control of amplifier output and input resistance, current series feedback circuit, voltage shunt feedback circuit. Oscillators: Introduction, Classification of oscillators, Damped and undamped oscillators, the oscillatory circuit, frequency stability of an oscillator, essentials of a feedback LC oscillator, tuned base oscillator, Hartley oscillator, Colpitts oscillator, crystal oscillator. Power Amplifiers: Introduction, Power relation in class-A amplifiers, effect of thermal environment, determination of the output

distortion, class-B amplifier, efficiency of class-A and class-B amplifiers. Modulation and Demodulation: Introduction, carrier wave modulation, Need for modulation, radio Broadcasting, Methods of modulation, amplitude modulation, Forms of amplitude modulation, single side band system of modulation, Diode for linear detector for amplitude modulation, High power level amplitude modulation, automatic volume control, Frequency modulation. Multivibrators: Multivibrators, Basic types of Multivibrators, uses of Multivibrators, Astable Multivibrators, Mono-stable Multivibrators, Bi-stable Multivibrators, Schmitt Trigger Circuit. Integrated Circuits: Introduction, Integrated circuit advantages and drawbacks, scale of integration, classification of integrated circuit by structure, Classification of integrated circuit by function, comparison between different integrated circuit. Integrated circuit terminology, Integrated circuit fabrication, Basic processing steps. Silicon device processes Silicon wafer preparation, diffusion, Oxidation photolithography, Chemical vapour deposition, Metallization, Circuit probing, Scribing and separating into chips, Mounting and packing applications of integrated circuit. Digital Circuits: Decimal, Binary, Octal, hexadecimal number systems, conversion of decimal numbers to any other number system and vice-versa, Binary codes, OR, AND, NOT, NAND, NOR logic gates, Boolean Algebra. Boolean expressions, simplification of Boolean expression using Boolean Algebra.

Statistical Mechanics

Review of Classical Thermodynamics: States, macroscopic vs. microscopic, "heat" and "work", energy, entropy, equilibrium, laws of thermodynamics, Equations of state, thermodynamic potentials, temperature, pressure, chemical potential, thermodynamic processes (engines, refrigerators), Maxwell relations, phase equilibrium. Foundation of Statistical Mechanics: Phase Space, Trajectories in Phase Space, Conserved Quantities and Accessible Phase Space, Macroscopic Measurements and Time Averages, Ensembles and Averages over Phase

Space, Liouville's Theorem, The Ergodic Hypothesis, Equal a priori Probabilities. Specification of the state of a system, concept of ensembles, elementary probability calculations, distribution functions, statistical interpretation of entropy (Boltzmann theorem). Statistical Ensembles: Microcanonical ensemble, canonical ensemble and examples (e.g., paramagnet), calculation of mean values, calculation of partition function and its relation with thermodynamic quantities, the grand canonical ensemble and examples (e.g., adsorption), calculation of partition function and thermodynamic quantities. Simple Applications of Ensemble Theory: Monoatomic ideal gas in classical and quantum limit, Gibb's paradox and quantum mechanical enumeration of states, equipartition theorem and examples (ideal gas, harmonic oscillator), specific heat of solids, quantum mechanical calculation of para-magnetism. Quantum Statistics: Indistinguishability and symmetry requirements, Maxwell-Boltzmann statistics, Bose-Einstein and photon statistics, Fermi-Dirac statistics (distribution functions, partition functions), Examples: polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE). Systems of Interacting Particles: Lattice vibrations in solids, van der Waals gas, mean field calculation, ferromagnets in mean field approximation.

Quantum Mechanics-II

Addition of Angular Momenta: Total angular momentum in classical mechanics, total angular momentum in quantum mechanics, addition of two spin $\frac{1}{2}$ angular momenta, addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, addition of spherical harmonics, vector operators, Wigner-Eckart theorem, electric Multi-pole moments, Evolution of two angular momenta J_1 and J_2 coupled by an interaction $aJ_1 \cdot J_2$. Stationary Perturbation Theory: Description of the method, perturbation of non-degenerate level, perturbation of a degenerate level, one-dimensional harmonic oscillator subjected to a perturbing potential, interaction between the magnetic dipoles of two spin $\frac{1}{2}$ particles, Van der Waals

forces, volume effect and the influence of the spatial extension of the nucleus on the atomic levels, variational method, energy bands of electrons in solids, a simple example of the chemical bond: The $H+2$ ion. Applications of Perturbation Theory to Atomic Systems: Fine and hyperfine structure of atomic levels in hydrogen, Calculation of the mean values of the spin-orbit coupling in the $1s$, $2s$ and $2p$ levels, hyperfine structure And the Zeeman effect for muonium and positronium, Stark effect. Approximation Methods for Time-Dependent Problems: Statement of the problem, approximate solution of the Schrodinger equation, An important special case: Sinusoidal or constant perturbation, Interaction of an atom with electromagnetic waves, linear and non-linear response of a two-level system subjected to a sinusoidal perturbation, Oscillations of a system between two discrete states under the effect of a resonant perturbation, Rabi flopping, decay of discrete state resonantly coupled to a continuum of final states, Fermi's golden rule. Systems of Identical Particles: Identical particles, Permutation operators, The symmetrization postulate, difference between bosons and fermions, Pauli's exclusion principle, many-electrons atom and their electronic configurations, energy levels of the helium atom, configurations, terms, multiplets, spin isomers of hydrogen (ortho and parahydrogen). Scattering by a Potential: Importance of collision phenomena, Stationary scattering states, scattering cross section, scattering by a central potential, method of partial waves, phenomenological description of collisions with absorption.

Atomic and Molecular Physics

One Electron Atoms: Review of Bohr Model of Hydrogen Atom, Reduced Mass, Atomic Units and Wavenumbers, Energy Levels and Spectra, Schrodinger Equation for One-Electron Atoms, Quantum Angular Momentum and Spherical Harmonics, Electron Spin, Spin-Orbit interaction. Levels and Spectroscopic Notation, Lamb Shift, Hyperfine Structure and Isotopic Shifts, Rydberg Atoms. Interaction of One-Electron Atoms with Electromagnetic

Radiation: Radiative Transition Rates, Dipole Approximation, Einstein Coefficients, Selection Rules, Dipole Allowed and Forbidden Transitions. Metastable Levels, Line Intensities and Lifetimes of Excited States, Shape and Width of Spectral Lines, Scattering of Radiation by Atomic Systems, Zeeman Effect, Linear and Quadratic Stark Effect. Many-Electron Atoms: Schrodinger Equation for Two-Electron Atoms, Para and Ortho States, Pauli's Principle and Periodic Table, Coupling of Angular Momenta, L-S and J-J Coupling. Ground State and Excited States of Multi-Electron Atoms, Configurations and Terms. Molecular Structure and Spectra: Structure of Molecules, Covalent and Ionic Bonds, Electronic Structure of Diatomic Molecules, Rotation and Vibration of Diatomic Molecules, Born-Oppenheimer Approximation. Electronic Spectra, Transition Probabilities and Selection Rules, Frank-Condon Principle, H_2^+ and H_2 , Effects of Symmetry and Exchange, Bonding and Anti-bonding Orbitals. Electronic Spin and Hund's Cases, Nuclear Motion: Rotation and Vibrational Spectra (Rigid Rotation, Harmonic Vibrations). Selection Rules. Spectra of Triatomic and Polyatomic Molecules, Raman Spectroscopy, Mossbauer Spectroscopy.

Solid State Physics I

Crystal Structure: Lattices and basis, Symmetry operations, Fundamental Types of Lattice, Position and Orientation of Planes in Crystals, Simple crystal structures Crystal Diffraction and Reciprocal Lattice: Diffraction of X-rays, Neutrons and electrons from crystals; Bragg's law; Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis of the Basis. Phonons and Lattice: Quantization of Lattice Vibrations, Phonon momentum, inelastic scattering by phonons, Lattice Vibrations for Mono-atomic and diatomic basis, Optical Properties in the Infrared Region. Thermal Properties of Solids: Lattice heat Capacity, Classical model, Einstein Model, Enumeration of normal modes, Density of state in one, two or three dimensions, Debye model of heat capacity, Comparison with experimental results, thermal conductivity and resistivity, Umklapp processes. Electrical Properties of

Metals: Classical free electron theory of metals, energy levels and density of orbitals in one dimension, effect of temperature on the Fermi–Dirac distribution function, properties of the free electron gas, electrical conductivity and Ohm's Law, thermal and electrical conductivities of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with applications.

Solid State Physics II

Dielectric Properties of Solids: Polarization, Depolarization, Local and Maxwell field, Lorentz field, Clausius-Mossotti relation, Dielectric Constant and Polarizability, Measurement of dielectric constant, ferroelectricity and ferroelectric crystals, Phase Transitions, First and 2nd order phase transitions, Applications. **Semiconductors:** General properties of semiconductors, intrinsic and extrinsic semiconductors, their band structure, carrier statistics in thermal equilibrium, band level treatment of conduction in semiconductors and junction diodes, diffusion and drift currents, collisions and recombination times. **Optical Properties:** Interaction of light with solids, Optical Properties of Metals and Non -Metals, Kramers Kronnig Relation, Excitons, Raman Effect in crystals, optical spectroscopy of solids. **Magnetic Properties of Materials:** Magnetic dipole moment and susceptibility, different kinds of magnetic materials, Langevin diamagnetic equation, Paramagnetic equation and Curie law, Classical and quantum approaches to paramagnetic materials. **Ferro-magnetic and anti – ferromagnetic order,** Curie point and exchange integral, Effect of temperature on different kinds of magnetic materials and applications. **Superconductivity:** Introduction to superconductivity, Zero-Resistance and Meissner Effect, Type I and Type II superconductors, Thermodynamic fields, Two fluid model, London equations, BCS and Ginzburg Landau Theory, Vortex Behaviour, Critical Current Density, Josephson effect and applications.

Nuclear Physics

History: Starting from Becquerel's discovery of radioactivity to Chadwick's neutron. **Basic Properties of Nucleus:** Nuclear

size, mass, binding energy, nuclear spin, magnetic dipole and electric quadrupole moment, parity and statistics. **Nuclear Forces:** Yukawa's theory of nuclear forces, Nucleon scattering, charge independence and spin dependence of nuclear force, isotopic spin. **Nuclear Models:** Liquid drop model, Fermi gas model, Shell model, Collective model. **Theories of Radioactive Decay:** Theory of Alpha decay and explanation of observed phenomena, measurement of Beta ray energies, the magnetic lens spectrometer, Fermi theory of Beta decay, Neutrino hypothesis, theory of Gamma decay, multipolarity of Gamma rays, nuclear isomerism. **Nuclear Reactions:** Conservation laws of nuclear reactions, Q-value and threshold energy of nuclear reaction, energy level and level width, cross sections for nuclear reactions, compound nucleus theory of nuclear reaction and its limitations, direct reaction, resonance reactions, Breit-Wigner one level formula including the effect of angular momentum.

Plasma Physics

Introduction: Occurrence of plasma, Concept of temperature, Debye shielding, the plasma parameter, Criteria for plasma. **Applications of Plasma Physics:** Single-particle motion in electromagnetic field, Uniform and non-uniform E and B fields, Time -variant E and B fields, Fluid description of plasma, Wave propagation in plasma, Derivation of dispersion relations for simple electrostatic and electromagnetic modes, Introduction to Controlled Fusion, Basic nuclear fusion reactions, Reaction rates and power density, radiation losses from plasma, operational conditions.

Methods of Experimental Physics

Vacuum Techniques: Gas Transport: Throughput, Pumping Speed, Pump down Time Ultimate pressure. **Fore-Vacuum Pumps:** Rotary Oil pumps, sorption pumps. **Diffusion pumps, sorption pumps (High Vacuum).** Production of ultrahigh vacuum, Fundamental concepts, guttering pumps, Ion pumps, Cryogenic pumps, Turbo molecular pumps. **Measurement of total pressure in Vacuums Systems,** Units pressure ranges, Manometers, Penning gauges, The McLeod

gauges, Mass spectrometer for partial measurement of pressure, Design of high Vacuum system, Surface to Volume ratio, Pump Choice, pumping system design. Vacuum Components, Vacuum valves, vacuum Flanges, Liquid Nitrogen trap, Mechanical feed throughs & Electrical feed throughs Leak detection: Basic consideration, leak detection equipment, Special Techniques and problems, Repair Techniques. Radiation Detection and Measurement: GM tubes, scintillation detector, channeltron, photo multipliers, neutron detectors, alpha/beta detectors, x-rays/gamma detectors, cosmic rays detectors, Spectrographs and Interferometers. Sensor Technology: Sensors for temperature, pressure displacement, rotation, flow, level, speed, rotation position, phase, current voltage, power magnetic field, tilt, metal, explosive and heat. Electronics and Electronic Instruments: Operational amplifiers, summing amplifiers, difference amplifiers, Differentiators, Integrators, Logarithmic amplifiers, current to voltage converter, Spectroscopy amplifiers, charge sensitive pre-amplifiers, Coincidence circuits, Isolators, Ramp Generators, and single channel analyzer. Power supplies, Signal Generators, Counters, Multichannel analyzer, Lock in Amplifiers, Boxcar averages. Computer Introduction: Introduction to computers, GPIB Interface, RS 232. Interfacing, DA/AD conversion, Visual c/visual Basic. Data Analysis: Evaluation of measurement: Systematic Errors, Accuracy, Accidental Errors, Precision, Statistical Methods, Mean Value and Variance, Statistical Control of Measurements, Errors of Direct measurements, Rejection of data, Significance of results, Propagation of errors, preliminary Estimation, Errors of Computation. Least squares fit to a polynomial. Nonlinear functions. Data manipulation, smoothing, interpolation and extrapolation, linear and parabolic interpolation.

Environmental Physics

Introduction to the Essentials of Environmental Physics: The economic system, living in green house, enjoying the sun, Transport of matter, Energy and momentum, the social and political context. Basic Environmental Spectroscopy: Black

body radiation, The emission spectrum of sun, The transition electric dipole moment, The Einstein Coefficients, Lambert – Beer's law, The spectroscopy of bi-molecules, Solar UV and life, The ozone filter. The Global Climate: The energy Balance, (Zero-dimensional Greenhouse Model), elements of weather and climate, climate variations and modelling. Transport of Pollutants: Diffusion, flow in reverse, ground water. Flow equations of fluid Dynamics, Turbulence, Turbulence Diffusion, Gaussian plumes in air, Turbulent jets and planes. Noise: Basic Acoustics, Human Perceptions and noise criteria, reducing the transmission of sound, active control of sound. Radiation: General laws of Radiation, Natural radiation, interaction of electromagnetic radiation and plants, utilization of photo synthetically active radiation. Atmosphere and Climate: Structure of the atmosphere, vertical profiles in the lower layers of the atmosphere, Lateral movement in the atmosphere, Atmospheric Circulation, cloud and Precipitation, The atmospheric greenhouse effect. Topo Climates and Micro Climates: Effects of surface elements in flat and widely undulating areas, Dynamic action of seliq, Thermal action of selief. Climatology and Measurements of Climate Factor: Data collection and organization, statistical analysis of climatic data, climatic indices, General characteristics of measuring equipment, Measurement of temperature, air humidity, surface wind velocity, Radiation balance, precipitation, Atmospheric Pressure, automatic weather stations.

Introduction to Quantum Computing

Computer technology and historical background, Basic principles and postulates of quantum mechanics: Quantum states, evolution, quantum measurement, superposition, quantization from bits to qubits, operator function, density matrix, Schrodinger equation, Schmidt decomposition, EPR and Bell's inequality, Quantum Computation: Quantum Circuits, Single qubit operation, Controlled operations, Measurement, Universal quantum gates, Single qubit and CNOT gates, Breaking unbreakable codes: Code making, Trapdoor function, One

time pad, RSA cryptography, Code breaking on classical and quantum computers, Schor's algorithm, Quantum Cryptography: Uncertainty principle, Polarization and Spin basis, BB84, BB90, and Ekert protocols, Quantum cryptography with and without eavesdropping, Experimental realization, Quantum Search Algorithm.

Quantum Information Theory

Review of Quantum Mechanics and overview of Quantum information: Postulates of quantum mechanics, quantum states and observables, Dirac notation, projective measurements, density operator, pure and mixed states, entanglement, tensor products, no-cloning theorem, mixed states from pure states in a larger Hilbert space, Schmidt decomposition, generalized measurements, (CP maps, POVMs), qualitative overview of Quantum Information. Quantum Communication: Dense coding, teleportation, entanglement swapping, instantaneous transfer of information, quantum key distribution. Entanglement and its Quantification: Inseparability of EPR pairs, Bell inequality for pure and mixed states, entanglement witnesses, Peres-Horodecki criterion, properties of entanglement measures, pure and mixed state entanglement, relative entropy as entanglement measure, entanglement and thermodynamics, measuring entanglement. Quantum Information: Classical information theory (data compression, Shannon entropy, von Neumann entropy), fidelity, Helstrom's measurement and discrimination, quantum data compression, entropy and information, relative entropy and its statistical interpretation, conditional entropy, Holevo bound, capacity of quantum channel, relative entropy and thermodynamics, entropy and erasure, Landauer's erasure. Quantum Computation: Classical computation (Turing machines, circuits, complexity theory), quantum algorithms (Deutsch's algorithm, Oracles, Grover's algorithm, factorization and quantum Fourier transform), role of entanglement in algorithms (search algorithm), modeling quantum measurements, Bekenstein bound, quantum error correction (general conditions, stabilizer codes, 3-qubit codes, relationship with Maxwell's

demon), fault tolerant quantum computation (overview). Physical Protocols for Quantum Information and Computation: Ion trap, optical lattices, NMR, quantum optics, cavity QED

Quantum Field Theory

Lagrangian Field Theory: Classical Field Theory. Canonical Quantization. Noether's theorem. Klein-Gordon Field: Real Klein -Gordon field. Complex Klein-Gordon field. Covariant commutation relations. Meson propagator. Dirac Field: Number representation for fermions. Quantization of Dirac field. Spin-statistics theorem. Fermion propagator. Electromagnetic Field: Classical electromagnetic field. Covariant quantization. Photon propagator. Interacting Fields: Interaction Lagrangian and gauge invariance. Interaction picture. S-matrix expansion. Wick's theorem. Feynman Diagrams. Feynman rules for QED. Cross sections and decay rates.

Digital Electronics

Review of Number Systems: Binary, Octal and Hexadecimal number system, their inter-conversion, concepts of logic, truth table, basic logic gates. Boolean Algebra: De Morgan's theorem, simplification of Boolean expression by Boolean Postulates and theorem, K-maps and their uses. Don't care condition, Different codes. (BCD, ASCII, Gray etc.). Parity in Codes. IC Logic Families: Basic characteristics of a logic family. (Fan in/out, Propagation delay time, dissipation, noise margins etc. Different logic-based IC families (DTL, RTL, ECL, TTL, CMOS). Combinational Logic Circuit: Logic circuits based on AND – OR, OR-AND, NAND, NOR Logic, gate design, addition, subtraction (2's compliments, half adder, full adder, half subtractor, full subtractor encoder, decoder, PLA. Exclusive OR gate. Sequential Logic Circuit: Flip-flops clocked RS-FF, D-FF, T-FF, JK -FF, Shift Register, Counters (Ring, Ripple, up-down, Synchronous) A/D and D/A Converters. Memory Devices: ROM, PROM, EPROM, EE PROM, RAM, (Static and dynamic) Memory mapping techniques. Micro Computers: Computers and its types, all generation of

computers, basic architecture of computer, microprocessor (ALU, UP Registers, Control and Time Section), Addressing modes, Instruction set and their types, Discussion on 8085/8088, 8086 processor family, Intel Microprocessor Hierarchy. Micro-controller/ Embedded System: Introduction to Embedded and microcontroller-based systems, The Microprocessor and microcontroller applications and environment, microcontroller characteristics, features of a general-purpose microcontroller, Microchip Inc and PIC microcontroller, Typical Microcontroller examples: Philips 80C51 & 80C552 and Motorola 68Hc05/08, Interfacing with peripherals.

Laser

Introductory Concepts: Spontaneous Emission, Absorption, Stimulated Emission, Pumping Schemes, Absorption and Stimulated Emission Rates, Absorption and Gain Coefficients, Resonance Energy Transfers. Properties of Laser Beam: Monochromaticity, Coherence, Directionality, Brightness. Spectroscopy of Molecule and Semiconductors: Electronic Energy Levels, Molecular Energy Levels, Level Occupation at Thermal Equilibrium, Stimulated Transition, Selection Rules, Radiative and Nonradiative Decay, Semiconductor. Optical Resonators: Plane Parallel (Fabry-Perot) Resonator, Concentric (Spherical) Resonator, Confocal, Resonator, Generalized Spherical Resonator, Ring Resonator, Stable Resonators, Unstable Resonators. Matrix Formulation of Geometrical Optics, Wave Reflection and Transmission at a Dielectric Interface, Stability Condition Standing and Traveling Waves in a two Mirror Resonator, Longitudinal and Transverse Modes in a Cavity, Multilayer Dielectric Coatings, Fabry-Perot Interferometer. Small Signal Gain and Loop Gain. Pumping Processes: Optical pumping: Flash lamp and Laser, Threshold. Pump Power, pumping efficiency, Electrical Pumping: Longitudinal Configuration and Transverse Configuration, Gas Dynamics Pumping, Chemical Pumping. Continuous Wave (CW) and Pulsed Lasers: Rate Equations, Threshold Condition and Output Power, Optimum Output Coupling, Laser Tuning, Oscillation and Pulsations in Lasers, Q-

Switching and Mode-Locking Methods, Phase Velocity, Group Velocity, and Group-Delay Dispersion, Line broadening. Lasers Systems: Solid State Lasers: Ruby Laser, Nd: YAG & Nd: Glass. Lasers and Semiconductor Lasers: Homojunction Lasers Double. Heterostructure lasers, Gas lasers: Helium Neon laser, CO₂ laser, Nitrogen Laser and Excimer Lasers, Free-Electron and X-Ray Lasers. Laser Applications: Material Processing: Surface Hardening, Cutting, Drilling, Welding etc. Holography, Laser Communication, Medicine, Défense Industry, Atmospheric Physics

Experimental Techniques in Particle and Nuclear Physics

Review of Basic Concepts: Units used in particle physics, Definition used in particle physics, Types of particles to be detected, Cross section, Decay width, Lab Frame and CM frame, Pseudo rapidity, History of Accelerator, Linear accelerators, Circular accelerators, Introduction to RHIC, Tevatron, LEP, LHC. Introduction to Accelerators: Lattice and geometry, The arcs, Periodicity, Aperture, Beam crossing angle, Luminosity, RF cavities, Power requirements, Longitudinal feedback system, Injection, Injection scheme, PS, SPS, Magnets, Cryogenics, Vacuum system. Introduction to Detectors: Introduction to detectors, Need of detectors, Passage of radiation through matter, Cross-section, Interaction probability in a distance x , Mean free path, Energy loss of heavy charged particles by atomic collisions, Bohr's, calculation – classical case - The Bethe Bloch formula, Cherenkov radiation, Energy loss of electron and photon, Multiple coulomb scattering, Energy straggling, The interaction of photons, The interaction of neutrons. General Characteristics of Detectors and Gas Detectors: Sensitivity, Detector response, Energy resolution The Fano-factor, The response function, Response time, Detector efficiency, Dead time- Ionization detectors, Gaseous ionization detectors, Ionization & transport phenomenon in gases, Transport of electrons and ions in gases, Avalanche multiplication, The cylindrical proportional counter, The multi-wire proportional counter, The drift chambers, Time projection chambers, Liquid ionization detector.

Scintillators, Photomultipliers, Semi-conductor Detectors: Scintillation detectors, Organic scintillation, Inorganic crystals, Gaseous scintillators Glasses, Intrinsic detector efficiency for various radiations, Photomultipliers, Basic construction and operation, The photocathode, The electron-optical input system, Semiconductor detectors, Silicon diode detectors, Introduction to CMS and its detectors. Detector Software and Physics Objects: Introduction to Linux operating system, Introduction to CMS software (CMSSW), Basic infrastructure of software, Introduction to PYTHIA, Introduction to GEN, SIM, DIGI, RECO, reconstruction of final state objects.

Electronics Materials and Devices

Semiconductor Fundamentals: Composition, purity and structure of semiconductors, energy band model, band gap and materials classification, charge, effective mass and carrier numbers, density of states, the Fermi function and equilibrium distribution of carriers, doping, n and p-type semiconductors and calculations involving carrier concentrations, EF etc., temperature dependence of carrier concentrations, drift current, mobility, resistivity and band bending, diffusion and total currents, diffusion coefficients, recombination-generation, minority carrier life times and continuity equations with problem solving examples. Device Fabrication Processes: Oxidation, diffusion, ion implantation, lithography, thin -film deposition techniques like evaporation, sputtering, chemical vapour deposition (CVD), epitaxy etc. PN Junction and Bipolar Junction Transistor: Junction terminology, Poisson's equation, qualitative solution, the depletion approximation, quantitative electrostatic relationships, ideal diode equation, non-idealities, BJT fundamentals, Junction field effect transistor, MOS fundamentals, the essentials of MOSFETs. Dielectric Materials: Polarization mechanisms, dielectric constant and dielectric loss, capacitor dielectric materials, piezoelectricity, ferroelectricity and pyroelectricity. Optoelectronic Devices: Photoconductors, photovoltaics and photodetectors, photodiodes and photovoltaics, solar cell basics, LEDs, Lasers, displays, LCDs. Magnetism and Magnetic Materials: Basics of magnetism, hysteresis loops,

magnetic domains and anisotropy, hard and soft magnetic materials, transformers, DC motors and data storage.

Fluid Dynamics

Phenomenological introduction to fluid dynamics Kinematics and conservational. Ideal fluids, the Euler equations, Irrotational flow The Navier-Stokes equations. Viscous flow: Stokes flow, drag, lubrication theory, thin film flow. Waves: Surface waves, internal gravity waves, nonlinear waves. solitons, shocks. Instabilities: Linear stability analysis, Kelvin-Helmholts instability, Rayleigh-Bénard convection, other instabilities. Other topics depending on interest and as time permits possibly: Airfoil theory, granular flows, biophysical flows.

Introduction to Photonics

Guided Wave Optics: Planar slab waveguides, rectangular channel waveguides, Single and multi-mode optical fibers, waveguide modes and field distributions, waveguide dispersion, pulse propagation. Gaussian Beam Propagation: ABCD matrices for transformation of Gaussian beams, applications to simple resonators. Electromagnetic Propagation in Anisotropic Media: Reflection and transmission at anisotropic interfaces, Jones Calculus, retardation plates, polarizers. Electro-optics and Acousto-optics: Linear electro-optic effect, Longitudinal and transverse modulators, amplitude and phase modulation, Mach-Zehnder modulators, Coupled mode theory, Optical coupling between waveguides, Directional couplers, Photoelastic effect, Acousto-optic interaction and Bragg diffraction, Acousto-optic modulators, deflectors and scanners. Optoelectronics: p-n junctions, semiconductor devices: laser amplifiers, injection lasers, photoconductors, photodiodes, photodetector noise.

Introduction to Materials Science

Atomic Structure of Materials: The packing of atoms in 2-D and 3-D, unit cells of the hexagonal close packing (hcp) and cubic closed packing (ccp) structures, interstitial structures, density computation, lattices and symmetry elements, indexing lattice directions and lattice planes,

interplanar spacing, lattices and crystal systems in 3-D, symmetry, crystallographic point groups and space groups, Bragg's law and the intensities of Bragg reflections. Imperfections in Solids: Vacancies, impurities, dislocations, interfacial defects, bulk or volume defects, atomic vibrations. Microstructure: Microstructure and microscopy, pressure vs. temperature phase diagrams, temperature vs. composition phase diagrams, equilibrium, thermodynamic functions, variation of Gibbs energy with temperature and composition, general features of equilibrium phase diagrams, solidification, diffusion mechanisms, nucleation of a new phase, phase diagrams of Fe-C system and other important alloys, materials fabrication. Mechanical Behaviour of Materials: Normal stress and normal strain, shear stress and shear strain, elastic deformation, plastic deformation, Young's modulus, shear modulus, Poisson's ratio, elastic strain energy, thermal expansion, estimate of the yield stress, dislocations and motion of dislocations, slip systems, dislocations and strengthening mechanisms, fracture mechanics, ductile fracture, brittle fracture, Griffith criterion, ductile fracture, toughness of engineering materials, the ductile-brittle transition temperature, cyclic stresses and fatigue, creep. Polymers: Polymer basics, polymer identification, polymer molecules, additional polymerization, step growth polymerization, measurement of molecular weight, thermosetting polymers and gels, rubbers and rubber elasticity, configuration and conformation of polymers, the glassy state and glass transition, determination of T_g , effect of temperature and time, mechanical properties of polymers, case studies in



polymer selection and processing. Biomaterials: Introduction to biomaterials, materials selection, biopolymers, structural polysaccharides, hard materials, biomedical materials

Introduction to Nano Science and Nanotechnologies

Introduction: Feynman talks on small structures, Nano scale dimension, Course goals and objectives. Quantum Effects: Wave particle duality, Energy quanta, Uncertainty principle, De Broglie relation, Quantum Dots, Moore's law, tunnelling. Surfaces and Interfaces: Interfaces, Surface chemistry and physics, Surface modification and characterization, Thin Films, Sputtering, Self-assembled films. Material Properties: Subatomic physics to chemical systems, types of chemical bonds, solid state physics / Material properties. Tools and Instrumentation: STM, AFM, Electron Microscopy, Fluorescence methods, Synchrotron Radiation. Fabricating Nano Structures: Lithography (photo and electron beam), MBE, Self-assembled masked, FIB, Stamp technology, Nano junctions. Electrons in Nano Structures: Variation in electronic properties, free electron model, Bloch's theorem, Band structure, Single electron transistor, Resonant tunnelling. Molecular Electronics: Lewis structures, Approach to calculate Molecular orbitals, Donor Acceptor properties, Electron transfer between molecules, Charge transport in weakly interacting molecular solids, Single molecule electronics. Nano Materials: Quantum dots, nano wires, nano photonics, magnetic nano structures, nano thermal devices, Nano fluidic devices, biomimetic materials. Nano Biotechnology: DNA micro-arrays, Protein and DNA Assembly, Digital cells, genetic circuits, DNA computing. Nanotechnology the Road Ahead: Nanostructure innovation, Quantum Informatics, Energy solutions

Particle Physics

Introduction to Elementary Particles: Fundamental building blocks and their interactions, Quantum Electrodynamics, Quantum Chromodynamics Weak Interactions Decays and conservation laws. Relativistic Kinematics: Lorentz transformations, Four-Vectors, Energy and momentum,

Particle collisions, Mandelstam variables. Symmetries: Symmetries and conservation laws, Spin and orbital angular momentum, Flavour symmetries, Parity, Charge conjugation, CP Violation, Time reversal and TCP Theorem. Quantum Electrodynamics: Klein-Gordon equation, Dirac equation, Solution of Dirac equation, Bilinear covariant. Feynman rules for QED. Casimir's trick, Cross sections & lifetimes, Neutrino Oscillations: Solar neutrino problem, Oscillations, Neutrino masses, PMNS mixing matrix Gauge Field Theories: Lagrangian in Relativistic Field Theory, Gauge Invariance, Yang- Mills Theory, the mass term, Spontaneous symmetry breaking, Higgs mechanism, Higgs boson, Grand Unification, Super symmetry, Extra dimensions, String theory, Dark energy, Dark Matter

Computer Simulations in Physics

Programming for Scientific Computation: Unix/Linux basics, the editing-coding-compiling-debugging-optimizingvisualizing-documenting production chain, Fortran95. Numerical Programming: Functions: approximation and fitting, Numerical calculus. Ordinary differential equations, Matrices, Spectral analysis, Partial differential equations. Modelling and Simulation: Molecular dynamics simulations, modelling continuous media Monte Carlo simulations. Project: A project will be chosen by the student in consultation with the instructor. Selection of the project should be done soon after the module on modelling and simulation starts and continues over the course of the rest of the semester. The final part of the course is reserved for presentation of preliminary and final results.

Computational Physics

Computer Languages: A brief introduction of the computer languages like Basic, C, Pascal etc. and known software packages of computation. Numerical Methods: Numerical Solutions of equations, Regression and interpolation, Numerical integration and differentiation, Error analysis and technique for elimination of systematic and random errors. Modelling & Simulations: Conceptual models, the

mathematical models, Random numbers and random walk, doing Physics with random numbers, Computer simulation, Relationship of modelling and simulation, some systems of interest for physicists such as Motion of Falling objects, Kepler's problems, Oscillatory motion, Many particle systems, Dynamic systems, Wave phenomena, Field of static charges and current, Diffusion, Population's genetics etc.

Employment Prospects

Students completing this program shall acquire broad knowledge and skills to work in various organizations looking for physicists. Scope for our graduates will be in:

- Research & Development organizations of Pakistan (PIEAS, SUPARCO, KRL, NESCOM etc.)
- National Centre of Physics
- Private/Public Industry
- Academia
- Higher studies at National/International universities



The image features a central robot head, a composite of various mathematical and scientific symbols. The head is constructed from a grid of blue and white squares, with a prominent white 'X' and 'Y' axis. The robot's face is a white, stylized human-like head with a large, glowing blue eye. The background is a dark blue gradient, overlaid with a complex network of mathematical formulas and symbols in white and yellow. These include algebraic equations like $x^2 + y^2 = r^2$, $a^2 + b^2 = c^2$, and $E = MC^2$; trigonometric functions like $\sin$ and $\cos$; calculus notations like $\frac{d}{dx}$ and $\int$; and chemical structures like H_2O and CO_2 . The overall composition suggests a deep integration of mathematics and science into a futuristic, artificial intelligence theme.

Department of Applied Mathematics and Statistics

Applied Mathematics and Statistics are two of the most important branches of science which helps all the modern fields of science, technology, and engineering branches to solve their complex problems and provides various opportunities in the field of smart designing.

It is an essential tool, which is required for enhancing research and development in the field of almost all branches of science. The study of AM&S enhances the knowledge in specific areas such as Calculus, Statistics, Applied Physics, Linear Algebra, Differential Equation, Computer Programming, Real Analysis, Business Mathematics, Analytic Mechanics, Integral Equations Complex Analysis, and many more important domains. There are other domains namely data science and artificial intelligence where AM&S plays a very important role.

The department of AM&S runs an HEC recognized academic program with three different specializations namely Mathematics, Data Science and Artificial Intelligence (AI). The department of AM&S runs an HEC recognized academic program with the help of faculty which has rich on hand experience of practical problem-solving skills in various fields of modern mathematical techniques. The existing department of AM&S is mainly focused on teaching, research, and development in the field of various branches of mathematics, and Space Science. Aerospace and Space Science program require a strong knowledge of mathematics for solving their complex problems during the design process.

The program is designed to provide all-round experience to students in fundamental principles and applications of advanced applied mathematics, numerical analysis, and various fields of Space Science.

The department provides continuous academic improvement through consultation with faculty, industry and various private and public sector organizations for fulfilling their future needs. The focus of the courses is to provide a platform in mathematics which incorporates

the theoretical and applied mathematics for the sake of development in science and technology; to provide sound foundation to engineers and scientists working for Space Science and related technologies in fulfilling the demands of their profession; to fulfill the future needs of socioeconomic requirements of our country.

After the completion of this degree program, the students will have stronger mathematical skills and applied mathematical knowledge, which will enable them to solve the complex problems in various fields of related engineering, scientific disciplines and create data-driven solutions.

Mission Statement

The mission of the program is three-fold: to provide a platform in mathematics which incorporates the theoretical and applied mathematics for the sake of development in data science and artificial intelligence; to provide sound foundation to computer engineers and data scientists working for Space Science and related domains in fulfilling the demands of their profession; to bridge the gap, which open the doors to possible careers in a wide variety of industries such as business, retail and finance.

Program Educational Objectives

After graduation, our students will be equipped not only with advanced mathematical tools but will also acquire skill set needed to apply mathematics towards engineering problems. Moreover, our graduates will be able to:

- Apply mathematical and related knowledge to identify and address the technical and societal problems.
- Enhance their intellectual and analytical abilities in taking initiatives and/or develop innovative ideas for professional growth in mathematics and allied disciplines.

- Work effectively as a team member or lead multidisciplinary teams while demonstrating the interpersonal and management skills & ethical responsibilities.
- Pursue professional career in education, business & finance, industry and research institutions OR continue higher education to obtain advanced degrees in mathematics or related fields.

Scope of Program

The scope for BS-Mathematics graduates will be in:

- Institutions/organizations tackling engineering problems/projects
- Strategic organizations of Pakistan
- Many public and private organizations where Data Specialist, Data Analyst, AI consultants, Business Intelligence Developer and Data Scientists are now highly paid key positions available.
- Teaching and Research
- Banking & Finance
- Pursuing higher studies at national/international level.

Program Learning Objectives

The curriculum for BS-mathematics is designed by collaboration of the mathematicians and engineers. Students undertaking research in this department will have a chance to learn not only the fundamental courses of mathematics but also advanced courses in different emerging areas. AM&S is also providing support to other engineering and sciences departments of IST so, upon successful completion of the courses taught by mathematics faculty, students will be able to:

- Applied and Basic Mathematical Knowledge:** An ability to learn basics and apply basic knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solution of multiplex scientific problems
- Problem Analysis & Investigation:** An ability to identify,

formulate and investigate research literature and analyze complex problems reaching substantiated conclusions using mathematics, natural sciences and engineering sciences.

iii. Design/Development of Solutions: An ability to design solutions for emerging problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

iv. Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling with an understanding of the limitations.

v. Ethics: Apply ethical principles and commit to professional ethics, responsibilities, and norms of mathematical practices.

vi. Communication: An ability to communicate effectively, orally as well as in writing with the scientific community and with society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

vii. Project Management and Team Work: An ability to demonstrate management skills and apply scientific principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.

General Education Courses (GEC) (All 12 courses of 30 Credit Hours)

- Space, Place, and Experiences
- A Science of Society I
- Exploring Quantitative Skills
- Introduction to Expository Writing
- Applications of Information and Communication

- Technologies (ICT)
- Ideology and Constitution of Pakistan (Pakistan Studies)
- Critical Reading and Academic Writing
- Entrepreneurship
- Tools for Quantitative Reasoning
- Civics and Community Engagement
- Islamic Studies
- The Science of Global Challenges

Major Courses (72 Credit Hours)

- Calculus
- Linear Algebra
- Numerical Analysis-I (with Programming)
- Probability and Statistics
- Ordinary Differential Equations
- Number Theory
- Complex Analysis
- Analytical Dynamics
- Vector and Tensor Analysis
- Multivariable Calculus
- Object Oriented Programming
- Set Topology
- Numerical Analysis-II (with programming)
- Differential Geometry I
- Partial Differential Equations
- Advance Calculus
- Differential Geometry II
- Optimization Theory
- Analytical Mechanics
- Group Theory
- Graph Theory
- Intro to Integral Equations
- Operation Research
- Numerical Solution of Ordinary Differential Equations

Interdisciplinary Courses (Any 4 courses of 12 Credit Hours)

- Discrete Structures
- Data Structures
- Statistical Methods
- Business Mathematics
- Parallel & Distributed Computing
- Digital Logic Design
- Computer Organization & Assembly Language
- Fundamentals of Software Engineering
- Database Systems
- Design & Analysis of Algorithms
- Parallel & Distributed Computing
- Programming Languages
- Software packages
- Applied Physics I, II
- Mathematical Biology
- Philosophy
- Psychology
- Business and Entrepreneurship
- Professional Practice

Minor Courses (For Data Science) (Any 4 Courses of minimum 12 Credit Hours)

- Intro to Data Science
- Fundamentals of Big data Analytics
- Data Analysis & Visualization
- Data Mining
- Data Warehousing & Business Intelligence

Minor Courses (For Artificial Intelligence) (Any 4 Courses of minimum 12 Credit Hours)

- Programming for AI
- Operating Systems
- Artificial Neural Networks
- Machine Learning
- Artificial Intelligence

Freshman

Semester - 1		
Code	Subject	Cr. Hr.
	Space, Place, and Experiences	2-0
	Science of Society I	2-0
	Exploring Quantitative Skills	3-0
	Introduction to Expository Writing	3-0
	Applications of Information and Communication Technologies (ICT)	2-1
	Ideology and Constitution of Pakistan	2-0
	Calculus	
Total		14-1

Sophomore

Semester - 3		
Code	Subject	Cr. Hr.
	Linear Algebra	3-0
	Object Oriented Programming	3-0
	Probability and Statistics	3-0
	Ordinary Differential Equations	3-0
	Number Theory	3-0
	Complex Analysis	3-0
Total		18-0

Semester - 2		
Code	Subject	Cr. Hr.
	Critical Reading and Academic Writing	3-0
	Entrepreneurship	2-0
	Tools for Quantitative Reasoning	3-0
	Civics and Community Engagement	2-0
	Islamic Studies	2-0
	The Science of Global Challenges	2-1
Total		14-1

Semester - 4		
Code	Subject	Cr. Hr.
	Analytical Dynamics	3-0
	Vector and Tensor Analysis	3-0
	Multivariable Calculus	3-0
	Numerical Analysis-I (with Programming)	2-1
	Set Topology	3-0
	Differential Geometry I	3-0
Total		17-1

Junior

Semester - 5		
Code	Subject	Cr. Hr.
	Numerical Analysis-II (with programming)	2-1
	Partial Differential Equations	3-0
	Advance Calculus	3-0
	Analytical Mechanics	3-0
	Differential Geometry II	3-0
	Discrete Structures	
Total		14-1

Senior

Semester - 7		
Code	Subject	Cr. Hr.
	Minor	3-1
	Minor	3-1
	Statistical Methods	3-0
	Numerical Solution of Ordinary Differential Equations	3-0
	Field Work/Internship	3-0
Total		15-0

Semester - 6		
Code	Subject	Cr. Hr.
	Minor	3-1
	Data Structures	3-0
	Optimization Theory	3-0
	Group Theory	3-0
	Intro to Integral Equations	3-0
Total		15-1

Semester - 8		
Code	Subject	Cr. Hr.
	Minor	3-1
	Operation Research	3-0
	Graph Theory	3-0
	Business Mathematics	
	Final Year Project-II(Thesis)	
Total		15-1

Total No of Credit Hours

131

Details of the courses are as follow:

Calculus

Functions, Single and multivalued functions, Limit, Continuity, Curve sketching, Complex numbers, Derivatives, Rules of differentiation, higher order derivatives, Chain rule, Applications of differentiation, Related rates, Mean value theorem, Extreme values, Taylor's and Maclaurin's expansion, L'Hospital's rule, Asymptotes, Integration, techniques of integration, Applications of integration, Arc length, Solid of revolution, Sequences and Series, Power and alternating series, convergence of series

Linear Algebra

System of linear equations, representation in matrix form, matrices, operations on matrices, echelon and reduced echelon form, inverse of matrix by elementary row operations, solution of linear system, Gauss-Jordan method, Gauss elimination method, determinants, vector spaces and subspaces, linear combination and spanning set, linearly independent sets, finitely generated vector spaces, bases and dimension, operations on subspaces, intersections, sums and direct sums of subspaces, quotient spaces, linear mappings, kernel and image of linear mapping, rank and nullity, reflections, projections and homotheties, change of basis, Eigen values and eigenvectors, Cayley-Hamilton theorem, inner product spaces, Cauchy inequality, Gram Schmidt process, diagonalization.

Multivariable Calculus

Functional of Several Variables, Limits and Continuity, Partial derivatives, Chain rule for function of several variable, Directional derivatives and the gradient vector, Equation of tangent plane and normal line, Taylor series of two variables, Maxima and Minima in two variables, Lagrange Multipliers, Coordinate system, Rectangular, cylindrical and spherical coordinates. The dot product, the cross product. Equations of lines and planes. Quadric surfaces, Vector-valued functions: Vector-valued functions and space curves, Derivatives and integrals of vector valued functions. Arc length, Curvature, normal and

binomial vectors, Double integrals over rectangular domains, Double integrals in polar, coordinates, Triple integrals in rectangular, cylindrical and spherical coordinates, Applications of double and triple integrals, Change of variables in multiple integrals, vector field, Line Integral, Gauss divergence theorem and its application, Stokes' s theorem and its application, Green theorem and its applications.

Advanced Calculus

Curvilinear coordinates, Scale factors and unit vectors in curvilinear coordinates, Displacement vector, arc length and volume elements in curvilinear coordinates, Differential operators in orthogonal curvilinear coordinates, Tensors and its type, rank of a tensor, Fundamental operations with tensors, The metric tensor and the Riemann metric, Christoffel's symbol of the first and second kind in Cartesian, cylindrical and spherical coordinates, Linearity and first shifting theorem, Dirac delta and Gamma functions, Differentiation and integral theorems, Inverse Laplace transformation, Unit step function, second shifting theorem, Applications to linear Differential equations with initial and boundary value problems, System of linear differential equations, Ordinary sine and cosine Fourier series, Even and odd periodic function, Complex Fourier series, Relation b/w ordinary and complex Fourier series, Fourier integral and Fourier transformation.

Ordinary Differential Equations

Introduction and formulation, classification of differential equations, existence and uniqueness of solutions, introduction of initial value and boundary value problems, Basic concepts, formation and solution of differential equations. Separable variables, Exact Equations, Homogeneous Equations, Linear equations, integrating factors. Some nonlinear first order equations with known solution, differential equations of Bernoulli and Riccati type, Clairaut equation, modeling with first-order ODEs, Basic theory of systems of first order linear equations, Homogeneous linear system with constant coefficients, Non homogeneous linear system, Initial value and boundary

value problems, Homogeneous and non-homogeneous equations, Superposition principle, homogeneous equations with constant coefficients, Linear independence and Wronskian, Nonhomogeneous equations, undetermined coefficients method, variation of parameters, Cauchy-Euler equation, Modeling, Introduction to Eigen value problem, adjoint and self-adjoint operators, self-adjoint differential equations, Eigen values and Eigen functions, Sturm-Liouville (S-L) boundary value problems, regular and singular S-L problems, properties of regular S-L problems, Power series, ordinary and singular points, Existence of power series solutions, power series solutions, types of singular points, Frobenius theorem, Existence of Frobenius series solutions, solutions about singular points, The Bessel, modified Bessel Legendre and Hermite equations and their solutions.

Partial Differential Equations

Introduction, formation of PDEs, solutions of PDEs of first order, The Cauchy's problem for quasilinear first order PDEs, First order nonlinear equations, Special types of first order equations, Basic concepts and definitions, Mathematical problems, Linear operators, Superposition, Mathematical models: The classical equations, the vibrating string, the vibrating membrane, conduction of heat solids, canonical forms and variable, PDEs of second order in two independent variables with constant and variable coefficients, Cauchy's problem for second order PDEs in two independent variables, Solutions of elliptic, parabolic and hyperbolic PDEs in Cartesian and cylindrical coordinates, Introduction and properties of Laplace transform, transforms of elementary functions, periodic functions, error function and Dirac delta function, inverse Laplace transform for PDEs, convolution theorem, solution of PDEs by Laplace transform, Solution of Diffusion and wave equations, Fourier integral representation, Fourier sine and cosine representation, Fourier transform pair, transform of elementary functions and Dirac delta function, finite Fourier transforms, solutions of heat, wave and Laplace equations by Fourier transforms.

Numerical Analysis

Floating point arithmetic, approximations and errors, Bisection method, regula-falsi method, fixed point iteration method, Newton-Raphson method, secant method, error analysis for iterative methods, Lagrange interpolation, Newton's divided difference formula, forward, backward and centered difference formulae, interpolation with a cubic spline, Hermite interpolation, least squares approximation, Forward, backward and central difference formulae, Richardson's extrapolation, Rectangular rule, trapezoidal rule, Simpson's 1/3 and 3/8 rules, Boole's and Weddle's rules, Newton-Cotes formulae, Gaussian quadrature, Direct methods: Gaussian elimination method, Gauss-Jordan method; matrix inversion; LU-factorization; Doolittle's, Crout's and Cholesky's methods, Iterative methods: Jacobi, Gauss-Seidel and SOR. The use of software packages/programming languages for above-mentioned topics is recommended.

Complex Analysis

The concept of analytic functions: the complex numbers and the complex plane, functions of a complex variable, general properties of analytic functions, linear transformations, basic properties of linear transformation, mapping for problems, stereographic projections, basic concepts of conformal mapping, the exponential and the logarithmic functions, the trigonometric functions, Taylor's series, Laurent's series, infinite series with complex terms, power series, infinite products. Integration in the Complex Domain: Cauchy's theorem, Cauchy's integral formula and its applications, Laurent's expansion, isolated singularities of analytic functions, the residue theorem and its applications. Contour Integration: definite integrals, partial fraction, expansion of $\cot 2z$, the arguments principle theorem and its applications: Rouché's theorem, analytic Continuation: the principle of analytic continuation.

Differential Geometry

Space Curves: Arc length, Tangent, Normal and Binormal, Curvature and Torsion of a Curve, Tangent Surface, Spherical Indicatrix, Involute and Evolute, Envelopes,

Existence Theorem for a Space Curve, Helices, Curves on Surfaces, Surfaces of Revolution, Helicoids, Families of Curves, Developable associated with Space Curves, Developable associated with Curves on Surfaces, The First and Second Fundamental form, Principle Curvatures, Lines of Curvature, Geodesics.

Analytical Mechanics

Division of classical mechanics, general motion of a rigid body, Euler's theorem and Chasles theorem, screw motion, addition of angular velocities, moment of inertia of a rigid body, inertia tensor, linear momentum, angular momentum and K.E. of a rigid body, parallel axes and perpendicular axis theorems, principal axes and principal moment of inertia, Momental ellipsoid, Equipomental systems, motion of a rigid body in space, Rotating axes theorem, Euler's dynamical equations and their solution in special cases, deduction from Euler's equations, Euler's angles and rigid body motion.

Statistics-I

Introduction to statistics, Sets, properties and types of sets; permutations and combinations; Statistical measures; measure of central tendency, quartiles, measures of dispersion, moments, skewness, kurtosis, statistical description and graphical representation of data, mean, standard deviation, variance and expectation, introduction to probability theory, simple and conditional probability, Bayes' theorem, random variables.

Business Mathematics

Use of ratios, proportion and percentage in real world scenarios, Ratios: Types, Solution, Use and Scope in Business Environment, Proportions: Types, Solution, Use and Scope in Business Environment, Percentage, Equations, and their use in business/professional environment, Solution of first and second degree equations in one variable, algebraic and graphical characteristics, slope-intercept form, determining the equation of a straight line, linear equations involving more than two variables, two, three and n-variable systems and their graphical and algebraic solutions, Mathematical

functions, Definition, types and graphical representation of functions, linear cost, revenue and profit functions, Mathematics of finance, Interest and its computation, single payment computations, annuities and their present/future value and practical use of all interest mechanisms, cost benefit analysis, Matrix algebra, Introduction, simple and special types of matrices, basic matrix operations. The determinant, inverse, solution of system of linear equations using matrices, and use of matrix algebra in business/profession, Differentiation Limits: properties and continuity; average rate of change, the derivative, differentiation, higher-order derivative, optimization, identification of maxima and minima, application on revenue, cost, and profit, Sequence, series and progression, Sequence, series and progression: introduction and comparison thereof, arithmetic series and its application in business, geometric series and its application in business, harmonic series and its application in business, Linear programming, and its application in real world introduction, linear programming for constraints optimization, scenarios for linear programming, and their solution, techniques/methods for solving linear programming problems: graphical method and simplex method.

Statistics-II

Introduction to R statistical software, introduction, getting started, names, help functions, arithmetic, vectors, matrices, basic operations, vector operations, logical vectors, logical operations, indexing vectors, concatenating strings, data frames, basic plot, sophisticated plots, margins, inner and outer margins, graphic devices and saving plots on pdf, control structures, for, while loops, conditioning, creating functions, Random variables and related topics, Probability distributions, Correlation and Regression, Sampling methods, Estimation methods, Testing of Hypothesis

Set Topology

Sets and their operations, countable and uncountable sets, cardinal and transfinite numbers. Topological spaces, open and closed sets, interior, closure and boundary of a set, neighborhoods and neighborhood systems, isolated points,

some topological theorems, topology in terms of closed sets, limit points, the derived and perfect sets, dense sets and separable spaces, topological bases, criteria for topological bases, local bases, first and second countable spaces, relationship between separability and second countability, relative or induced topologies, necessary and sufficient condition for a subset of a subspace to be open in the original space, induced bases. Metric spaces, topology induced by a metric, equivalent topologies, formulation with closed sets, Cauchy sequence, complete metric spaces, characterization of completeness, Cantor's intersection theorem, the completion of metric space, metrizable spaces. Continuous functions, various characterizations of continuous functions, geometric meaning, homeomorphisms, open and closed continuous functions, topological properties and homeomorphisms. Separation axioms, T1 and T2 spaces and their characterization, regular and normal spaces and their characterizations, Urysohn's lemma, Urysohn's metrization theorem (without proof). Compact spaces their characterization and some theorems, construction of compact spaces, compactness in metric spaces, compactness and completeness, local compactness. Connected spaces, characterization and some properties of connected spaces.

Group Theory/ Algebra-I/ Abstract Algebra

Groups: Definition of a group, subgroup, subgroup generated by a set. The cyclic groups, cosets and Lagrange's theorem. Normalizer centralizer. The center of a group. Equivalence relation in a group, conjugacy classes. Normal subgroups, quotient group. Group homomorphisms: Homomorphisms and isomorphism and Automorphism. Kernel and image of homomorphism. Isomorphism theorems. Permutation groups. The cyclic decomposition of a permutation group. Cayley's theorem. Direct product of two groups and examples.

Discrete Mathematics

Counting methods: Basic methods: product, inclusion-exclusion formulae. Permutations and combinations.

Recurrence relations and their solutions. Generating functions. Double counting. Applications. Pigeonhole principle, applications, Relations: Binary relations, n-ary Relations. Closures of relations. Composition of relations, inverse relation, Graphs, Graph terminology. Representation of graphs. Graphs isomorphism. Algebraic methods: the incidence matrix. Connectivity, Eulerian and Hamiltonian paths. Shortest path problem. Trees and spanning trees. Complete graphs and bivalent graphs.

Functional Analysis

Metric Space: Review of metric spaces, Convergence in metric spaces, Complete metric spaces, Dense sets and separable spaces, No-where dense sets, Baire category theorem.

Normed Spaces: Normed linear spaces, Banach spaces, Equivalent norms, Linear operator, Finite dimensional normed spaces, Continuous and bounded linear operators, Dual spaces.

Inner Product Spaces: Definition and examples, Orthonormal sets and bases, Annihilators, projections, Linear functionals on Hilbert spaces. Reflexivity of Hilbert spaces.

Elements Of Set Theory And Mathematical Logic

Set theory: Sets, subsets, operations with sets: union, intersection, difference, symmetric difference, Cartesian product and disjoint union, Functions: graph of a function. Composition; injections, surjections, bijections, inverse function. Computing cardinals: Cardinality of Cartesian product, union. Cardinality of all functions from a set to another set. Cardinality of all injective, surjective and bijective functions from a set to another set. Infinite sets, finite sets. Countable sets, properties, examples ($\mathbb{Z}$, $\mathbb{Q}$). $\mathbb{R}$ is not countable. $\mathbb{R}$, $\mathbb{R} \times \mathbb{R}$, $\mathbb{R} \times \mathbb{R} \times \mathbb{R}$ have the same cardinal. Operations with cardinal numbers. Cantor-Bernstein theorem, Relations, Equivalence relations, partitions, quotient set, examples, parallelism, similarity of triangles. Order relations, min, max, inf, sup; linear order. Examples: $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{R}$, $P(A)$. Well-ordered sets and induction. Inductively ordered sets and Zorn's lemma, Mathematical logic,

Propositional Calculus. Truth tables. Predicate Calculus.

Technical Writing

Introduction, Comparison of technical and non-technical writing, Features of technical and non-technical, Technical Writing Style, Write clear sentences, Avoid choppy sentences, Avoid nominalization, Avoid wordiness, Avoid redundancies, Choose a tone for the reader Continued, Technical Writing Style, Avoid noun clusters, Avoid sexist language, Write clear paragraph, Audience Analysis, Report Writing, Formal Report Writing, Informal Report Writing, (Recommendations or Feasibility Reports or Research Report), Proposal Writing, Research Proposal writing, Technical Research Paper, Abstracts, Outline of a Technical Research a Paper, Introduction to Patent Writing, Researching: Formatting & Visual Aids, Plagiarism, Documenting sources (IEEE, APA, MLA, Numbered References etc.), Using soft wares (End Note, Turn it in, Zotero), Supporting reports with visual, Writing reports including visual data.

Religious Studies

Introduction to Islamic Methodology, Importance of Knowledge and Proofs, Blind following in Islam, Final Authority in Islam, Why Islam is being alienated from Society, Concept of Worship in Islam, Linguistically and Technical Meaning of Worship, Worship in Different World Religion, Modification of Islam in Course of Worship, Direct Relationship between God and Man, Worship Comprises of Believer's Whole Life, Course of Easiness in Worship, Sources of Islamic Law, Introduction to the Legal aspect of Quran, Introduction to the Sources of Law, Quran, its Definition, Type of Verses,, Legal Approach to the Study of Verses, Diversity of Thought and Opinions, Conditions of An Authentic Hadith, Ruling of Weak Hadith, Fabricated Hadith and Its Rulings, Four types of Hadith with respect to number of narrators and their Rulings, Ijma, Its Definition and Authority, Types of Ijma, Conditions of Ijma, Ijma as a source of Law, Qiyas, Its Definition and Authority, Types of Qiyas, Parts of Qiyas,, Qiyas as Source of Law, Practical Examples from Divine text, Principles of Interpreting the Devine Text, Agreed upon Principles of interpretation, Interpretation of Quran through Quran, Interpretation of

Quran through Sunnah, Interpretation of Quran by the words of Sahaba and their Companions, Interpretation of Quran by following the Rules of Arabic Language, Interpretation of Quran through its context, Combining Quran and Authentic Sunnah, Avoiding the weak Hadith as a source of Interpretation, Ethics and Morality in Islam, Introduction to Ethics, Answering some Important questions regarding Ethics, Human Intellectual Heritage upon Ethical system, Quranic Principles of Ethical system, Quranic View on Modern Ethical Philosophy, An Analytic study of selected Verses from Surah al- Furqan, an-Noor and al-Hujraat, Political System of Islam, Concept of State in Islam, Basic Principle of Governance in Quran, Shura and democracy, Rights of Nationals and non-muslims in Islamic state, Qualities and pre-requisites of Leader of Islamic state, Role of Ijtehad in islamic political theories, A Psycho Emotional study of Quran, Selected Verses from Surah Maryam, al-Aaraaf, Qaaf,, Study of An Islamic Historical Figures, Psychological study of that figure through his actions and Stances.

English Composition

Course introduction, Ice breaking, Syllabus needs and utility, Diagnostic test, Critical Thinking Skills, Developing reading habits, Link between reading and writing, SQ3R, reading with purpose, How to approach the text, An introduction to writing, Writing in response to reading, Subjective and analytical response, Paragraph Writing, The writing process, Prewriting, Placing the main idea, Writing the first draft, Crafting Sentences/Style of Writing, Active/passive voice, Subject-verb agreement, Parallelism, Using Noun clauses, Choppy sentences, Wordiness, Redundancy Inflated phrases, choosing a tone Language choice, Editing and proof reading, Exploratory drafting, Mind mapping, Persuasive and Argumentative Writing, Supporting Claims with Evidence, Avoiding fallacies.

Communication Skills

This course aims to help students improve their communication skills and English language proficiency. During this course students will work on the four main skills

(reading, writing, speaking and listening) through interaction with one another and the teacher in individual, pair and group work. The primary focus would be to improve students' presentation skills. They will be given opportunities to research and present on various topics.

Pakistan Studies

Geo Political Importance of Pakistan, Ideological Foundation of Pakistan, Freedom Movement, Political and Constitutional Developments, Key elements of current constitution; a brief review of 1973+amendments , Rights (my rights), Duties (My duties), How to really act for your rights (Judiciary System, Federal Ombudsman) , Foreign Policy of Pakistan , Determinants of foreign policy of Pakistan, Foreign Policy of Pakistan , Pak – Afghan Relationship, Pak – China Relationship, Pak – US Relationship, Pak – India Relationship, Pakistan in Regional and International Organizations, SAARC, OIC, UNO, Economic planning and development:, Agricultural Sector of Pakistan, Industrial Sector of Pakistan, Innovation/IT/knowledge driven economy, Military in Politics, Bureaucracy in Pakistan, Political Parties of Pakistan, Elections in Pakistan, Current Challenges, Good governance (What & How), Financial development, Poverty reduction, Water disputes(Scarcity) with India (Bhagliar Dam, Kissan Ganga), Food Security, Energy Crises, War on terror, Health.

Dynamics

Introduction, kinematics of particles and rectilinear motion , Curvilinear motion, Newton's equations of motion and angular momentum , Work and energy, power, and conservation of energy , Impulse and momentum, and impact, Dynamics of systems of particles, Kinematics of rigid bodies, Plane motion of a particle relative to a rotating frame and Coriolis acceleration , Forces and accelerations in plane motion of a rigid body , Principles of energy and momentum, and of impulse and momentum in plane motion of a rigid body.

Mathematical Biology

Population models, Models for population growth, Exponential, Logistic, and Gompertz., Interacting populations, Predator-prey, Lotka-Volterra, and food webs, Epidemics, SIR models and their generalisations, e.g. SIRS, SIS, Vaccination, and Herd Immunity. Compartmental Modelling & Pharmacokinetics, Chemical Interactions, Law of Mass Action, Michaelis-Menten Kinetics and Enzymatic Reactions, Chemical Master Equations, Mathematical Models of Biological Diffusion, Brownian Motion, Random Walks, and Fick's Law, Diffusion with Advection and Chemotaxis, Reaction- Diffusion Equations, Simple Models of Nerve Cells, Hodgkin-Huxley Equations, The Cable Equation, Rall's Model for the Dendritic Tree, Turing Patterns and Reaction-Diffusion Models for Pattern Formation, Animal Coat Patterns, Phyllotaxis, Min proteins and e. coli Cell Division, Tumour Growth Models.

Principles Of Management

Introduction to Management Organization, The management Process , The History and evaluation of Management , Organizational theories and different approaches to management , The organizational Culture and the Manager , The external environment and the Manager , The internal environment and the manager , Foundations and basic elements of Planning , Process of planning and MBO , Effective strategic planning , Decision Making , The manager's role as decision maker , Decision making process , Basics of Strategic Management , Case of Strategic Management , Strategic management process, Organizational Structure, Types of organizational structures

Introduction To Communication Technology

Basic terminology, computer, user, hardware, software, chip, program, Input, data, instructions (programs, commands, user responses), Output, text, graphics, video, audio, Types of computers, personal, notebook, handheld, PDA, internet appliance, server, mainframe, supercomputer, History, Early devices (Pascaline, Jacquard's Loom), Babbage (Difference Engine, Analytical Engine), Lovelace, Hollerith, Watson Sr, ABC machine, Eniac Modern

pioneers, von Neumann, Turing Hardware generations, vacuum tubes, transistors, printed circuits, integrated circuits, Moore's law, Programming languages Machine, assembly, High-level, Key terms: VLSI, microprocessor, microcomputer, Social implications, Terms: computer literacy, the digital divide, computer power.

Computer Programming

Storage classes, Default Argument, Practice of functions, 1-dimensional array, searching, sorting and practice session, 2-dimensional arrays, pointers, Pointers and character array, structures, Nested structures, Passing structure to function, pointers with structures, practice of structures, Dynamic memory allocation, Introduction to classes and objects, correlation between structures and classes, class definition, instantiation, calling member function, controlling access to members and concept of data hiding, Objects as function arguments returning objects from functions, Introduction to operator overloading, motivation of operator overloading, Overloading binary arithmetic operators, Inheritance, Inheritance vs. Composition, Derived and Base class, Accessing base class members, the protected access specifier, Derived class constructors/ destructors, overriding member functions, Class hierarchies, public and private inheritance, access combination, polymorphism, real world examples and motivation, Base/Derived class pointers, virtual functions and concept of late binding, Pure virtual functions and abstract classes, using arrays, of pointers to objects, Composition vs. Aggregation, Class diagram, The C++ string class, assigning string objects, input/output with string objects, String manipulation functions, Introduction to exception handling in C++, Examples of exception handling, File I/O with streams, file pointers and file error handling, Reading and writing objects.

Programming Languages

Additional C++ operators, Increment, Decrement operators, Bitwise Operators, The Cast Operation, the size of operator, the operator, Operators Precedence, working

with character data, Strings, file input/output, Type coercion in arithmetic and relational expressions, Type coercion in assignments, argument passing, and return of a function value. 2-D Arrays, User defined simple types, Simple and Structured data types, Enumeration, Records, Nested Records, Unions, Data Abstraction, Abstract Data Types, C++ Classes concepts, Class objects, Class members, built in operations on class objects, arrays of class objects, class scope, Information hiding. Specification and implementation of classes, Class constructors, OOP, Inheritance, Multiple Inheritance, Composition, Dynamic binding and Virtual functions, Object oriented design and implementation. Dynamic data, Pointers, Reference Types, Classes and Dynamic Data, The Null pointer, Inaccessible Object, Dangling Pointer, Linked structures, Stacks, Array implementation of stacks, Queues, Array implementation of Queues.

Introduction To Communication Technology

Computer, history, advantages and limitations of computer, parts of system unit, types and function of processors, types of memory, types of busses, types of ports and connector, Number systems, Conversion of decimal numbers to binary, octal and hexadecimal numbers, Binary arithmetic, Binary addition rules, examples of addition of binary numbers, examples of multiplication of binary numbers, EBCDIC coding systems, examples of conversion of alphabetic and numbers in EBCDIC codes, ASCII coding system, examples of conversion of alphabetic and numbers in ASCII codes, UNICODEs, system software, operating system, utility programs, viruses and system protection from viruses, types of codes, difference between source code and object codes, compiler, interpreter and assembler, difference between compiler and interpreter, programming techniques, structured programming, object-oriented programming and visual programming, Introduction to C++ programming language, History of C++ , basic structure of C++ program, Preprocessor directives, Header files and main function, creating and editing of a C++ program, Compiling, Linking and executing C++

programs, Debugging C++ program, types of errors, adding comments in program, types of identifiers, data types used in C++ language, Variables and constants, Expression, Operators, Compound Assignment operators, Increment operators, difference between pre-increment and post increment operators, Decrement operators, difference between pre decrement and post decrement operators, Syntax of writing Input and output statement in C++ language, Escape Sequences, C++ Manipulators with examples, examples of C++ programs using output statements with flow charts, Execute programs on multimedia and discuss output of the programs, examples of C++ programs using input and output statements, Introduction to file management system, definition of database and database management system, file management system vs database management system, Relation data base management system, (RDBMS) Object-oriented database (OODB), database administration (DBA), definition of information system, types of information systems (IS), Classification of IS, Introduction to C++; Basic Input Output statements, Practice set for basic IO in programming, Introduction to variables, data types, Arithmetic Expression evaluation, operator precedence concept, practice set of operator evaluation activities, Selection structures and conditional statements (if-else structure), Introduction to nested selection statement, Practice of if-else statements, selection structures and conditional statements (switch structure), practice of the basic switch structure, repetition structure and application, nested repetition structures, Introduction of functions, basic functions pass by reference, Inline functions, function overloading, practice of overloading functions.

Statics

Introduction to the basic quantities and idealizations of mechanics, Newton's laws of motion and gravitation, SI system of units, Standard procedures for performing numerical calculations, e. General guide for solving problems, Parallelogram Law, angle between two vectors or projection of one vector onto another, Equilibrium of a Particle, Force System Resultants, force in two and three

dimensions, the moment of a about a specified axis, moment of a couple, the resultants of nonconcurrent force systems, simple distributed loading to a resultant force, Equilibrium of a Rigid Body, the free-body diagram for a rigid body, rigid-body equilibrium problems, Structural Analysis, internal forces, friction.

Thermodynamics

Thermodynamic system, Surrounding and Boundaries, Type of systems, Macroscopic and microscopic description of system, Properties and state of the substance, Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium, Processes and Cycles, Isothermal, Isobaric and Isochoric, Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics, The state of the system at Equilibrium, Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts, Internal energy of an ideal gas, Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state, First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion, Reversible and irreversible processes, Second law of thermodynamics, Carnot theorem and Carnot engine. Heat engine, Refrigerators. Calculation of efficiency of heat engines, Thermodynamic temperature scale, Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process, Entropy and Second law of thermodynamics, Entropy and Probability, Thermodynamic Functions, Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule-Thomson effect and its equations, Thermoelectricity, Thermocouple, Seaback's effect, Peltier's effect, Thomson effect.

Applied Physics-I

The Nature of Science and Physics, Kinematics, Two-Dimensional Kinematics, Dynamics, Force and Newton's Laws of Motion, Further Applications of Newton's Laws: Friction, Drag, and Elasticity, Uniform Circular Motion and

Gravitation, Work, Energy, and Energy Resources, Linear Momentum and Collisions, Statics and Torque, Rotational Motion and Angular Momentum

Number Theory

The division algorithms. Basis representation theorem, Prime and composite numbers, Canonical decomposition, The greatest common divisor, The Euclidean algorithm, The fundamental theorem of arithmetic, least common multiple, Congruences., Linear congruences, System of linear congruences. The Chinese remainder theorem, Divisibility tests, Solving polynomial congruences, Fermat's and Euler's theorems, Wilson's theorem., Euler's phi-function. The functions of J and σ . The Mobius function, The sieve of Eratosthenes, Perfect numbers. Fermat and Mersenne primes, the order of an integer mod n , Primitive roots for primes, Composite numbers having primitive roots, Legendre symbols and its properties, the quadratic reciprocity law, Quadratic congruences with composite moduli, Pythagorean triples, Representing numbers as sum of two squares.

An Introduction To Fluid Mechanics

Fluid, Viscosity, Surface tension, Compressibility, Density, specific gravity and specific volume, Characteristics of a perfect gas, Pressure, Forces acting on the vessel of liquid, Streamline and stream tube, Three-dimensional, two-dimensional and one-dimensional flow, Reynolds number, Incompressible and compressible fluids, Rotation and spinning of a liquid, Circulation, Conservation of mass, Conservation of energy, Conservation of momentum, Conservation of angular momentum, Drag and lift, Flow of an ideal fluid, Velocity potential, Stream function, Complex velocity and speed, Example of potential flow, Stagnation points, Conformal mapping, Flow of compressible fluid, Thermodynamical characteristics, Sonic velocity, Mach number, Basic equations for one-dimensional compressible flow, Isentropic flow, Shock waves, Fanno flow and Rayleigh flow, Source and sinks, Strength of source in two and three dimensions, Theorem of Blasius, Flow over

immersed bodies, an introduction to Turbomachines, Streaming motion past a circular cylinder, Milne-Thomson circle theorem.

Object Oriented Programming

Evolution of Object Oriented (OO) programming, OO concepts and principles, problem solving in OO paradigm, OO program design process, classes, methods, objects and encapsulation, constructors and destructors, operator and function overloading, virtual functions, derived classes, inheritance and polymorphism, I/O and file processing, exception handling.

Data Structure

Introduction to Data structures and types of data structures, Definition of algorithm, running time of algorithm, examples, role of efficient algorithms, Definition of Recursion, Direct and Indirect Recursion, Examples of Recursive Functions, Linear Queue & Its Features, Linear Queue Implementation, Circular Queue, Linked List & Its Features, Linked List Implementation, Doubly Linked List & its Implementation, Stack & Its Implementation, Postfix Notation Concept, Implementation Of Postfix Notation, Binary Trees, Strictly Binary Tree, Complete Binary Tree, Almost Complete Binary Tree, Binary Tree Applications, Traversing Trees, Pre-Order Traversing In-Order Traversing, Post-Order Traversing, Bubble Sort, Quick Sort, Binary Sort, Merge Sort, Insertion Sort, Heap, Heap Construction, Heap Sort, Heap Sort Implementation. Hashing & its Implementation, Linear and Binary Search, What Are Graphs, Representation of Directed Graphs, Graph Vocabulary, Graph Operations (Add Vertex, Add Edge), C++ Implementation, Hashing, dictionaries and hash tables, hashing function, hashing implementation using array and linked list.

Database Systems

Basic database concepts, Database approach vs file based system, database architecture, three level schema architecture, data independence, relational data model,

attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub-queries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems.

Fundamentals Of Big Data Analytics

Introduction to Big Data Analytics, Big Data Platforms, Data Store & Processing using Hadoop, Big Data Storage and Analytics, Big Data Analytics ML Algorithms, Recommendation, Clustering, and Classification, Linked Big Data: Graph Computing and Graph Analytics, Graphical Models and Bayesian Networks, Big Data Visualization, Cognitive Mobile Analytics.

Artificial Intelligence

Introduction (Introduction, basic component of AI, Identifying AI systems, branches of AI, etc.); Reasoning and Knowledge Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, First order Logic); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Constraint Satisfaction Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Learning (Unsupervised learning, Supervised learning, Reinforcement learning) ;Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems).

Operating Systems

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from

deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security

Artificial Neural Networks

This course will introduce Artificial Neural Networks and Deep Learning. ANN's basic architecture and how they mimic the human brain using simple mathematical models. Many of the important concepts and techniques around brain computing and the major types of ANN will also be introduced. Emphasis is made on the mathematical models, understanding learning laws, selecting activation functions and how to train the networks to solve classification problems. Deep neural networks have achieved state of the art performance on several computer vision and speech recognition benchmarks. This course will further build on the fundamentals of Neural networks and artificial intelligence and will introduce advanced topics in neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning.

Machine Learning

Machine learning is one of the fastest growing areas of computer science, with far-reaching applications. The aim of this course is to: a) Present the basic machine learning concepts; b) Present a range of machine learning algorithms along with their strengths and weaknesses; c) Apply machine learning algorithms to solve problems of moderate complexity.

(Note: The minor courses will be offered subject to the availability of specialized faculty and the number of students interested in each course.)



Dr. A.Q Khan Institute of Computer Science and Information Technology (KICSIT)

Sub Campus of IST

Dr. A.Q Khan Institute of Computer Sciences and Information Technology

Introduction

Dr. A.Q Khan Institute of Computer Sciences and Information Technology (KICSIT), Kahuta was inaugurated in November 2000 by Dr. Abdul Qadeer Khan himself, the founder and the then Chairman of KRL.

KICSIT Aims

KICSIT aims to offer quality education at an affordable cost. Currently, is offering following degree programs:

- Bachelor of Science in Computer Engineering (BSCE)
- Bachelor of Science in Computer Science (BSCS)
- Bachelor of Science in Physics
- Masters of Science in Computer Science (MSCS)

The Bachelor of Science in Computer Engineering (BSCE) 4 Years Degree program is now internationally accredited under Washington accord (Level-2). KICSIT Computer Engineering degree is now accepted worldwide under Washington accord in the countries including UK, USA, Japan, Canada, Australia and New-Zealand.

The Bachelor of Science in Computer Science (BSCS) 4 Years Degree program is accredited by NCEAC. Now also offering Bachelor of Science in Physics 4 Years Degree program from fall 2023.

The Masters of Science in Computer Science (MSCS) 2 Years Degree program is approved by HEC.

KICSIT is committed to provide a conducive learning environment which allows each student to gain confidence and maximize his or her potential in the selected field. KICSIT is a place, where each student will not only gain practical knowledge in his and her chosen field, but also learn to serve the country and humanity. It has disciplined and secure environment. KICSIT is an academic institution with remarkable achievements in various inter-university competitions, and has ambitious plans for the future. Our academic programs and courses are designed keeping in view the latest trends in technology, business, and science.

KICSIT is ideally located in an exclusively peaceful and secure environment. On one hand, it is free from the congestion of the present-day cities and, on the other hand, it is accessible from the twin cities of Rawalpindi-Islamabad at an easy drive of about 50 minutes. KICSIT is housed in its own purposefully-built air-conditioned campus. It has furnished class rooms with audio-visual teaching aids, well-equipped computer and electronic labs and a well-established library with book-bank.

Broad-band internet connectivity is available at all computers of the Institute. KICSIT provides transport to its students and faculty traveling from twin cities and Kahuta area at a subsidized rate. The Institute can rightly boast of having an elite faculty with foreign-qualified PhDs as well as the Master degree-holders having decades of practical industrial experience.

In view of its increasing students strength and scope, the New Campus of KICSIT is under construction in the midst of lush green and scenic hills of Kahuta. This is on main Rawalpindi-Kahuta Road and covers an area of above 100Kanals. Here, Academic and Administration blocks are already operational with our BSCE and BSCS programs, while a large new block is under construction.

Though KICSIT is a small-size institute, yet it has a shining record in terms of students and alumni. A large number of alumni have joined Strategic Organizations, Armed Forces and Multinational Companies. In higher education, many studied and got degrees from US, UK and Australian Universities. Also, KICSIT students have been competing well in the inter-university competitions and have won many awards recently.

Office of Research, Innovation & Commercialization

Office of Research, Innovation and Commercialization (ORIC) was established at Institute of Space Technology (IST) under the aegis of Higher Education Commission (HEC) in June 2011.

ORIC is commissioned with to manage and advance the university's strategic initiatives around Research & Development (R&D), innovation and commercialization. ORIC has been creating an enabling environment for IST students, faculty and researchers to conduct world-class research, accomplish Industry-focused projects, translate academic research into products and services, and to commercialize the intellectual property.

Team ORIC envisions to transform IST into a Research University. We strive to make IST an elite research-intensive university by fostering multidisciplinary R&D in the fields of Engineering, Science and Technology. As professionals, we are committed to create a cohesive university-wide environment of research excellence in order to support and commercialize cutting-edge research outputs of our students, faculty and researchers; those are responsive to the regional and national emerging needs of the country.

The office oversees a variety of functional areas, such as, Research Management, University-industry Linkages, Intellectual Property Rights, Business Incubation and Technology Transfer.



Research Management

Research Management section strives to promote innovative research at IST to address the strategic and national problems/issues in engineering science and technology. In this regard faculty members/researchers and students are facilitated to avail funding opportunities for R&D initiatives and execution of Joint Research Projects (JRP). Moreover, this section is responsible for:

- Promoting innovative research to address strategic/national issues in Engineering, Science & Technology
- Extending support regarding proposal development, pre-award and post-award formalities across the lifecycle of a research project(s)
- Providing seed grants from IST R&D fund for prototype development, supplementing manpower requirement in R&D projects and international research travel
- Coordination/liaison with National and International R & D Organizations for potential Academia-Industry collaborations and joint R&D projects. This also involves effective monitoring and smooth execution of all the funded JRPs sponsored by such R&D Organizations
- Focal point on all HEC's funded projects' related matters. This includes overall correspondence regarding timely submission of research proposals against the

grants announced under different research programs (like NRPU, TDF, SRGP, PBAIRP, TTSTF, ICRG, GCF, LCF etc.)

- Processing of Approved Supervisor Applications
- Conducting Project Management Review (PMR) meeting to monitor timely completion and also ensuring timely release of regular installments against the funded project(s)
- Drafting & implementation of SOPs, Research Proposals and Deed of Agreements for effective research collaborations with National/International R&D Organization(s)
- Preparation and submission of a complete duly signed annual HEC's ORIC Assessment Report/ Scorecard used for maintaining the ORIC active status for obtaining ORIC'S share from future funding
- Correspondence with Pakistan Science Foundation (PSF) for obtaining Travel Grants, Survey Grants and R&D projects etc.
- Enhancing the scope & pace of R & D related work through the established departmental R&D Cells
- Overall coordination of all professional commitments of the department with and through respective/ concerned ORIC officials for effective management
- Besides internal funding, the section has successfully attracted a huge amount of R&D funding from the following donor agencies under different programs:

- Pakistan Air Force (PAF)
- British Council under HEC's ICRG Program
- Chinese Academy of Sciences
- Belt and Road Aerospace Innovation Alliance (BRAIA)
- Deutsche Forschungsgemeinschaft

University-industry Linkages (UIL)

UIL section at ORIC serves as the point of contact for national R&D organizations, other Academia, Industry, and national and international donor agencies to foster stakeholder collaboration for joint industrial R&D initiatives, technology transfer and commercialization of Intellectual Property.

UIL primarily focuses on to bridge the gap between Academia and Industry. In pursuance of so, the section extends maximum possible facilitation to IST faculty and researchers for industry-focused research, collaborative projects and acquiring hands-on technical experience.

Numerous R&D projects have been initiated on account of licensing technologies to the Industry. While, several technology transfer endeavors are underway with renowned engineering firms, like, TeReSol, ABM SATUMA, UHealth International Hospital, Joyn, SoluNox and many other industrial partners.

IST UIL has also established close linkages/MoUs with chamber of commerce(s) to bridge with industrial partners for joint collaborations

Business Incubation Center (BIC)

Business Incubation Center (BIC) was

established at IST in partnership with Higher Education Commission (HEC) with an aim to create a new breed of entrepreneurs, who believe in their passion and aspire to become a job creator rather than a job seeker. BIC provides a supportive entrepreneurial environment and infrastructural support to IST faculty, students and alumni to reinforce and commercialize their innovative ideas by launching their own startup companies. The main goal of IST BIC is to develop successful startup companies those are sustainable and can compete in national and international markets. To develop and inculcate a culture of innovation and entrepreneurship among IST faculty and students, various initiatives have been launched through the platform of IST BIC. These initiatives include IST Business Acceleration Program (IST BAP), interaction with seasoned entrepreneurs, guest speaker

sessions, seminars / workshops, ideas competitions and participation in various business plan competitions. BIC rolled-out IST Business Acceleration Program in 2017. It is an intense six-months acceleration program which provides a launching platform, mentoring and coaching, business development services and enterprise management support to IST students and faculty to launch their own technology based startups. The BIC is also mandated to organize various internationally accredited Business Plan and Ideas competitions like, Pakathone, ActInSpace, and Hult Prize On Campus and Impact Summit. In collaboration with TiE Islamabad, an entrepreneurial society, named as IST Entrepreneurial Society (IES) is also functioning at IST. IES is being managed by IST students and is commissioned with to organize various entrepreneurial events, Business Plan competitions, guest speaker sessions and outreach programs. IST BIC enjoys kinships with different national and international entrepreneurial entities across the globe. Some of the partnering

organizations include TiE Islamabad, Rawalpindi and Islamabad Chambers of Commerce & Industries, International Labor Organization (ILO), STEDEC, Cambridge Advisors Network (CAN), JumpStart Pakistan, OPEN Islamabad and Hult Prize to name a few.

Technology and Innovation Support Center (TISC)

Technology and Innovation Support Center (TISC) is a subsidiary of IST ORIC and was being established at IST in collaboration with World Intellectual Property Office (WIPO), Higher Education Commission (HEC) and Intellectual Property Office (IPO-Pakistan).

TISC is primarily responsible to determine the patentability of inventions, provide assistance in drafting patent applications and exclude patent infringements. It facilitates our faculty, researchers, inventors, innovators and entrepreneurs to manage and protect their Intellectual Property Rights (IPRs). IST TISC also takes pride to mention that the core services are not only offered to IST Faculty & Researchers, but are also rendered to National R&D organizations and industries. The center provides them with access to high-quality technology information and prior art searching. Alongside, awareness seminars and trainings on the importance of IPRs in commercialization of technologies are being organized at TISC. It is worth mentioning that, IST TISC is a part of WIPO Directory of TISCs.



Admissions

General Eligibility Requirement for HSSC/ A Level/ Equivalent

A candidate seeking admission to a baccalaureate degree program at IST must meet the following criteria:

For Engineering Programs:

- Matric/ Equivalent Certificate (Science) with 60% marks
- FSc Pre-Engineering/ ICS/ DAE/ Equivalent Certificate with minimum 60% overall marks*
- Obtained Marks in Entry Test

*Candidates with HSSC Pre-Medical backgrounds can now apply for all engineering programs after completing an 8-week condensed Mathematics course from any university.

*ICS candidates will be required to study Chemistry as a remedial subject/ course in the 1st semester after admission.

For Computer Science/ Data Science/ Artificial Intelligence/ Software Engineering:

- Matric/ Equivalent Certificate
- HSSC/ DAE/ Equivalent with Mathematics with minimum 50% overall marks OR HSSC Pre-Medical/ Equivalent with minimum 50% overall marks*
- No Entry Test Required

*HSSC Pre-Medical/ Equivalent applicants, if admitted, will be required to study additional two Mathematics courses, worth 6 credit hours, during first year of studies at the institution.

For Computer Engineering:

- Matric/ Equivalent Certificate
- HSSC or DAE with Physics, Mathematics, and Chemistry/CS or equivalent 12 years of education with these subjects with minimum 60% overall marks
- No Entry Test Required

For Physics/ Space Science:

- Matric/ Equivalent Certificate
- FSc Pre-Engineering/ ICS/ Equivalent Certificate with Mathematics & Physics
- No Entry Test Required

For Mathematics/ Mathematics with AI/ Mathematics with DS:

- Matric/ Equivalent Certificate
- HSSC (12 years of schooling) or an IBCC equivalent qualification in any group with a subject of Mathematics/ General Mathematics
- No Entry Test Required

For Biotechnology

- Matric/ Equivalent Certificate
- FSc (12 years of education) or an IBCC equivalent qualification in any science group, with at least one of the following subjects: Biology, Chemistry, Physics, Mathematics, or Computer Science
- No Entry Test Required

Eligibility Requirement for Diploma Holder

A candidate seeking admission based on Diploma of Associate Engineer (DAE) should have passed diploma examination from a Board of Technical Education in the relevant technology.

A candidate shall not be eligible to apply for admission unless his/her DAE discipline is in relevant technology as specified against each degree course given below:

A DAE candidate seeking admission to a baccalaureate degree program at IST must meet the following criteria:

- Matric/ Equivalent Certificate (Science) with 60% marks
- DAE (Aggregate) with 60% overall marks
- Obtained Marks in Entry Test

Aerospace Engineering

- Diploma in Aerospace
- Diploma in Auto Diesel
- Diploma in Automation
- Diploma in Mechanical with any Specialization
- Diploma in Mechatronics

Avionics Engineering

- Diploma in Electronics
- Diploma in Telecommunication
- Diploma in Mechatronics
- Diploma in Avionics
- Diploma in Computer/IT
- Diploma in Instrumentation/Instrumentation & Process Control
- Diploma in Automation
- Diploma in Radar Technology
- Diploma in Radio Technology
- Diploma in Software

Electrical Engineering

- Diploma in Electronics
- Diploma in Telecommunication
- Diploma in Electrical
- Diploma in Mechatronics
- Diploma in Avionics
- Diploma in Computer/IT
- Diploma in Instrumentation/Instrumentation & Process Control
- Diploma in Automation
- Diploma in Radar Technology
- Diploma in Radio Technology
- Diploma in Instrumentation
- Diploma in Precision Mechanical & Instrument
- Diploma in Information

Mechanical Engineering

- Diploma in Aerospace
- Diploma in Mechanical with any Specialization
- Diploma in Mechatronics
- Diploma in Automation

- Diploma in Auto & Diesel Tech
- Diploma in Precision Mechanical & Instrument
- Diploma in Dies & Mould
- Diploma in Refrigeration & Air Conditioning
- Diploma in Bio-medical
- Diploma in Vacuum

Materials Science & Engineering

- Diploma in Mechanical with any Specialization
- Diploma in Foundry and Pattern Making
- Diploma in Cast Metal & Foundry
- Diploma in Glass, Ceramics & Pottery Development

Entry Test

IST doesn't conduct its own entry test. The results of following tests are accepted to apply for admission in undergraduate programs

- NAT which is conducted by NTS in every month
- HAT which is conducted by ETC-HEC
- NET which is conducted by NUST Islamabad
- ECAT which is conducted by UET Lahore
- ETEA which is conducted by UET Peshawar
- Entry Test for Engineering Programs conducted by MUET Jamshoro
- Entry Test for Engineering Programs conducted by NED Karachi
- Entry Test for Engineering Programs conducted by American College Testing (ACT)

Applicants have an option to apply for admission in IST either on the basis of NAT/ NET/ ECAT/ ETEA/ MUET/ NED/ ACT/ HAT. Applicants can appear in any one of the above-mentioned tests and can use the higher score to apply for admission in IST i.e. if an applicant has obtained a higher score/ marks in NAT then he/ she should apply on the basis of NAT. Likewise, if an applicant has a higher score/ marks in NET or ECAT or HAT or NET or ETEA or MUET or NED or ACT entry test, then he/she should apply on the basis of NET or ECAT or

HAT or NET or ETEA or MUET or NED or ACT entry test score/ marks.

Further details related to NAT/ NET/ ECAT/ ETEA/ MUET/ NED/ ACT/ HAT. Entry Test are given below:

NAT Acceptable Test Dates & Categories

The test is conducted by NTS in all major cities of Pakistan in every month. Interested students are required to visit NTS website i.e. <https://www.nts.org.pk/new/NAT.php#vd> or contact NTS to get desired information related to the registration procedure, test dates and centers etc.

Acceptable Dates

The results of the NAT conducted by NTS from July 01, 2024 to last date of admissions of Fall 2025 are acceptable to offer provisional admission in engineering programs.

Acceptable Categories

- NAT-1E and NAT-1CS, both are acceptable to apply for admission in BS Engineering Programs

HAT Acceptable Test Dates & Categories

HEC has established Education Testing Commission (ETC) to hold Higher Education Aptitude Test (HAT) for UG admissions.

Acceptable Dates

The results of the HAT-UG tests announced/ available from July 01, 2024 to last date of admissions of Fall 2025 are acceptable to offer provisional admission in engineering programs.

Acceptable Categories

- HAT-UG-E and HAT-UG-CS, both are acceptable to apply for admission in BS Engineering Programs

NET Acceptable Test Dates & Categories

The result of NUST Entry Test (NET) announced/ available from December, 2024 to August 2025 are acceptable to apply for admission in BS programs offered by IST.

Acceptable Categories

- NET (Engineering Category), NET (Computer Science) both are acceptable to apply for admission in all BS Engineering Programs

ECAT Acceptable Test Date & Category

The result of ECAT conducted by University of Engineering & Technology (UET) Lahore for Fall 2025 intake in Engineering Programs announced/ available before last date of admissions announced by IST will be acceptable to apply for admission in all BS Engineering Programs offered by IST.

ETEA Acceptable Test Date & Category

The result of ETEA conducted by University of Engineering & Technology (UET) Peshawar for Fall 2025 intake in Engineering Programs will be acceptable to apply for admission in all BS Engineering Programs offered by IST.

MUET Jamshoro Acceptable Test Date & Category

The result of Entry Test conducted by Mehran University of Engineering & Technology (MUET), Jamshoro for Fall 2025 intake in Engineering Programs will be acceptable to apply for admission in all BS Engineering Programs offered by IST.

NED UET Acceptable Test Date & Category

The result of Entry Test conducted by NED University of Engineering & Technology, Karachi for Fall 2025 intake in Engineering Programs will be acceptable to apply for admission in all BS Engineering Programs offered by IST.

ACT Acceptable Test Dates

The composite score of ACT conducted from July 01, 2024 to September 30, 2025 is acceptable to apply for admission in BS Engineering Programs offered by IST. Candidates are required to enter their ACT Composite Score in their online application form and upload the score card available in "MyACT account" otherwise their application will not be processed.

Application

Application for admission can be submitted online on IST's website www.ist.edu.pk. Candidates must specify order of preference of disciplines in the application form. Please note that the

order of preference is NOT CHANGEABLE after closing date of admissions.

Candidates possessing O-Level, A-Level or any other international certificates are required to obtain Equivalence Certificates from Inter Board Committee of Chairmen (IBCC), Islamabad.

Pakistani Students are required to deposit the application processing fee amounting to Rs. 3000/- (for engineering and computing programs) and Rs. 3000/- (for Science programs) through online deposit slip, available at online admissions form. Application processing fee can be deposited in any online branch of HBL. Application will be processed after confirmation of



bank regarding the receipt of fee against the given particulars at online deposit slip and in application form. **International Students** are required to send Bank Draft of US\$ 100 along with copy of online application form to Admissions Office through courier service

Selection of Students of HSSC/ A-Level/ Equivalent Foreign Qualification

Admission shall be granted absolutely on merit which will be determined on the basis of marks obtained in the following examinations, and according to the weightage mentioned against the respective examination

Engineering Programs

For FSc/ DAE Students:

Matric/ Equivalent:	20%
FSc Part-1 or DAE (03 years aggregate marks):	40%
Entry Test:	40%

For A-Level/ Equivalent Students:

Matric/ Equivalent:	40%
Entry Test:	60%

Science Programs

For FSc applicants:

Matric/ Equivalent:	40%
FSc Part-1:	60%

For A-Level/ Equivalent Students:

Matric/ Equivalent:	100%
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Registration

Before the commencement of classes of each semester, all active students are registered for courses offered by respective department. Students are required to check their registered courses during the first week of each semester through My IST (member area) by using log-in & password. In case of wrong course registration or if

courses are found missing/not shown in member area, a student is required to visit and inform admissions office for necessary corrections. A student shall not be considered to have been registered for the semester unless the fees have been paid. It is a prerequisite for students to submit the copy of CNIC or Form B with the Admissions' Office at the time of admission and to undertake the Institute Code of Conduct and Undertaking.

Important

- Fee status of applicant will be updated at online application form after the deposit of fee in any online HBL Branch
- An application for admission shall not be considered unless submitted on the prescribed online form and completed as required
- Order of preference of discipline once made is NOT CHANGEABLE after closing date of admissions
- The admission letters along-with other necessary documents/ requirements will be issued in the logins' of successful applicants. Applicants who fail to deposit fee within specified due date mentioned on fee challan/ offer letter/ email shall be considered to have forfeited their chance for admission
- Original certificates of all examinations must be produced at the time of registration or immediately after the announcement of results from concerned board to confirm whether a student is fulfilling the eligibility criteria mentioned in advertisement/ prospectus/ IST website for admission in IST

- Only those Pre-medical students are eligible to apply for BS Engineering/ BS Space Science/ BS Physics/ BS Mathematics Programs who have already appeared/ passed additional math papers or registered to appear for additional math papers in first term papers to be conducted by the concerned board
- It is also mandatory requirement for all students to get attested their original SSC/ Equivalence Certificate and HSSC/ DAE/ Equivalence Certificate from IBCC and submit the copy of the same in Admissions Office during first semester.
- In case of documents/certificates submitted by student are later found to be fake/ bogus/ false/ fictitious/ forged or not in line with academic regulations of the university at any stage (during his/her studies or after leaving IST), he/she will be liable to expulsion from the institute with no liability on IST. In case of Graduation, IST reserve the right to cancel his/her Transcript & Degree and initiate the legal proceedings against him/her with no liability on IST.
- In case of cancellation of admission/suspension from the Institute, admission fee and other dues shall not be refunded
- Applicant is not eligible to claim for any refund or document without submission of duly signed 'No Demand Certificate'
- IST is the final authority to interpret the rules & regulations written in prospectus/student hand book/IST website or anywhere else. Students are not allowed to infer the meanings based on self-interpretations. Similarly, in situations where existing rules & regulations are found silent/unavailable, the decision made by IST will

be the final which can't be challenged anywhere else

- The Admissions Committee reserves the right to cancel or refuse admission to any applicant without assigning any reason

Fee Structure (for Local Students)

Fee Structure	Engineering Programs (Aerospace Engineering/Avionics Engineering/ Electrical Engineering/Mechanical Engineering)	M&ME	CS/ AI /DS/ SE/ CE	Space Science Biotechnology	Mathematics with AI Physics
Admission Fee	35,000/-	35,000/-	35,000/-	35,000/-	35,000/-
Library Development Fund	7,000/-	7,000/-	7,000/-	7,000/-	7,000/-
Endowment Fund	7,000/-	7,000/-	7,000/-	7,000/-	7,000/-
Total of One Time Charges	49,000/-	49,000/-	49,000/-	49,000/-	49,000/-
Per Semester Dues					
Tuition Fee	151,534/-	144,946/-	127,962/-	122,399/-	80,526/-
Service Charges	8,470/-	8,470/-	8,470/-	8,470/-	8,470/-
Safe/Smart Campus Charges	2,420/-	2,420/-	2,420/-	2,420/-	2,420/-
Total of Per Semester Dues	162,424/-	155,836/-	138,852/-	133,289/-	91,416/-

Optional Charges per Semester

*Hostel Charges	55,000/-
*Transport Charges	As per actual
Locker Rent	1000/-

Continual Enrollment Fee per semester (after 8th semester)

All Service Charges + 3 Cr. Hr. Fee + Fee of any Registered Course
(Rs. 9,900 + Rs. 30,000 = Rs. 39,900 + Fee of any Registered Course)

Note;

- Repeat/Add Course Fee is Rs 10,000 per credit hour.
- All Fees/ Charges are subject to change from time to time.
- All Govt. Taxes will be charged as notified by FBR.
- Student ID Card Fee is Rs. 1000.
- Application processing Fee is Rs. 3000
- Freeze charges are Rs. 10,000 per semester.

Fee Structure (for International Students)

Fee Structure	Engineering Programs (Aerospace Engineering/Avionics Engineering/ Electrical Engineering/Mechanical Engineering)	M&ME	CS/ AI /DS/ SE/ CE	Space Science Biotechnology	Mathematics with AI Physics
Admission Fee	2,000/-	2,000/-	2,000/-	2,000/-	2,000/-
Library Development Fund	250/-	250/-	250/-	250/-	250/-
Endowment Fund	250/-	250/-	250/-	250/-	250/-
Total of One Time Charges	2500/-	2500/-	2500/-	2500/-	2500/-
Per Semester Dues					
Tuition Fee	5,357/-	5,124/-	4,822/-	4,612/-	3,045/-
Service Charges	275/-	275/-	275/-	275/-	275/-
Safe/Smart Campus Charges	275/-	275/-	275/-	275/-	275/-
Total of Per Semester Dues	5,907/-	5,674/-	5,372/-	5,162/-	3,595/-

Optional Charges per Semester

Hostel Charges	US \$ 600/-
Transport Charges	As per actual
Locker Rent	Pak Rs. 1000/-

Continual Enrollment Fee per semester (after 8th semester)

All Service Charges + 3 Cr. Hr. Fee + Fee of any Registered Course
(US \$ 500 + US \$ 1,320 = US \$ 1,820 + Fee of any Registered Course)

Note;

- Repeat/Add Course Fee is US \$ 650/- per credit hour
- All Govt. Taxes will be charged as notified by FBR.
- All Fees/ Charges are subject to change from time to time.
- Application processing Fee is US \$ 150/- through direct remittance in IST Bank Account. (e) Freeze charges is US \$. 1000/- for each semester.
- Student ID Card Fee is Rs. 1000.
- Direct remittance in IST Bank Account.

Fee Refund Policy

- The date of request for fee refund claims will be considered from the date of receipt of application through email at refund@ist.edu.pk
- To apply for refund, an applicant is required to email refund request at refund@ist.edu.pk along-with the reason of leaving IST, Fee Payment Proofs (Paid Challan Form/s or Online Transaction Record) & Copy of CNIC of Guardian.
- Application Processing Fee and Admission Fee are non-refundable.
- From Registration, all students are required to complete NDC to process the refund of dues (if any) as per fee refund policy.
- Tuition Fee, Service Charges, Safe/Smart Campus Charges, Endowment Fund, Library Development Fund and ID Card Fee are refundable within 30 days of commencement of classes on a pro rata basis as given below. No refund shall be admissible after 30 days of commencement of classes either one joins IST/avails facilities or not.

Timeline for Refund of Compulsory Fees	%age of Refund
Upto 10th day of commencement of classes	100%
Upto 15th day of commencement of classes	80%
Upto 20th day of commencement of classes	60%
Upto 30th day of commencement of classes	50%
31st day onwards of commencement of classes	0%

- If admission is offered after commencement of classes, date of commencement of classes will be considered as mentioned in offer letter.
- The Tuition Fee can be carried forward and utilized in the subsequent semester if a student seeks postponement (Freeze) of his/her studies within two (2) weeks of the commencement of the semester. However, after the above-mentioned time frame, any request for the Tuition Fee to be carried forward shall only be permitted under

special hardship circumstances as per IST's semester freeze policy. If student wants to leave the institute after freezing his/her semester, then dues will be refunded according to prevailing refund policy at the time of freezing the semester.

- Adjustment of student liability from 2nd Semester onward will be based on class attendance & facility will be charged as per actual. The application for the adjustment of student's liability will only be entertained on the verification by concerned HoD and approval of Registrar.
- In case of Admission cancellation in 1st semester cheque of fee refund will be issued in the name of Student's Father/Guardian.
- 100% dues will be refunded in case where student could not attain requisite marks/grade for admission as prescribed by the institute. This policy is only applicable on fresh admissions. However Optional Charges will be deducted as per actual usage of facilities based on 4.5 Month/Semester Basis.
- Hostel Charges are refundable within 30 days of registration on a pro rata basis as given below. No refund shall be admissible after 30 days of registration either one joins IST/avails facilities or not. However, refund will be calculated based on the date of application or date of leaving the facilities whichever is later.

Timeline for Refund of Optional Dues	%age of Refund
Up to 7th day of Registration	90%
From 8th to 15th day of Registration	75%
From 16th to 21st day of Registration	50%
From 22nd to 30th day of Registration	25%
From 31st day of Registration	0%

- 100% optional dues will be refunded if application is received before the registration day.

- During continual enrollment, a student can avail monthly hostel facility maximum up to two months. Otherwise S/he will have to pay full semester charges.

Registration

- Before the commencement of classes of each semester, all active students are registered for courses offered by respective department. A student shall not be considered to have been registered for the semester unless all previous dues have been paid.
- Hostel accommodation and transport facilities shall only be provided to students after registration.
- Every student must update his/ her personal information shown in student portal at the start of every semester.

Fine for Late Payment

The following fine will be levied for payment of fee after due date:

- For first fifteen days after the due date, 5% of the total payable amount.
- After fifteen days and up to one month after due date, 10% of the total payable amount.
- Students will only be allowed to appear in final exam after deposit of outstanding dues along with fine.

Mode of Payment

Payment of fees can be made through online Transfer/Bank Draft/Pay order against the fee challan issued at any online branch of HBL (Nationwide).

Note: Cheques and Cash are not acceptable

Financial Assistance

Sponsorships

Several elite national Research and Development (R&D) organizations provide sponsorships to the deserving students after test/ interview. The sponsorship covers tuition fee and a guaranteed job after graduation, provided all requirements of the sponsoring organization are fulfilled by the candidate.

Scholarships

IST awards merit scholarships to high achievers in each semester as per the existing policy. Need Based Scholarships are also given to the students, depending upon the availability of funds.

Note: A student obtaining scholarship/ sponsorship from any source will not be considered for merit scholarship or any other scholarship offered/ announced by IST.



Academic Regulations

The Academic Program

The Bachelor of Engineering/Science is a four year degree program consisting of eight semesters. There shall be two regular semesters (Fall and Spring) in each academic year. Each semester shall be of 19 weeks duration including 17 weeks of classes followed by final examinations in the 18th & 19th week. The Undergraduate degree program typically includes theory courses, laboratory work, final year project and internship etc.

The maximum duration for completing the BS/BE degree program is six years, extendable by one additional year (in case of valid reason) subject to the approval from the relevant statutory bodies (FBS & ACM).

Course Load for Fall and Spring Semesters

- Each course at IST is assigned credit hours. For theory courses 1 credit hour corresponds to 1 hour of lecture per week, while for laboratory courses 1 credit hour corresponds to 3 hours of lab work per week.
- The normal course load for undergraduate students is as prescribed in the approved study plan of their respective degree program. Students are expected to follow this study plan to ensure timely completion of degree requirements.
- The undergraduate program of instruction generally includes a 15-18 credit hours course load including exams in a regular semester. However, students may be allowed to enroll in an additional course beyond 18 credit hours under the following conditions:
 - In alignment with recent guidelines of HEC & PEC departments may allow a maximum of 21 credit hours per semester, to accommodate newly introduced General Education / Non-Engineering domain mandatory courses, as

required by the program structure (w.e.f Fall 2025).

- If CGPA is 3.5 or above at the time of application, student may take an additional course (along with its lab) in any semester.
- If CGPA is below 3.5 at the time of application, student may take an additional course only after completion of 6th semester.
- All such requests are to be sent to Dean for approval through concerned HoD along with justification and an endorsement confirming that enrolling in the additional course will ensure degree completion on time (i.e. within four years).

All such requests are to be sent to Dean for approval through concerned HoD along with justification and an endorsement confirming that enrolling in the additional course will ensure degree completion on time (i.e. within four years).

Summer Semester

Undergraduate students having "F" grade or below "C" grade can repeat/improve the courses in Summer semester which will be of 08 weeks' duration and 01 week of examination. Moreover, undergrad students having grades including "W (Voluntary Withdrawal)", "WSA (Withdrawn due to Short Attendance)" and "WMI (Withdrawn due to Medical Illness)" grade(s) are also allowed to repeat the course(s) in Summer semester. Repeat/improve grade(s) shall be marked on the transcript as "R" and "#". A student can take maximum of 2 courses. The 3rd course may be offered only to those students, who are running short of degree completion time (6 years), with the approval of Dean IST. Maximum 'B+' grade is awarded in the Summer semester. BE/BS students who have completed all degree requirements but are enrolled in the Summer semester to repeat or improve any course shall not be eligible to participate in the convocation ceremony of that

academic year.

Degree Requirements

All undergraduate degree programs are composed of between 133-142 Credit Hours (as required by the Accreditation Councils). The requirement to earn the degree of Bachelor of Engineering/Science is completion of a specific number of credit hours in respective disciplines, with a Cumulative GPA of 2.00 or more and a minimum of 'C' grade in Senior Design Project. All Program Learning Objectives (PLOs) must be attained as per the relevant IST's policy.

These requirements are to be completed in a maximum duration of six years, further extendable by one additional year (total seven years). Extension of one-year has to be approved by the relevant statutory bodies (FBS & ACM) - on a case to case basis. The student(s) who will not complete studies within stated periods including extension shall be struck off from the rolls of the institute. The students who have been given the right to extend the duration of study for one additional year are required to pay new registration fee along with continual enrollment fee for that academic year as per HEC/IST policy in vogue.

A student shall be registered continuously for the entire duration. BE/BS students who have completed 8 semesters but their degree requirements have not yet been completed and are enrolled for the 9th semester will be charged a "Continual Enrollment Fee" as per IST policy in vogue along with course(s) fee, if applicable. There shall be no unresolved "F" grade, or "W", "WSA", "WMI", "WDA", "WIC" or "I" grade left during the program.

*Breakdown of credit hours are available in Undergraduate Prospectus/IST's website (<https://www.ist.edu.pk/>).

Discipline	Credit hours*
Aerospace Engineering	139
Avionics Engineering	139
Electrical Engineering	136
Metallurgy & Materials Engineering	136
Mechanical Engineering	139
Computer Science	130
Artificial Intelligence	130
Data Science	130
Software Engineering	133
Computer Engineering	136
Mathematics	133
Mathematics with AI	135
Mathematics with Data Science	142
Space Science	142
Physics	138
Bio-technology	130
Remote Sensing & GISc	130

Semester Structure & Assessment Plan

Effective from Fall 2025, the semester is divided into two study periods to facilitate effective academic monitoring and assessments:

First Study Period: This period concludes at the end of the 8th week. A Midterm Examination of a minimum duration of two hours will be conducted during the 9th week of the semester (Fall and Spring), and during the 5th week of the Summer semester.

Second Study Period: Concludes by the end of 17th week which is considered as dead week and during this week classes are held as per schedule however, student's attendance does not count towards final attendance percentage.

Final Exam will be held in 18th & 19th weeks. A student's academic progress and standing is

determined and monitored through the following modes and number of evaluations: -

***Assignments:** At least 2 assignments for each course

Quizzes: At least 4 unannounced quizzes in each course

Lab Reports: Minimum 14 lab reports in each lab

Oral Exams: Minimum 1

Mid Term Exam: Minimum 1

***Projects/Case Study:** Minimum 1

Final Exam: One announced final exam of up to three hours' duration

*Instructor may choose one or both for undergraduate courses

In each semester, students is required to appear in quizzes, 1x Mid Term Exam, 1x final examination, presentations (individual/group), and submit projects/assignments/lab reports, etc. for each course. These assessment marks (to be determined by the teacher concerned) will have different weightage contributing towards the overall assessment in percent marks. A typical break-up of weightage assigned to each mode of evaluation for a course and that for a laboratory is as follows:

Course	
Assignments	10-15%
Quizzes	10-15%
Mid Term Exam	25-35%
Project/Case Studies/CEA/PBL	10-15%
Final	45-55%

Lab	
Mid Term Exam	10%
Oral Exam / Final Viva	15%
Lab Reports	15%
Lab Performance	20%
OEL/CEA / PBL	20%
Lab Final Exam	20%

Open Ended Lab (OEL), Complex Engineering Activity (CEA), Project Based Learning (PBL)

- At least 80% attendance is mandatory to appear in the final exam of a course, whether it is a normal or repeat/improve course.
- There will be no choice of questions in quizzes, mid-term and final exams. Retake of mid-term and final exam is allowed under special circumstances as per SOP.
- One lab credit hour corresponds to three hours of lab work per week.
- All final exams of lab tests/Viva shall be conducted under the supervision of the respective theory course instructors. Grades awarded to students in lab exams shall be reviewed and approved by the concerned theory course instructors.

Grading System

IST, as a matter of rule, follows a relative grading system by default for the undergraduate programs (irrespective of the number of students). Relative grading allows for screening students according to their performance relative to their peers. The ranges for assigning grades are determined using the class average and its standard deviation.

The labs and FYP, however, are graded according to the absolute grading system.

Interpretation	Grades	Marks
Excellent	A	$85 \leq \text{marks} \leq 100$
	A-	$81 \leq \text{marks} < 85$
Very Good	B+	$77 \leq \text{marks} < 81$
	B	$73 \leq \text{marks} < 77$
Good	B-	$69 \leq \text{marks} < 73$
	C+	$65 \leq \text{marks} < 69$
Average	C	$61 \leq \text{marks} < 65$
	C-	$57 \leq \text{marks} < 61$
Poor	D+	$52 \leq \text{marks} < 57$
	D	$50 \leq \text{marks} < 52$
Fail	F	Marks < 100

FYP-1 in 7th semester will be awarded as a deferred grade against the course and the final grade will be awarded in 8th semester. The deferred grade in 7th semester shall not appear on the final transcript.

Grading Criteria for Summer Semester:

The grading criteria for Summer semester is different than the regular semesters. For courses with less than 20 registered students, absolute grading shall be applied according to the marks ranges defined in the table above. Maximum 'B+' grade is awarded in the Summer semester.

'Temporary Enrollment' and 'Extended Temporary Enrollment' Status for summer:

- A student is not awarded 'Temporary Enrollment' and 'Extended Temporary Enrollment' status on the basis of the result in Summer semester.
- A student awarded any of the above academic status in the preceding Spring semester, will be carried forward to the next Fall semester. In other words, the result of Summer semester will not change the academic status, earned in the preceding semester.

Computation of Semester and Cumulative Grade Point Average (SGPA & CGPA)

Semester Grade Point Average (SGPA) and Cumulative Grade Point Averages (CGPA) is calculated by using following formula:

$$\text{SGPA} = \frac{\text{Sum of (credit hours x grade points)}}{\text{Total Semester Credit Hours}}$$

$$\text{SGPA} = \frac{\text{Sum over all taken courses in all Semesters (Course Credit Hours x Grade Point)}}{\text{Total Credit Hours taken in all Semester}}$$

Semester GPA is calculated by multiplying the grade points earned in a course with the number of credit hours of that course; taking the sum of such products for each course in a semester and dividing the sum by the total

number of credits in the semester. SGPA is rounded off to two decimal places by taking into consideration 9 digits after the decimal. Similarly, Cumulative GPA (CGPA) is calculated by taking into account all the courses, in each semester, and rounded off accordingly.

Grade "I": Incomplete

Grade "I" is awarded to a student who is unable to take the final examination of a course due to unavoidable/extreme circumstances. The student is required to take the final examination of that course within six weeks after approval of results from FBS, provided all the other requirements of the course have been completed. If a student fails to appear in an examination within six weeks, the "I" grade shall be converted to "F" grade.

Grade "F": Fail

Grade "F" is awarded to a student in a course for not demonstrating adequate performance. Such course(s) must be repeated by the student when offered the very next time.

Repeat Course

Students are allowed to repeat course(s) whether they want to improve their CGPA or to pass any F-grade. In such cases both the previous and new grade obtained will be recorded on the transcript. A letter "R" will be affixed against the course attempted first time and a symbol of # will be affixed with the grade earned in the repeated course (last attempted). Students must pay the per credit hour Repeat Course Fee as specified in the Fee Structure section of the prospectus.

- If a student earns an F-grade in an elective course, then he/she is allowed to repeat that course or its approved alternate only once
- Students are allowed to repeat a course in which s/he has obtained grade below "C". In such a

case of course repetition, both the previous and new grade obtained will be recorded on the transcript, however, only the better grade shall be used in the calculation of CGPA (Effective from Summer 2025).

- Student will only be allowed to repeat a course if seats are available in a classroom, without effecting a regular batch. Preference will be given to students who have lower grades compared to students who have higher grades, if the number of students exceeds the capacity of a classroom
- Students who have repeated any course(s) are ineligible to get President Medals and merit certificate however they are eligible for Best FYP if the course is repeated for grade improvement.

Rules for Repeat of Course with Theory and its linked Lab

- A student repeating a course to improve the grade will have to enroll/register the entire course in totality (Theory + Lab) in a semester.
- If theory part is passed and lab is failed / withdrawn, student can repeat only the lab in subsequent semester.
- If lab is passed and theory part is failed / withdrawn, "WIC" grade will be awarded in the lab. Students will have to re-register for both theory course and its associated lab simultaneously in the subsequent semester.

Rule for Improvement of Grades for Graduating Students

The graduating students must submit the application for improvement of grades to the concerned departments within 15 days of result announcement. After due date no such case will be entertained.

Provision of Additional Repeat Chances to Improve Grade for Final Year Students

After the completion of 6th semester, a student with

probationary status (temporary/extended temporary enrollment) will be allowed to avail additional chances of

course repeat to remove his/her probationary status: -

- This provision of availing additional chances for grade improvement will remain valid for final year students (7th & 8th semesters) till the completion of their degree program with following instructions: -
 - Students can avail maximum chances of grade improvement Only courses with below "C" grade can be repeated Better grade shall be used in the calculation of CGPA (Effective from Summer 2025)

Non-Credit Course

A non-credit course will be registered by the student at the start of the semester if a student desires to study such a course. A student is also allowed to change the status of a course to a non-credited course, before the withdrawal date mentioned in the academic calendar. Such courses will be listed separately at the bottom of the transcript. These courses will not be counted towards CGPA, however, fee for the non-credit courses will be charged.

Replacement of Elective Course

If a student wishes to replace an elective course with another elective course, it shall be treated as a "repeat course". Similarly, "F" grade in an elective course, replaced by another elective course will be counted towards the count of "F" grade limit.

Semester Freeze

Undergraduate students may freeze studies for at most four regular semesters (Spring/Fall) based on medical grounds or other genuine reasons. However, the student cannot apply for semester freeze in the 1st semester. Students must submit a semester freeze request within two weeks of the start of semester. The student will lose his/her registration from the university

roll in case of failure to rejoin/report during the stipulated semester he/she is supposed to rejoin. IST will not make any special arrangements for his/her remaining studies. No extra time will be given and student will have to complete all degree requirements within the maximum time allowed by IST. Student will apply for semester freeze on prescribed form along with undertaking available on IST website, after respective HoD and Dean IST approval; student will pay the prescribed fee and submit the challan in Finance Office. Admission office will update the student status in AMS after confirmation by Finance Office.

If a student is on the fee defaulters' list, a semester freeze will not be granted until all outstanding dues are cleared. If a registered student applies for semester freeze within due date as per academic calendar issued by Dean Office, he/she will have to pay only semester freeze charges, regardless of attendance. Already deposited semester fee will be adjusted in the next semester. In case of discontinuation of studies from IST, all paid charges will be refunded as per HEC National Fee Refund Policy.

Semester Freeze after due date

A student who is unable to continue the semester due to medical reasons can have the semester frozen with the semester fees carried forward even after elapse of the semester freeze deadline, provided the student's medical condition and the fact that the student is unable to continue studies is verified by a physician/medical officer on the IST panel.

Grade "W": Withdrawn

Students may withdraw courses in a semester according to the dates mentioned in the academic calendar. The request for withdrawn courses shall be made with the approval of the concerned HoD on a prescribed form. Fee paid for these courses will not be

reimbursed. These courses are to be repeated.

Grade "WIC": Withdrawn due to Incomplete Course

Theory and Lab course of a particular subject shall be offered in the same semester. "WIC" grade would be awarded in Lab course if student fails or withdrawn from the corresponding Theory course due to any reason. If Theory course is passed and Lab course is failed/debarred, then only Lab course will be repeated.

"WMI" Request Approval

All "WMI" requests (from Fall 2021) must be accompanied by supporting certificate from a Medical Professional employed in any hospitals which are on IST's panel.

Interpretation	Grades
Voluntary Withdrawal	W
Withdrawn due to Short Attendance	WSA
Withdrawn due to Medical Illness	WMI
Withdrawn on recommendation of Disciplinary Committee	WDA
Incomplete Lab Course due to F, W, WSA, WMI or WDA grade in related theory course	WIC

Add/Drop Course

Students may add or drop courses in a semester according to the dates mentioned in academic calendar. The request for add or drop courses shall be made with the approval of the Dean through HoD on the prescribed form.

Attendance

Students are required to be regular and punctual. A

student with less than 80% attendance in a course shall not be allowed to sit in the final exam of that course and a “WSA” grade will be awarded. Minimum 80% attendance is mandatory in a regular/repeat/improve/non-credit course as well as labs.

Readmission

A student dropped-out on academic grounds (not on disciplinary grounds) may apply for readmission through the regular admission process with the subsequent intake.

Academic Integrity

At IST, academic integrity is fundamental. The Institute enforces a zero-tolerance policy toward academic dishonesty to uphold fairness, trust, and respect across the academic community.

Students are expected to adhere unwaveringly to values of honesty, trust, fairness, respect, and responsibility in all academic pursuits. Academic misconduct including but not limited to plagiarism, cheating, falsification, unauthorized collaboration, and facilitating dishonesty is strictly prohibited.

Members of the IST community are encouraged to report suspected violations. Ensuring the integrity of academic work protects the value of every student's education

All cases of suspected dishonesty are reviewed by the institute's relevant committees (Disciplinary Committee, University Antiplagiarism Standing Committee (UAPSC) etc). The process includes:

- Investigation and Hearing: A fair, transparent procedure is conducted to assess the case.
- Right to Appeal: Students may appeal the Disciplinary Committee's and UAPSC written decision to the Vice Chancellor (IST) within 15 days of notification. The Vice Chancellor's decision is final and binding.

Academic Advisor

Students are assigned academic advisors in all departments. The role of an academic advisor is to assist students to overcome their academic problems; guide and assist in their academic progress and monitor their discipline and general behavior during their stay at IST. However, it is primarily students' responsibility to contact the advisor for consultation.

Grade Reports

Grade reports are posted on students' web portal at the completion of each semester. The report contains grades obtained in each course, semester GPA, cumulative GPA. Upon request a transcript of grades is issued free of charge to students at the completion of semester/ academic program. Grade reports are marked to parents of students with weak academic performance on their home address. Every student must update his/her personal information including latest mailing/residential address, email, and mobile number in student portal at the start of every semester.

Conduct and Discipline

All students are expected to uphold high standards of conduct, integrity, and discipline. Respectful behavior, adherence to institutional rules, and responsible use of campus resources are essential components of the learning environment at IST.

Any form of misconduct or indiscipline will be dealt with strictly under the Institute's disciplinary regulations. Disciplinary action may include warning, probation, suspension, or expulsion, depending on the severity of the violation. A student whose registration is cancelled on disciplinary grounds shall be permanently ineligible for readmission to the Institute. Students are not allowed to take books, files, bags, programmable calculators and any other electronic device including cell phone, iPad, PDA etc. or any other material, which can be helpful during the

examination inside exam hall.

Examples of misconduct include (but are not limited to):

- Cheating or use of unfair means in exams, quizzes, or assignments
- Forgery or falsification of documents or academic records
- Disruptive, disrespectful, or aggressive behavior on campus
- Harassment, bullying, or intimidation of others
- Vandalism, theft, or damage to Institute property
- Unauthorized access to university systems or misuse of facilities
- Possession or use of prohibited substances on campus

Violation of exam rules may lead to disciplinary action, including cancellation of the exam paper or further penalties, as determined by the Institute's examination and disciplinary authorities.

Academic Standards

GPA will be the primary measure of academic performance and standing:

- **Good Standing:** A student is considered in good academic standing if their CGPA is 2.00 or higher.
- **Temporary Enrollment:** If a student's CGPA falls below 2.00 for the first time, they will be placed on temporary enrollment status. This serves as an academic warning, allowing the student an opportunity to improve their performance.
- **Extended Temporary Enrollment:** If a student's CGPA remains below 2.00 for two consecutive semesters, they will be placed on extended temporary enrollment. This indicates continued academic difficulty and requires immediate improvement to avoid further consequences.
- **Dropout:** If a student's CGPA remains below 2.00 for three consecutive semesters, he/she will be dismissed from the program and considered a dropout.

- A copy of the advisory note will be sent to sponsor or parents of academically deficient student
- A student with a Dropout standing will lose student status and will have to leave the institute
- Dropout conditions are applicable from Spring 2023.

Condition	Status
CGPA is 2.00 or more	Good Standing
CGPA<2.0 (1st Occurrence)	Temporary Enrollment
CGPA<2.0 (Consecutive Semester)	Extended Temporary Enrollment
CGPA<2.0 for three consecutive semesters	Dropout

Dean's List

Students with full load and Cumulative GPA of 3.50 or above are placed on the Dean's List. Graduation honors are awarded on the students' transcript according to the following criteria:

Honour	CGPA
Summa Cum Laude	3.90 or more
Magna Cum Laude	3.70 to 3.89
Cum Laude	3.50 to 3.69

Students Official Duty (OD) Procedure:

After taking approval from the respective HoD, the departmental coordinator shall mark the students OD (Official Duty) request in AMS system describing the job/duty of student concerned before his/her departure on OD. The departmental coordinator shall send the evidence (approval of OD by HoD/ attendance on specific event in shape of certificate endorsement) to Dean Office immediately after the event, for regularization/approval of OD requests.

Dean after review of the documents (AMS system entry date/approval of HoD in hard form) will approve/not approve the OD request in AMS system. OD approval depends on system entry date (i.e. well before the actual event date and approval of respective HoD). Any other department approval will not be considered in this regard. Student should get approval from respective departmental HoD, through academic coordinator before attending an event, otherwise his/her request will not be considered for approval and any justification will not be entertained. Back dated requests shall not be considered for approval. Cutoff date for all OD requests to reach the Dean's Office (after following the above procedure) will be the last day of the 16th week of the respective semester.

Registration

- Before the commencement of classes of each semester, all active Undergraduate students are registered for courses offered by the respective department.
- Students are required to check their registered courses during the first week of each semester through My IST (member area) by using login & password. In case of wrong course registration or if courses are found missing/not shown in member area, a student is required to visit and inform Admissions Office in writing for necessary corrections.
- A student's status in the AMS shall be marked as NR (Not Registered) for all the courses of the semester, unless all outstanding dues including liabilities of the current semester are cleared
- It is a mandatory for students to submit a copy of their CNIC or Form B with the Admissions Office at the time of admission and to give an undertaking to abide by the Institute Code of Conduct
- A student may add a course up to the 2nd week and may drop a course by 4th week (as per the dates mentioned in the academic calendar) from the start

of the semester.

- A student may withdraw a course by the 14th week (as per the dates mentioned in the academic calendar) from the start of the semester; however, he/she has to pay the fee of that course when he/she applies again. Student will be awarded "W" grade in the course for that semester.
- Attendance in lectures is governed by the Attendance Regulations
- If the registration of a student is cancelled on disciplinary grounds, the student shall be ineligible for readmission to the Institute
- Registration must be completed prior to the 1st day of classes and is a basic requirement for attending classes. Every student must update his/her profile each time he/she register in a semester

Enrollment Cancellation

Students' enrollment will be cancelled under the following conditions: -

- If student do not pay semester dues within the due date announced by the institute
- If student do not attend any class of a course in the first 4 weeks of the semester without prior notice;
- If student do not apply for semester freeze and he/she has no other application in process that affects the semester registration
- Registration/enrollment of a particular student shall be cancelled by the Admissions Office after two reminders in week 5 & 6 respectively, and admission cancellation shall be notified to all concerned.
- Finance Department will cancel the issued voucher after the notification of admission cancellation by the Admissions Office for the concerned student(s) for the respective semester.

The above changes shall be applicable from Spring 2023 and onwards.

Faculty of Aeronautics & Astronautics

Dr Raees Fida Swati

Head of Department
PhD (Structural Design of Flight Vehicle)
Aeronautical & Astronautical Science and Technology
School of Astronautics, Northwestern Polytechnical University,
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Registrar

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HOD - Metallurgy & Materials Engineering

HOD - Mechanical Engineering

HOD - Space Science

HOD - Computing

HOD - Electrical Engineering

HOD - Applied Mathematics & Statistics

HOD - Avionics Engineering

HOD - Humanity

Director ORIC

Director Administration & Project Development

Director Human Resource

Director QEC

Director IT

Controller of Examinations

Acting Director National Centre for Failure Analysis

Incharge Library

Incharge Transport

Incharge Student Affairs

Incharge Admissions

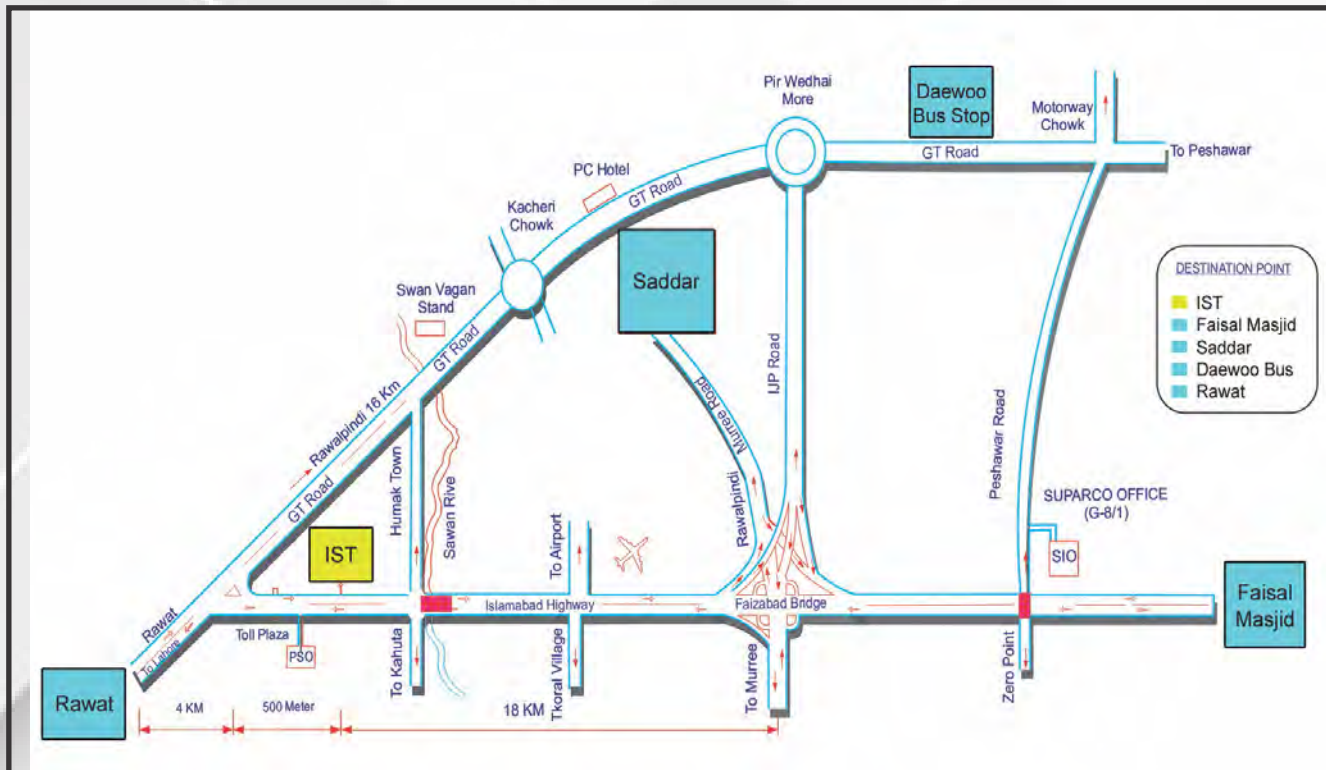
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Disclaimer

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