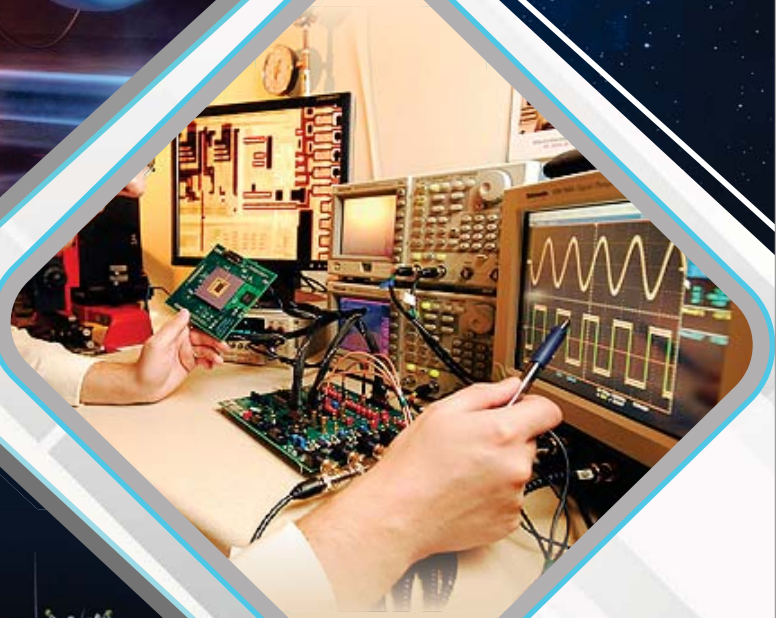
# 2024

## 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

The institute aims at providing outstanding quality education to diverse groups of national and international students.

Academic programs focus on rigorous scientific and theoretical foundations to create professionals with thorough understanding of the fundamentals and capability of applying this knowledge for research, analysis and design.

ZERTIFIKAT | CERTIFICATE | CERTIFICAT | CERTIFICADO | СЕРТИФИКАТ | شهادة | 证书 | 인증서

# CERTIFICATE

TÜV AUSTRIA

**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
www.tuvaustriahellas.gr

IAF ESYD MS Certification No. of Certificate 236

CaPRK478_A1e

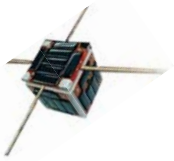
Headquarters in Athens bear the responsibility of the Certification decision

017833-18-4



ISO 9001
BUREAU VERITAS
Certification

BUREAU VERITAS 1828



iCUBE-1
(a project of IST)
"First Cube Sat" by Pakistan
launched on November 21, 2013

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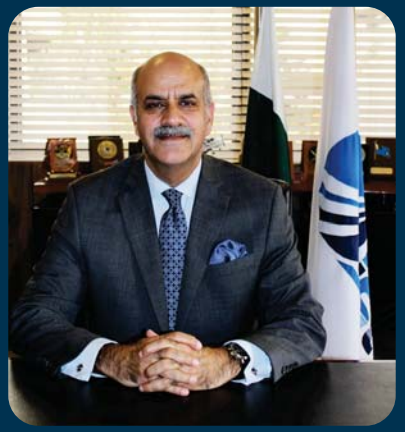
Message of the

# Vice Chancellor



Institute of Space Technology offers engineering and Science programs in cutting edge technologies at the undergraduate and graduate levels and is ranked among the leading engineering universities of Pakistan. Our programs fulfill the requirements of international standards as we are mindful of the rapidly transforming technological scenario. At IST we aim to provide the knowledge and skills to our students so that they become leaders in their respective fields. This requires students to search for a direction and purpose that extends beyond their individual selves and necessitates them to work together with others. Hence we emphasize on inculcating human aspect in our students by signifying the importance of human values to enhance their ability to effectively collaborate as a group. We are aware that acquisition of knowledge coupled with the ability to work as a team is going to help our students to deliver the required outcome in providing sustainable technological solutions to the industry.

Not only is technology changing rapidly but its various domains are becoming highly integrated. Therefore, in order to succeed, our students are being provided not just the latest knowledge but are also imparted with skills and are being trained to become flexible to adapt to the ever changing technological landscape.

IST welcomes you to a journey of discovering new avenues and in playing your role as an effective and responsible citizen of Pakistan, and groom you as a leader in your specialty for a brighter future for yourself and your beloved homeland.

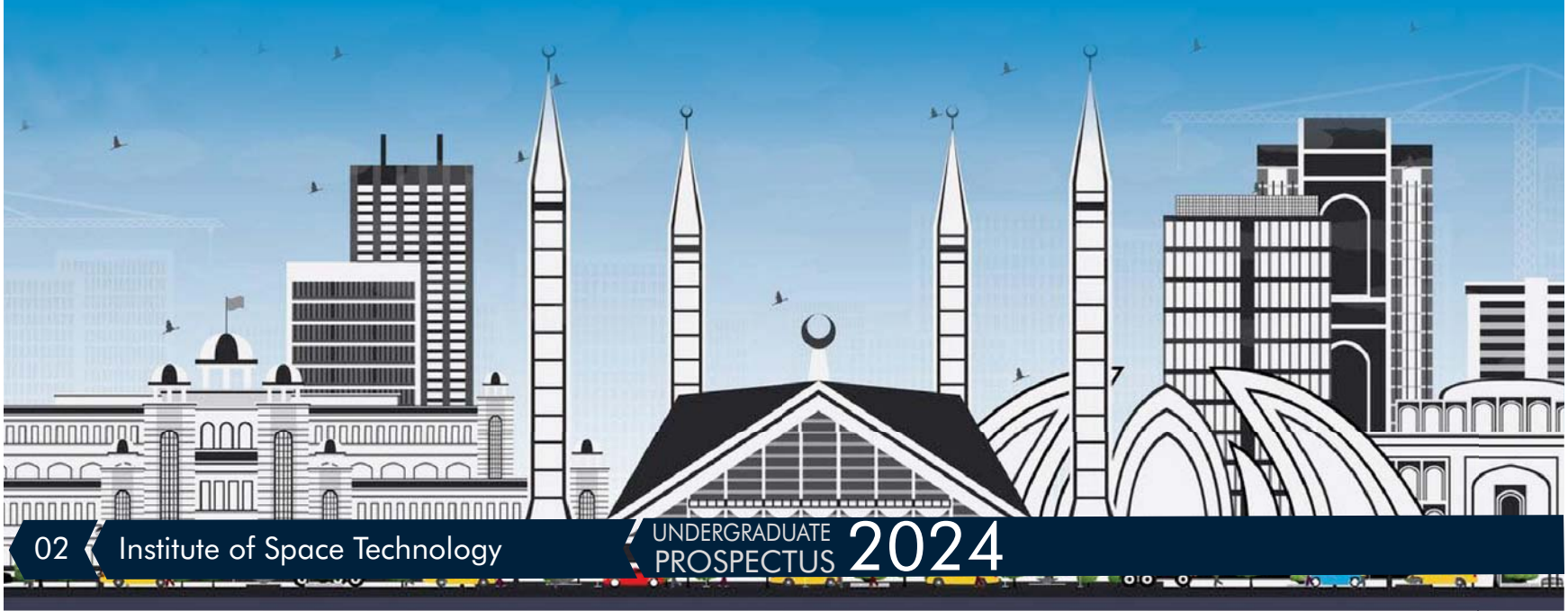
Major General Rehan Abdul Baqi
HI(M), (Retd)

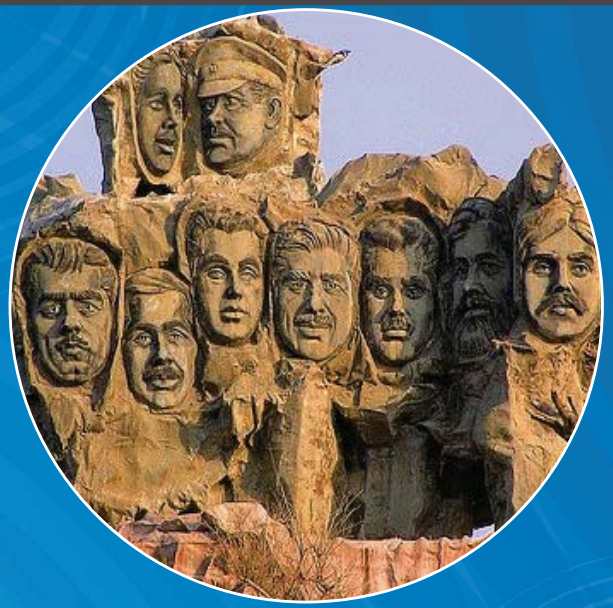
# Location

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.

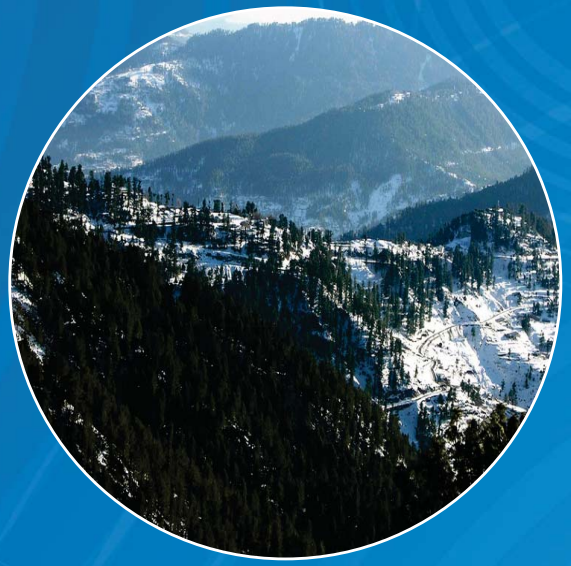




**Rawalpindi** Rawalpindi, named after Raja Pindi, is a city bustling with life. It is located on the northern most part of the Punjab province, strategically located between the Khyber Pakhtoon Khwa and Azad Jammu & Kashmir. It is also known as the twin city of Islamabad. It is the military headquarters 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.

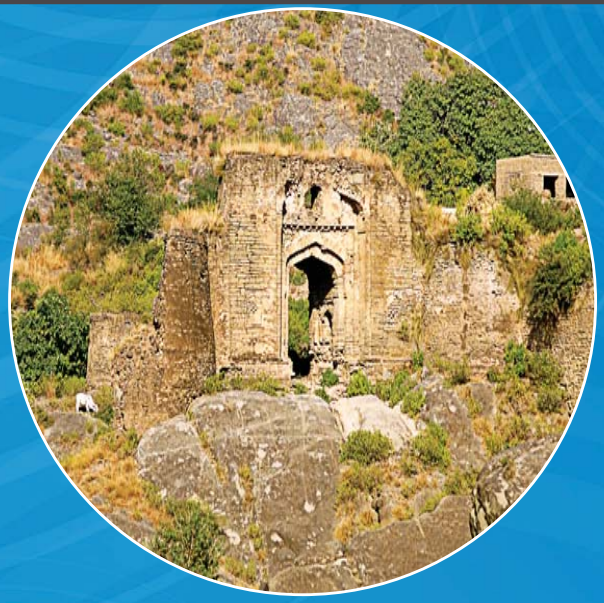
**Gurudwara Panja Sahib in Hasan Abdal** Gurdwara Panja Sahib is situated at Hassan Abdal, 48 km from Islamabad. The town of Hassan Abdal has a particular association with Mughals and Sikhs. This is one of the most holy places of Sikhism because it marks the spot where the founder of the faith, Guru 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.



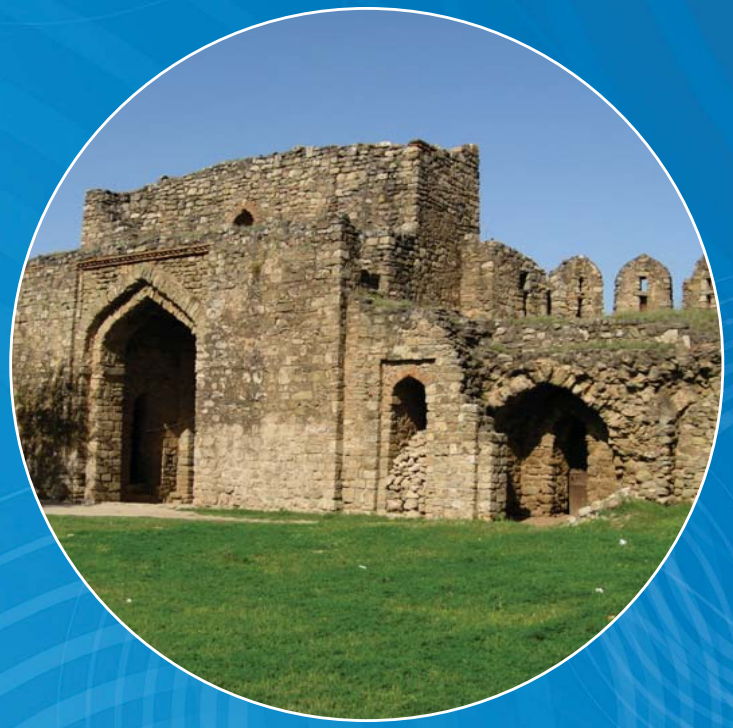
**Murree** Murree is a popular hill station and a summer resort in Pakistan. It is a delightful place especially for the residents of Islamabad. Its altitude is 2,300 m (7,500 ft) above sea level. Murree is a place for all seasons; in summers it is an ideal place to beat the scorching heat of the twin 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
- Materials Science & Engineering
- Mechanical Engineering
- Computer Science
- Data Science
- Artificial Intelligence
- Space Science
- Physics
- Mathematics

## 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

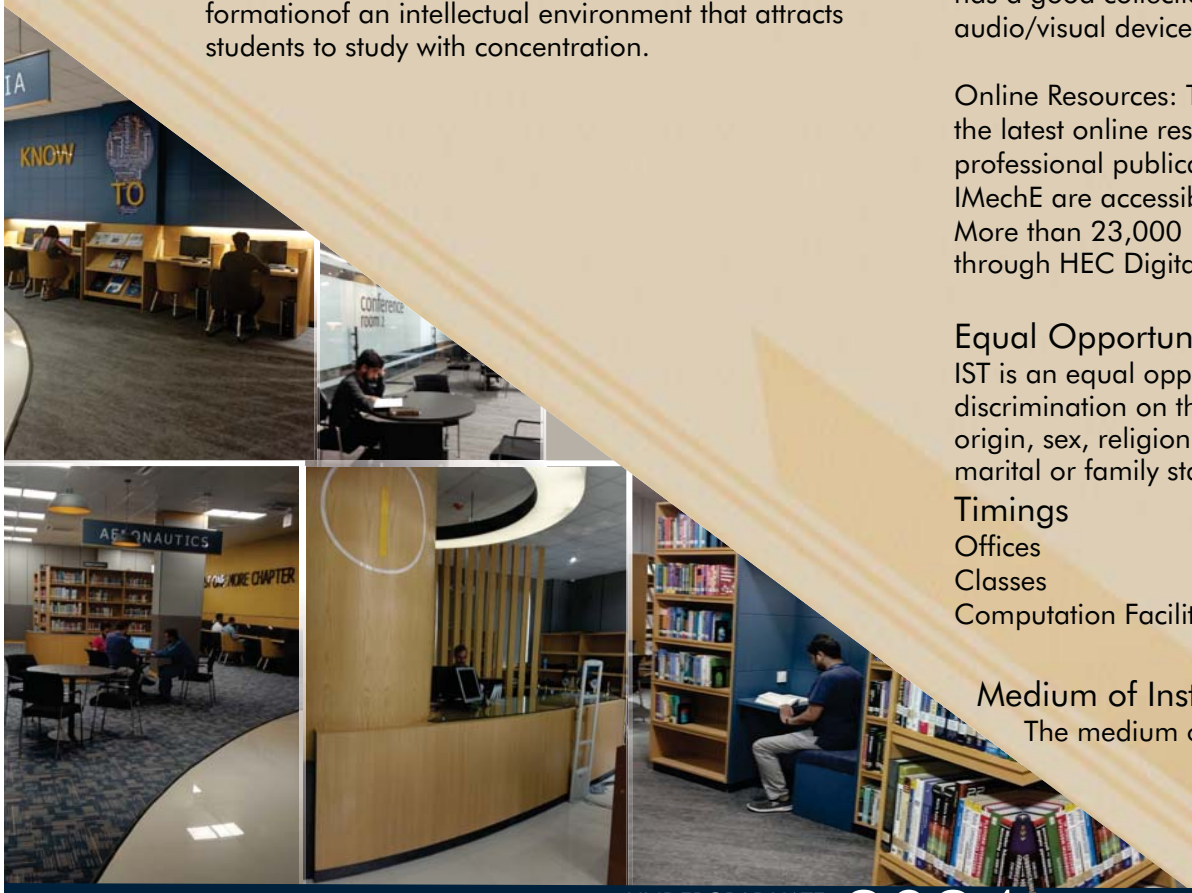
The academic program is supported by laboratories equipped with state-of-the-art equipment. Multiple equipment and instruments are available to ensure hands-on training of each student in the following laboratories:

- 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 (CVCM)
- 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 formationof 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

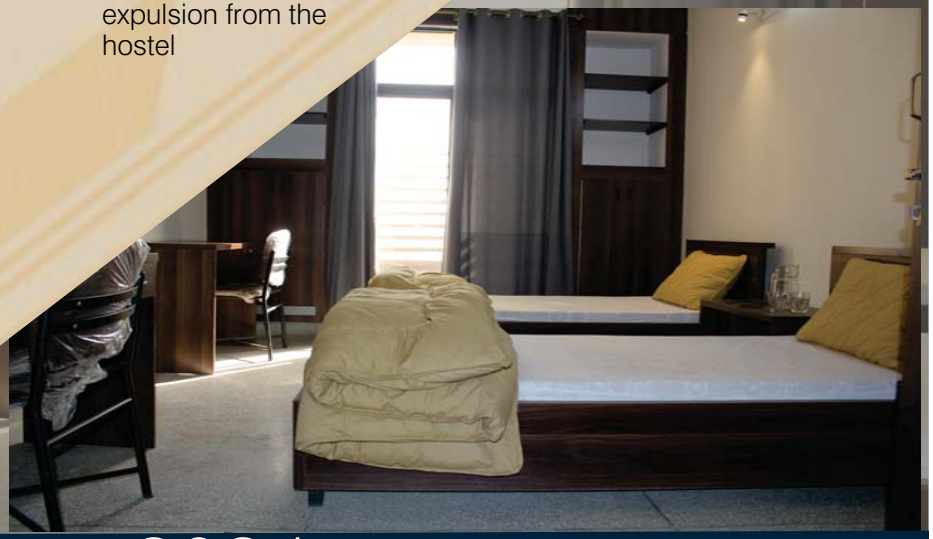
Laundry facility is available at the IST.

## 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

Technically sound and managerially efficient graduates of IST are ranked among top professionals by numerous employers. We strive for the best placement opportunities for our graduating students. A yearly 'Profiles Book' is developed that encompasses graduating students' profiles with project abstracts. This book is shared with many reputed employers from public and private sector during the Open House. Open House is an annual activity of IST and numerous employers from Public and Private Organizations are invited to provide an opportunity of employment to the graduating students.

## 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 - AOUJ

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. AOUJ 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 Non-Engineering Courses

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

## HUMANITIES & SOCIAL SCIENCE


### English

**English composition**

Intensive instruction in writing focusing on analysis, argument, inquiry, and research. The course aims to develop strategies for reading critically, analyzing text from different perspectives, formulating and investigating questions, locating and evaluating information, developing substantive argument through systematic revision, integrating sources, and expressing ideas with clarity and correctness.

**Communication Skills**

The course builds theoretical background in communication and walks students through the best practices of communication for work purposes. Core modules include extemporaneous speech, presentation skills, designing A/V aids, delivering research-based content, intercultural communication, drafting effective correspondence, and writing a resume.

**Technical Writing**

Dual focus on writing conventions as well as the format and organization of technical documents.The course covers formal and informal report writing, proposals, feasibility studies, technical research papers, citation styles, use of software tools in research, plagiarism concerns, and ethical considerations in technical writing.

### Culture

**Islamic Studies/Ethics/Religious Studies**

Introduction to Islamic Methodology, Importance of knowledge and proofs, blind following in Islam, authority in Islam, why Islam is being alienated from society, concept of worship in Islam, linguistical and technical meaning of worship, course of easiness in worship, source of Islamic law, Quran, its definition, type of Verses, conditions of an authentic Hadith, Ruling of weak Hadith, Fabricated Hadith and its rulings, agreed upon principles of interpretation, ethics and morality in Islam, introduction to Ethics, political system of Islam, concept of state in Islam, basic principle of governance in Quran, democracy, qualities and pre-requisites of leader of Islamic state, emotional study of Quran, selected verses from surah Maryam, al-Aaraaf, Qaaf, study of Islamic historical figures

**Pakistan Studies**

Geopolitical importance of Pakistan, Ideological foundation of Pakistan, Freedom Movement, Political and constitutional developments, a brief review of 1973+ amendments, rights and obligations of a citizen under 1973 constitution, Foreign policy of Pakistan, Pakistan in regional and international organizations (SAARC, OIC, UNO), Economic planning and development, Agricultural sector, Industry, Innovation/IT/knowledge driven economy, Military in politics, Bureaucracy, Political parties and elections, Good governance, Current challenges, Poverty

reduction, Water disputes with India, Food security, energy crisis, War on Terror, Public health.

## Social Science Electives

### Psychology

Scope of Psychology, Biological Bases of Behavior, Emotions, Perception and Motivation, Cognitive Psychology, Personality, Psychology of Communication, Mass Communication, Psychology of Work Environment, Performance, Organizational Behavior, Stress Management, Relaxation Techniques

### Anthropology

Introduction to anthropology, Language and classifications, Cultural translation, witchcraft and rationality, Exchange, Reciprocity & Social Relations, Rites of Passage, An Introduction to Medical Anthropology. Styles of Discourse: Music, Myth, Oral History, Stories, Games

### Sociology

Historical Perspectives, Society & Community, Social Groups & Social Institutions, Social Interaction & Social Norms, Social Stratification & Socialization, Culture, Social & Cultural Change, Health & Population, Collective Behavior, Civil Society & Development, Research in Sociology, Discussion on Social Problems of Pakistan

### Philosophy

Definition and Nature of Philosophy, Theory of Knowledge, Philosophy of Religion, Proving the Existence of God, Anselm, Aquinas, Paley, Dawkins (Selection), Justifying Religious Beliefs, Metaphysics, Idealism and Materialism, Freedom to Choose, Ethics, Political and Social Philosophy, The State as Natural, Plato the Republic (Selection), Aristotle Politics (Selection), Russel, The Problems of Philosophy.

### International Relations

Introduction, International relations in the twentieth century, Constraints and opportunities - freedom of action in international relations, National interest, Power, Balance of power, International security, Principal causes of war, International political economy, International trade & monetary system International law, International organization, national integration, international cooperation, Future world order

### Globalization

Introduction to selected global issues, Globalization as it impacts identity and culture. The Legacy of Historical Globalization, Globalization in Sustainable Prosperity, The Role of the Citizen of Globalization.

### 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

### Organizational Behavior

Introduction to Organizational Behaviour, Organizational Disciplines and topics, Psychological Perspective, Social-Psychological Perspectives, Structure and Control in Organization, Individual Differences, Personality and its factors, Motivation and Job Satisfaction, Theories of Motivation and job satisfaction, Group and Work, Group and Inter group Behaviour, Leadership, Patterns of Work, Conflict and Consent in Work, Organizational culture

## Foreign Language

**French/Spanish/Chinese/German/Arabic**

# MANAGEMENT SCIENCE


## Electives

### Professional Practice

This course introduces contemporary and controversial ethical issues facing the professional community. Topics include moral reasoning, moral dilemmas, law and morality, equity, justice and fairness, ethical standards, and moral development. Upon completion, students should be able to demonstrate an understanding of their moral responsibilities and obligations as members of the workforce and society

### Engineering 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

### Business and Entrepreneurship

Evolution of the concept of entrepreneur; Characteristics of an entrepreneur. Distinction between an entrepreneur and a Manager in Economic Development, Factors affecting entrepreneurial growth (Economic, Non-Economic and Government factors) Critical factors for stalling a new enterprise. Ingredients for a successful new business self assessment and feedback Personal entrepreneurial competencies Goal setting. Creativity and sources of new business ideas, Screening and evaluating opportunities; Product planning and development process Creating parallel Product life cycle, finding sponsorship. Acquiring a going concern, Ecommerce and business start-up and growth. Marketing as a philosophy, marketing management: Creating a marketing plan, the business plan as selling document reasons for writing a business plan; Business Plan compilation exercise franchising? Becoming franchisees versus starting a stand alone business

### Human Factor Engineering

Understanding Human capabilities; Human performance and limitations; Social psychology; Factors affecting human performance; Physical environment; Tasks and communication; Safe practices in the field; Human errors and case studies

### TQM

Fundamental principles; standards; techniques for quality analysis and improvements; statistical methods and SPC. Acceptance sampling, QFD, value engineering, cross-functional management and bench marking; ISO-9000 application, clauses and implementation issues

### Safety Health and Environment

Introduction of Health and Safety, Industrial Safety: introduction, objectives of safety, importance of safety in an industry, industrial accidents, types of accidents. Fire prevention and control, techniques of safety management, principles of accident prevention, hazard analysis, legal, humanitarian and economic reason for action, safety inspection procedures, safety raining, first aid and emergency procedures. Importance of clean environment, scale of environmental pollution, atmospheric pollution, its effect on human health and

technologies for pollution control, Industrial wastes and their treatment. Noise pollution and its effect on human health, remedial measures. ISO Standards for Safety, Health and Environment

**Project Management**
Fundamental principles, project proposals and feasibilities, project life cycle, project organization, PM planning, Work breakdown structure, Estimating time and cost, Precedence relationships, Project scheduling and control techniques, Project risk analysis, Time compression and resource leveling, Computerized project management, special software packages (primavera) PERT, CPM (detailed), GANTT Chart, Project Charter, change management plan

**Operation Research**
Operation Research Techniques and basics, Linear programming, graphical method, simplex method dynamic programming, sensitivity and post-optimal analysis, transportation models, Queuing theory (weighting live models). Replacement Models. Simulation.basic principles, discrete models vs. continuous system simulation, Markov Chain

**Product Design and Development**
The focus of product design and development is the integration of planning, design and manufacturing function in creating a new product student will be taught various activities involved in creating the styling, look and feel of the product, deciding on the product's mechanical architecture, selecting materials and processes, and engineering the various components necessary to make the product work. In this course students will learn how to emply engineering, scientific and mathematical principles to execute design development from concept to finished product in light of different product architectures, industrial design and testing procedures

**Engineering Economics & Optimization**
Types of Costs: Direct, Indirect, Overheads, Fixed, Variable, Opportunity, Sunk. Cash flow diagrams, time value of money, discounted cash flows. Equivalence: Present worth, annual equivalent costs, internal rate of return, Payback period. Project feasibility analysis. Types of investments: Equity vs. debt financing. Depreciation accounting: Straight line, declining balance and sum of year digits. Plant replacement analysis. Types of taxes, after tax economic analysis Inflation and Economic Considerations: Cost estimating methods. Project cost control. Financial management and accounting methods, Case studies in process industries

**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

## Space Management

**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 defense 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

**Space Systems Project Management**
Introduction to organization, planning and decision aids,

# NATURAL SCIENCE

## Mathematics

### 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, Tailor and Maclaurin series comparison, ratio, root and integral tests, absolute series, integration, Wall's formula, application, quadrature, arc length, solid of revolution

### Calculus I
Introduction, Complex conjugate and moduli, functions, limits and continuity, infinite series, infinite sequence, comparison, ratio and roots tests for nonnegative terms, power series, derivative and its applications Taylor's and Maclaurin series, Taylor's theorem tor two variables integration, techniques of integration, wall's formula, arc length, solid of revolution

### Calculus II
Multiple integration and applications in space coordinates, cylindrical and spherical coordinates, advance vector analysis, directional derivatives, green
theorem and its application, green theorem and its application, Fourier series &Fourier transforms, even and odd periodic function, Fourier integral and Fourier transformation, complex variables, analytic function, Cauchy integral theorem, finding of residual using Laurent series, contour integration

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

**Differential Equations**
First order differential equations, separation of variables, homogeneous, exact and linear first order ODE, higher order differential equations, Cauchy Euler differential equations, the method of variation of parameters, power series method, Laplace transformation, linearity and first shifting theorem dirac delta and gamma functions, differentiation and integral theorems, inverse Laplace transformation, system of linear differential equations, partial differential equations, method of separation of variables, solution of one dimensional heat and wave equations D'Alembert to solve wave equation

**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

**Numerical Methods**
Error analysis, roots of transcendental equations, linear iteration method, newton method, regula falsi method, bisection method, non linear 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 metho

### Complex variables and Transforms

Develop fundamental skills complex variable analysis and apply it in solving differential equations through Laplace transform. Complex numbers and functions. Complex integration. Power series, Taylor series. Laurent series, residue integration. Laplace Transform. Use of Laplace transform in solving differential equations

### Mathematical Methods for Space Science

Infinite Series: Sequences of numbers and their convergence, algebra of convergent sequences, infinite series and their convergence, convergence tests for infinite series. Differential Equations: Introduction to differential equations, modeling and solution of first order differential equations, Bernoulli, Riccati and Clairaut equations, Solution of ODE by the method of undetermined coefficients, Cauchy Euler differential equations, System of second order linear differential equations, variation of parameter, Power series method
Fourier series: Periodic and piecewise continuous functions, Fourier series, Fourier sine and cosine series, Fourier integrals and Laplace transform

### Statistical Analysis

Statistical measure, statistical description and graphical representation of data set, mean, standard deviation, introduction to probability theory, conditional probability, Bayes' theorem, random variables, probability distributions, Binomial, Poisson, hyper-geometric and normal distributions, Chi-square distribution, Students' distribution, Sampling distribution of mean, estimation of mean and variance, Hypothesis testing, Regression analysis and co-efficient of correlation energy of rotation; Moment of inertia, Parallel axis theorem, perpendicular axis, Determination of moment of inertia of various shapes, Angular Momentum: Angular Velocity

### 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

## Physics

### Applied Physics

Newtonian Mechanics, Motion in two and three dimensions, Work and Energy, Potential Energy and Energy Conservation, Gravitational Potential Energy, Momentum and Impulse, Rotational Kinematics and Dynamics, Equilibrium of Bodies, Fluid Mechanics, Waves, Oscillation and Acoustic, Doppler Effect, Electromagnetism , Electric Field, Coulombs Law, Gauss's Law, Faraday's Law, Maxwell's Equations and Electromagnetic Waves, Semiconductor Physics, Modern Physics, theory of relativity and the Einstein's idea of Gravity and space-time, Lorentz Transformation

### 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

**Applied Physics II**
Temperature and Heat Concept of temperature and heat, Quantity of heat, Heat capacity & Specific heat, Change of phase, Heat transfer, conduction, convection & radiation process. ,First Law of Thermodynamics Heat as energy and work, Work and heat in volume changes, Internal energy, Adiabatic, Isothermal, Isobaric and Isochoric process, Differential form of first law, Second Law of Thermodynamics Heat engines, Refrigerator, Second law of thermodynamics, Carnot's cycle, Entropy and the second law, Waves & Optics, Periodic motion Elastic restoring force, Simple harmonic motion (SHM), Differential equation of SHM & its solutions with explanation, Examples of SHM, Mechanical Waves, Vibrating Bodies and Acoustic Phenomena Periodic Waves, Mathematical description of a wave, Boundary condition for a string, Standing waves, Vibration of a string fixed at both ends, Sound Waves, Intensity level and loudness, Quality and pitch, Beats, The Doppler effects, Application of acoustic Phenomena ,Nature and propagation of Light, Reflection & Refraction, Image Nature, Reflection and Refraction, total internal reflection, Focal point and focal length of a spherical surface, Interference and Diffraction Coherent sources and Interference, Young's Experiment, diffraction from a single slit, diffraction grating.

**Mechanics**
Vector and scalar triple product, Divergence Theorem, Stokes Theorem, Particle Dynamics: Effect of drag forces on motion: Applications of Newton's Laws, Noninertial 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 centre 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

**Introduction to 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

**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, Variational 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

## Chemistry

### Industrial chemistry

The properties of various groups and periods of the periodic table. Sources, production and uses of the major chemicals especially with relevance to Pakistan. Manufacture and uses of various hydrocarbons. Oxidation/reduction processes. Lubricants and oils. paints, batteries, rubbers, fuels & liquid crystals, cement, glass. Environmental pollution and control

## COMPUTING

### Computing Electives

**Introduction to Information Technology**

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

**Computer system and Programming**

Introduction to Computers. Computer components and systems, Networks, Operating Systems. Input/output devices, CPU, Primary and secondary storage devices. logical expressions and selection control structures, loops, functions, scope, single and multidimensional arrays, structures, strings, pointers

**Introduction to computer Programming**

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

**Computer Aided Drafting**

Introduction to drafting, introduction to orthographic projections, projection of points/lines, isometric drawing, conversion of pictorial views into orthographic views, solid section, introduction to CAD, moving around existing drawing, drawing editing, simple 2D drawing, drawing with precision, drawing objects, object manipulation, layers and object properties, solid modeling and rendering

**Programming Language**

Introduction to programming, flow chart & seudo-code, compilers, programming structures, variables, decision making, functions, arrays, pointers, object oriented programming, manipulation of numbers, characters, file, handling, controlling I/Os, language platform, C++, data structures and ADTs, data types & arrays, queue ADT, array based queue implementation, sequence ADT, comparison of sorting algorithms, graph ADT, directed

**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

# 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

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

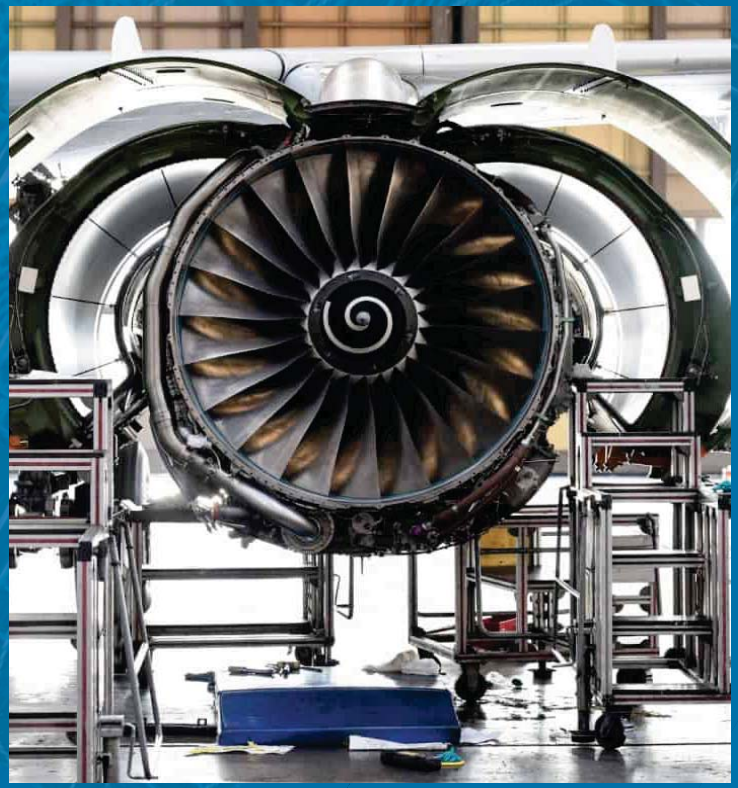
viii. Ethics: An ability to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice

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. |
|---|---|---|
| 100316 | English Composition | 2-0 |
| 100102 | Pakistan Studies | 2-0 |
| 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 |
| **Total** | | **16-2** |

### Semester - 2

| Code | Subject | Cr. Hr. |
|---|---|---|
| 300317 | Communication & Presentation Skills | 2-0 |
| 300318 | Communication & Presentation Skills Lab | 0-1 |
| 100101 | Religious Studies | 2-0 |
| 123204 | Linear Algebra | 3-0 |
| 108101 | Circuits & Electronics | 3-0 |
| 108102 | Circuits & Electronics Lab | 0-1 |
| 114527 | Workshop Technology | 1-0 |
| 114528 | Workshop Technology Lab | 0-1 |
| 115201 | Engineering Drawing | 0-1 |
| 205901 | Engineering Mechanics-I | 3-0 |
| **Total** | | **14-4** |

## Sophomore

### Semester - 3

| Code | Subject | Cr. Hr. |
|---|---|---|
| 223203 | Differential Equations | 3-0 |
| 117438 | Fundamentals of Space Sciences | 2-0 |
| 214301 | Thermodynamics | 3-0 |
| 305902 | Engineering Mechanics-II | 3-0 |
| 305226 | Incompressible Aerodynamics | 3-0 |
| 205202 | Aerodynamics Lab | 0-1 |
| 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. |
|---|---|---|
| 300304 | Technical Writing | 2-0 |
| 205905 | Aerospace Materials | 3-0 |
| 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 |

### Semester - 6

| Code | Subject | Cr. Hr. |
|---|---|---|
| 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** | | 12-5 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| 499901 | Design Project I | 0-3 |
| 123401 | Probability And Statistics | 2-0 |
| 327120 | Artificial Intelligence | 2-0 |
| 327110 | Artificial Intelligence Lab | 0-1 |
| | Management Elective I | 2-0 |
| 405907 | Structural Dynamics & Aeroelasticity | 3-0 |
| | Engineering Elective III | 2-0 |
| | Engineering Elective IV | 3-0 |
| **Total** | | 14-4 |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| 499902 | Design Project II | 0-3 |
| | Management Elective II | 3-0 |
| | Social Sciences Elective I | 2-0 |
| | Social Sciences Elective II | 2-0 |
| **Total** | | 7-3 |
| **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 | Fluid Mechanics | 2-0 |
| 405361 | Flight Control Systems | 2-0 |
| 514407 | Turbo Machinery | 3-0 |
| 405502 | Spacecraft Dynamics and Control | 3-0 |

## Management Sciences Electives

| Code | Course | Ch |
|---|---|---|
| 300448 | Entrepreneurship | 2 |
| 300449 | Total Quality Management | 2 |
| 300450 | Engineering Management | 3 |

## Social Science Electives

| Code | Course | Ch |
|---|---|---|
| 300106 | Psychology | 2 |
| 300232 | Sociology | 2 |
| 300233 | Professional Ethics | 2 |
| 300234 | Human Factor Engineering | 2 |

## Stream wise distribution of Electives

| | Structures | Aerodynamics | Propulsion | GNC |
|---|---|---|---|---|
| Elective I (3-0) | Aerospace Structures II | Rotorcraft Dynamics | Space Propulsion | Guidance and Navigation of Aerospace Vehicles |
| Elective II (2-1) | Computational Mechanics | Computational Mechanics | Computational Mechanics | Digital Systems Design |
| Elective III (2-0) | Fluid Mechanics / Flight Control Systems | Fluid Mechanics | Fluid Mechanics | Flight Control Systems |
| Elective IV (3-0) | Turbo Machinery/ Spacecraft Dynamics and Control | Turbo Machinery | Turbo Machinery | Spacecraft Dynamics and Control |

## Courses Description

### English Composition
Intensive instruction in writing, focusing on analysis, argument, inquiry and research strategies for reading critically, analyzing text from different perspective, strategies for formulating and investigating questions, locating and evaluating information.

### Communication and Presentation Skills
Listening and speaking skills, types of communication, research documentation, speech and pronunciation, presentation environment, presentation configuration, presentation strategies, conversation skills, illustrations and visual aids.

### Technical Writing
Intensive instruction in writing: strategies for reading critically, analyzing texts from diverse perspectives, integrating source and expressing ideas with clarity and correctness, strategies for formulating and investigating questions, locating and evaluating information.

### Pakistan Studies
Events of 1857, ideology of Pakistan, Pakistan Movement, independence, distribution of water resources, political history, dismemberment of East Pakistan, constitution, wars, Kashmir issue, disputed areas.

### Religious studies
Khutaba Hujjat-ul-Wida (Farewell Address), the life of the Holy Prophet (Peace be upon Him), Influence of Islamic Civilization on the Subcontinent, International influence of Islamic civilization.

### 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.

### Psychology
Scope of Psychology, Biological Bases of Behavior, Emotions, Perception and Motivation, Cognitive Psychology, Personality, Psychology of Communication, Mass Communication, Psychology of Work Environment, Organizational Behavior, Stress Management Relaxation Techniques.

### Professional Ethics
An Overview of Business ethics, Ethical issues in Business, Appling 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, Fundamentals and basic principles of OSHA will be covered in the course for enhancing awareness of workplace safety and health.

### Human Factor Engineering
Understanding Human capabilities; Human performance and limitations; Social psychology; Factors affecting human performance; Physical environment; Tasks and communication; Safe practices in the field; Human errors and case studies. Fundamentals and basic principles of OSHA will be covered in the course for enhancing awareness of workplace safety and health.

### 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.

### Total Quality Management
Fundamental Principles, Seven quality tools, Quality assurance & quality Control, statistical methods and statistical process control. Acceptance sampling, Quality Function Deployment, value engineering, cost of quality,

total productive maintenance, bench marking; ISO-9000 application, clauses and implementation issues, FMEA, Pokayoke, design of experiments.

### 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, Tailor 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, Guass divergence theorem, Stokes's and green theorems, Fourier series, complex variables, Cauchy Riemann equation.

### Probability and Statistics
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.

### 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.

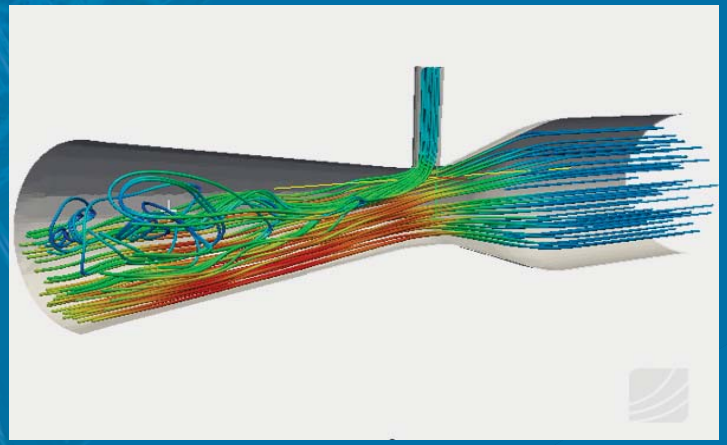
### Engineering Mechanics-II
Kinematics of particle motion in various coordinate systems, kinetics of particle using force mass acceleration, work-energy and impulse-momentum, Kinematics of body motion in 2D, Kinetics of rigid bodies, using force-mass acceleration, work-energy and impulse-momentum.

### 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.

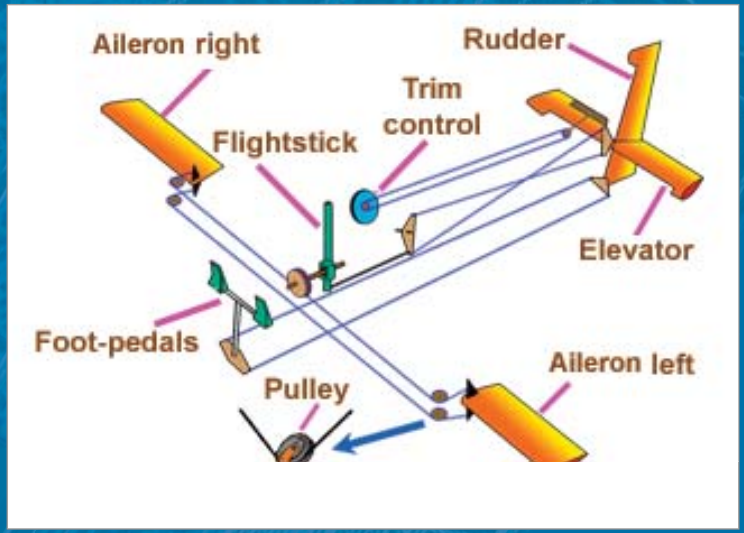
### Aero Vehicle Performance
Performance analysis of air vehicles under steady flight and accelerated conditions, drag polar, power available, power required, endurance, range, climb, ceiling, maximum speed, stalling speed, high lift devices, turning, take-off and landing performance.

### Flight Dynamics and 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 and Aeroelasticity
Structural dynamics and aeroelasticity study, with an

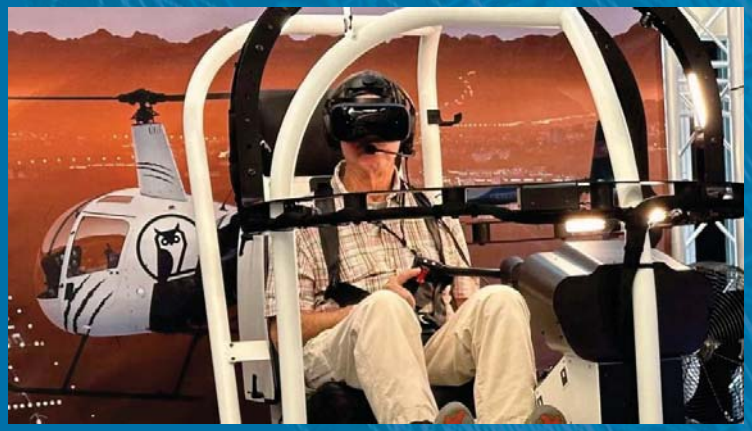
emphasis on conventional aircraft. Majorly structural dynamics comprising vibration, modal representation, and dynamic response, (b) static aeroelasticity including divergence, aileron reversal, flight load redistribution and (c) dynamic aeroelasticity including flutter, unsteady aerodynamics, and elastic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

### Fluid Mechanics
Introduction to governing equations of fluid statics and dynamics. Fluid mechanics is taught in detail supported by tools of control volume analysis and infinitesimal system analysis and flow in boundary layer.

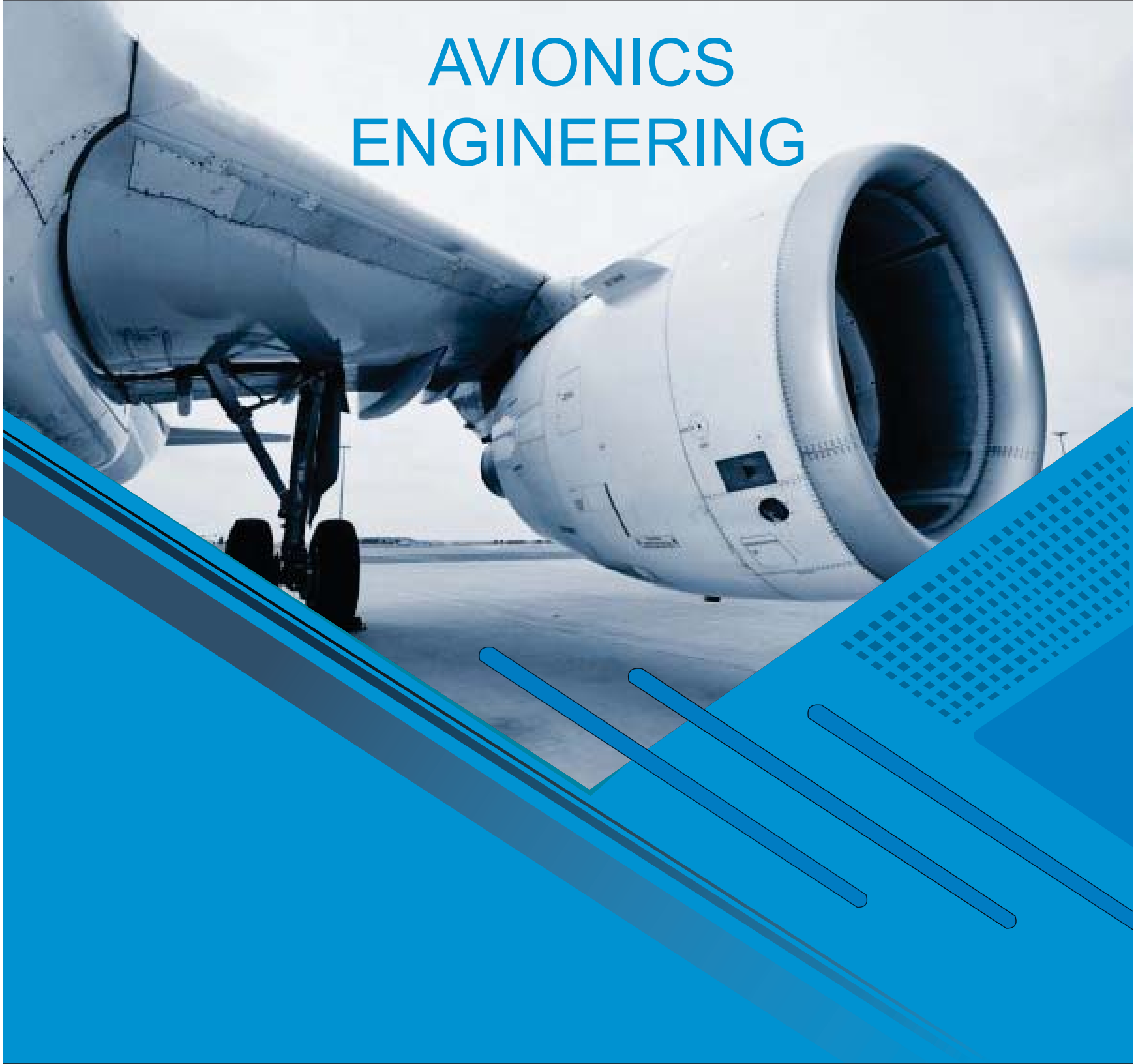
### Turbo Machinery
Turbo Machinery Impact of free jets; dimensional analysis and similitude; impulse turbines; reaction turbines; centrifugal pumps; reciprocating pumps; power plants their types and principle of operation.

### 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.

### Fundamentals of 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 | English Composition | 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 | Computer Programming | 2-0 |
| 208446 | Computer Programming Lab | 0-1 |
| 108126 | Linear Circuit Analysis | 3-0 |
| 108127 | Linear Circuit Analysis Lab | 0-1 |
| 115202 | Computer-Aided Drafting | 0-1 |
| 223217 | Complex Variables and Transforms | 3-0 |
| 223203 | Differential Equations | 3-0 |
| 100101 | Religious Studies | 2-0 |
| **Total** | | 16-3 |

## Sophomore

### Semester - 3

| Code | Subject | Cr. Hr. |
|---|---|---|
| 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 | 3-0 |
| 214337 | Thermodynamics and Propulsion | 3-0 |
| **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 | Introduction to Space Science | 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 |
| **Total** | | 13-4 |

### 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 |
| 200311 | Communication Skills | 2-0 |
| **Total** | | 14-4 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| 499901 | Senior Design Project I | 0-3 |
| 300304 | Technical Writing | 2-0 |
| 405805 | Avionics System Design | 3-0 |
| 405803 | Avionics System Design Lab | 0-1 |
| 405347 | Guidance and Navigation of Aero Vehicles | 2-0 |
| 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 - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| 499902 | Senior Design Project II | 0-3 |
| 400401 | Engineering Management | 3-0 |
| 400227 | Human Factors Engineering | 2-0 |
| 400225 | Professional Practices | 2-0 |
| **Total** | | 7-3 |

**Total No of Credit Hours** 136

### 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, Poison, 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 Magnetostatics. The Electrodynamic 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 tacking 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, 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 programing. CCP module configuration and programing.

### 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.

### Elective Depth Courses

- Avionics System Design
- Guidance & Navigation of Aero Vehicles
- Flight Control System
- Radar System

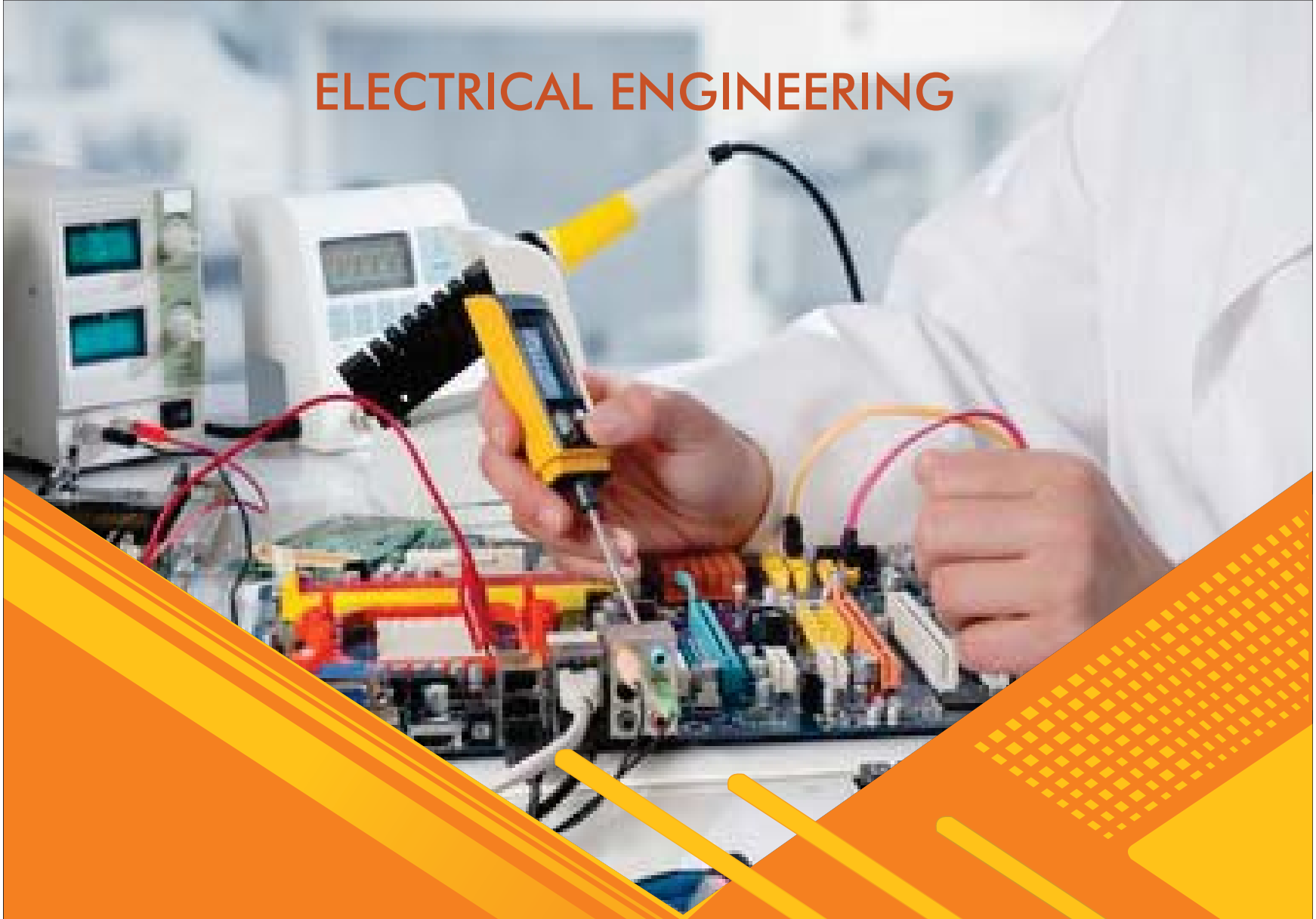
Total 12 credit hours are reserved for 4 core courses, may be divided as per the requirement of the core course offered.

### 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, image processing, wireless technologies, fiber-optics, satellite systems, artificial Intelligence (AI) and internet of things (IoT). The curriculum will provide the students 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 (and Computer Science) that encompass the fast growing telecommunication, electronics, computers, wireless & satellite industry.

## Program Educational Objectives

The Department of Electrical Engineering has designed 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 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 Department of Electrical Engineering has adopted the graduate attributes defined in EAB Manual 2014 and these are supported by our defined PEOs:

i. Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and engineering specialization to the solution of complex engineering problems.

ii. 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/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: An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data and

synthesis of information to derive 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. The 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 and solution to complex engineering problems.

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.

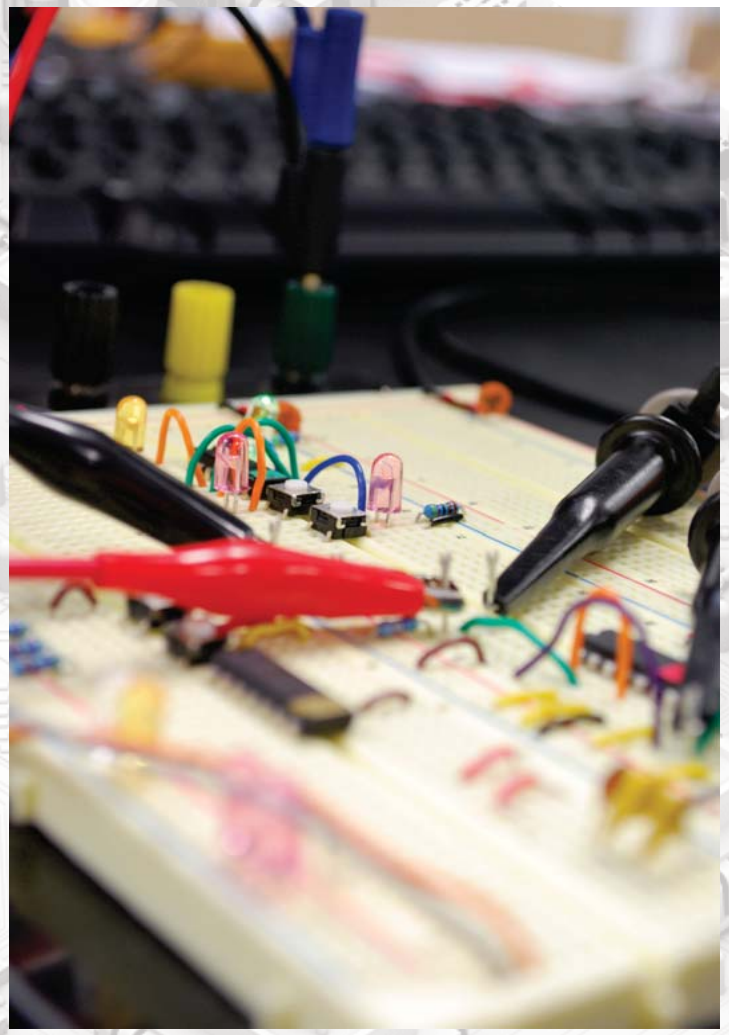
viii. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

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

x. Communication: An ability to communicate effectively, orally as well as in writing, 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: 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.

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



## Freshman

### Semester - 1

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Functional English | 3-0 |
| | IDEE Elective I | 3-0 |
| 123201 | Calculus | 3-0 |
| 115203 | Engineering Drawing | 0-1 |
| | Applied Physics | 2-0 |
| | Applied Physics Lab | 0-1 |
| | Introduction to ICT | 2-0 |
| | Introduction to ICT Lab | 0-1 |
| | 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 |
| 114502 | Workshop Practice | 0-1 |
| 223203 | Differential Equations | 3-0 |
| | Expository Writing | 3-0 |
| 308409 | Programming Language | 3-0 |
| 308410 | Programming Language Lab | 0-1 |
| | Social Science Elective I | 2-0 |
| Total | | 14-3 |

## Sophomore

### Semester - 3

| Code | Subject | Cr. Hr. |
|---|---|---|
| 208118 | Electronics Devices | 3-0 |
| 208119 | Electronics Devices Lab | 0-1 |
| 223217 | Complex Variables & 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 |
| | Philosophy/History/Creative Art | 2-0 |
| Total | | 14-3 |

### Semester - 4

| Code | Subject | Cr. Hr. |
|---|---|---|
| 408136 | Electronics Circuit Design | 3-0 |
| 208503 | Electronics Circuit Design Lab | 0-1 |
| 208504 | Signals & Systems | 3-0 |
| 208406 | Signals & Systems Lab | 0-1 |
| 200407 | Embedded Systems | 3-0 |
| 123204 | Embedded Systems Lab | 0-1 |
| | Social Science Elective II | 2-0 |
| 408137 | Linear Algebral | 3-0 |
| Total | | 14-3 |

## Junior

### Semester - 5

| Code | Subject | Cr. Hr. |
|---|---|---|
| 308801 | Electro-Mechanical Systems | 3-0 |
| 308802 | Electro-Mechanical Systems Lab | 0-1 |
| 123403 | Probability in Engineering | 3-0 |
| 208122 | Instrumentation & Measurement | 3-0 |
| 208123 | Instrumentation & Measurement Lab | 0-1 |
| 308201 | Communication Systems | 3-0 |
| 308202 | Communication Systems Lab | 0-1 |
| 308115 | Electromagnetic Field Theory | 3-0 |
| Total | | 15-3 |

### Semester - 6

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Natural Science Elective I | 3-0 |
| | Technical Writing | 2-0 |
| | Engineering Elective I | 3-0 |
| | Engineering Elective I Lab | 0-1 |
| 308301 | Control Systems | 3-0 |
| 308303 | Control Systems Lab | 0-1 |
| | Engineering Elective II | 3-0 |
| | Engineering Elective II Lab | 0-1 |
| Total | | 14-3 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| | IDEE Elective II | 3-0 |
| | Engineering Elective III | 3-0 |
| | Engineering Elective III Lab | 0-1 |
| | Engineering Elective IV | 3-0 |
| | Engineering Elective IV Lab | 0-1 |
| 499901 | Senior Design Project I | 3-0 |
| | Management Elective I | 2-0 |
| Total | | 14-2 |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Engineering Elective V | 3-0 |
| | Engineering Elective V Lab | 0-1 |
| | Management Elective II | 2-0 |
| 499901 | Senior Design Project II | 3-0 |
| | Ideology & Constitution of Pakistan | 2-0 |
| | Islamic Studies | 2-0 |
| Total | | 12-1 |

Total No of Credit Hours 136

## Engineering Electives

- Digital Signal Processing
- Digital Communications
- Antennas & Propagation
- Artificial Intelligence
- Internet of Things
- Instrumentation and Measurement
- Electronic Circuit Design
- Embedded System Design
- Mobile Communications
- Satellite Communications
- Radar Systems
- Optical Communications
- Opto Electronics
- RF and Microwave Engineering
- VLSI Design
- Industrial Process Control
- Digital Electronics
- Power Electronics
- Digital System Design
- Electromagnetic Compatibility
- Computer Networks

## 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 in Engineering**
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, Poison, 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

**Electronic Devices**
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

**Embedded Systems**
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

**Instrumentation & Measurements**
Overview of instruments, data, standards, calibration, introductory material on measurement system, description of waveforms, linear and non-linear graphs, data analysis, reporting measured results, circuits used in instrumentation, measurements of circuits in general, analog switches, automatic gain control, A/D and D/A conversion, bus systems, measurements of circuit parameters, meters, oscilloscope, function generators, logic analyzers, spectrum analyzers, linear and digital instruments, relationship of frequency to sampling effects, instrument loading, problems associated with electronic measurement systems, noise, transducers, data acquisition, representative systems

**EMF Theory**
Introduction to electromagnetism, Coordinate Systems, Del Operator, Vector Calculus, Differential length, area, volume, Line surface volume Integrals, Grad, Div, Curl of a vector, Stocks 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

**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

**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

**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 wring and testing methods, wiring schemed 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

**Electro-Mechanical Systems**
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), Superhetrodyne 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, Interchange-ability 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

**Electronics Circuit & Devices**
The course focuses on the formation of complex integrated electronic circuits such as operational amplifier and their applications in analog as well as digital circuits.

Main course contents include op amp construction, parameters and basic configuration, op amp based practical circuits, linear digital ICs, frequency characteristics of amplifiers and filters, different types of active filters and oscillators.

### Spacecraft Engineering

The course is designed to cover various aspects of conceptual and practical satellite design, space environment and satellite orbit. These subsystems include power, communication, on-board computer, attitude determination and control etc. The course will also cover the reliability analysis of the designed systems. Apart from the theoretical concepts, the students are involved as a team to develop a small prototype satellite; ICUBE-CSAT, which contains all the major subsystems of the satellite, and they will be involved in the practical design process of satellite development considering the given dimensional, mass and engineering constraints.

### 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 faction 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

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

The Department of Electrical Engineering runs an internationally recognized academic program in Electrical Engineering (EE), Computer Science (CS), Artificial Intelligence (AI) and Data Science (DS). 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 the courses in EE program is on the design, analysis, development and testing of communication & electronic systems encompassing both wired and wireless technologies. The curriculum of EE 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, image processing, wireless technologies, fiber-optics and satellite systems.

Computer Science program focuses on the design and development of the software-based platforms and technologies which can help the industries to revolutionize themselves to gain competitive edge. The courses 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 can enable the students to gain wide range of practical knowledge.

Artificial Intelligence program aims to give 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 EE, CS , AI and DS will provide the students a chance to study a variety of courses over the period of four years. Opportunities exists for students to develop expertise in their areas of interest through enrolment in elective courses offered by the department which will provide the necessary knowledge and skillset to open the opportunities in the leading firms in the market or as an entrepreneur as well.

## Mission Statement

To equip students with in-depth knowledge in the field of computing and related interdisciplinary areas thereby providing an opportunity to align themselves with new trends in the field so that they are able to contribute toward society through R&D innovations and entrepreneurship.

## 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) and BS (DS) 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 |
| | Quantitative Reasoning 1 | 3-0 |
| | Quantitative Reasoning 2 | 3-0 |
| Total | | 14-2 |

### 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 |
| Total | | 14-3 |

## 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 - 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 |
| | Domain Core 3 | 2-0 |
| | Domain Core 3 Lab | 0-1 |
| | Domain Core 4 | 2-0 |
| | Domain Core 4 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. |
|---|---|---|
| | Domain Core 5 | 2-0 |
| | Domain Core 5 Lab | 0-1 |
| | Domain Core 6 | 2-0 |
| | Domain Core 6 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 |
| | Domain Elective 6 | 2-0 |
| | Domain Elective 6 Lab | 0-1 |
| Total | | 12-6 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Final Year Project– I | 0-3 |
| | Analysis of Algorithms | 3-0 |
| | Domain Elective 7 | 2-0 |
| | Domain Elective 7 Lab | 0-1 |
| | Elective Supporting Course | 3-0 |
| | Technical & Business Writing | 3-0 |
| | Entrepreneurship | 2-0 |
| Total | | 13-4 |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Final Year Project – II | 0-3 |
| | Ideology and Constitution of Pakistan | 2-0 |
| | Arts & Humanities | 2-0 |
| | Civics and Community Engagement | 2-0 |
| Total | | 6-3 |

**Total No of Credit Hours** 136

# Artificial Intelligence

## 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 |
| | QR 1 (Discrete Structures) | 3-0 |
| | QR 2 (Calculus and Analytic Geometry) | 3-0 |
| | Functional English | 3-0 |
| Total | | 14-2 |

### 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 |
| Total | | 15-3 |

## 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 & 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 - 4

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Computer Organization & Assembly Language | 2-0 |
| | Computer Organization & Assembly Language Lab | 0-1 |
| | Domain Core 1 | 2-0 |
| | Domain Core 1 Lab | 0-1 |
| | Domain Core 2 | 2-0 |
| | Domain Core 2 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. |
|---|---|---|
| | Domain Core 3 | 2–0 |
| | Domain Core 3 Lab | 0–1 |
| | Operating Systems | 2–0 |
| | Operating Systems Lab | 0–1 |
| | Domain Core 4 | 2–0 |
| | Domain Core 4 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. |
|---|---|---|
| | Domain Core 5 | 2–0 |
| | Domain Core 5 Lab | 0–1 |
| | Domain Core 6 | 2–0 |
| | Domain Core 6 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 |
| | Domain Elective 6 | 2–0 |
| | Domain Elective 6 Lab | 0–1 |
| **Total** | | 12–6 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Domain Elective – 7 | 2–0 |
| | Domain Elective – 7 Lab | 0–1 |
| | Final Year Project – I | 0–3 |
| | Analysis of Algorithms | 3–0 |
| | Elective Supporting Course | 3–0 |
| | Technical & Business Writing | 3–0 |
| | Entrepreneurship | 2–0 |
| **Total** | | 13–4 |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Final Year Project – II | 0-3 |
| | Ideology and Constitution of Pakistan | 2-0 |
| | Arts & Humanities | 2-0 |
| | Civics and Community Engagement | 2-0 |
| **Total** | | 6-3 |

**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 |
| Total | | 14-2 |

### 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 |
| Total | | 15-3 |

## 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 - 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 |
| | DS Elective – 6 | 2-0 |
| | DS Elective – 6 Lab | 0-1 |
| **Total** | | 12-6 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Final Year Project – I | 0–3 |
| | Analysis of Algorithms | 3–0 |
| | DS Elective – 7 | 2–0 |
| | DS Elective – 7 Lab | 0–1 |
| | Elective Supporting Course | 3–0 |
| | Technical & Business Writing | 3–0 |
| | Entrepreneurship | 2–0 |
| **Total** | | 13–4 |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| | Final Year Project – II | 0-3 |
| | Ideology and Constitution of Pakistan | 2-0 |
| | Arts & Humanities | 2-0 |
| | Civics and Community Engagement | 2-0 |
| **Total** | | 6-3 |

**Total No of Credit Hours** 136

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

- 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

Core Courses details of BS(CS) 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 Automat
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.

# MATERIALS SCIENCE & ENGINEERING

# Department of Materials Science & Engineering

Materials Science & 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 Materials Science & 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 on the other. Diversification in specialties is the strength of our faculty; energy harvesting and storage, micro/nano electronic devices, optoelectronics, bio-inspired nanostructured materials, electroactive 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 MS&E aims to prepare technically strong engineers who can contribute to the society and to the science and technology of materials through innovation, research, leadership and entrepreneurship.

## Program Educational Objectives

The MS&E program has the following objectives:

- Graduates will be employed as competent engineers in materials engineering related fields, pursue post-graduate education, and some of them will also be entrepreneurs, running their own startups, in the field of Engineering
- Graduates will act as ethical and responsible professionals providing solutions with due consideration to economic, environmental and safety impacts of their work on society
- Graduates will apply their knowledge to research, analysis and design and be involved in continued professional development as individuals or 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: Students will be able to apply knowledge of mathematics, science & engineering fundamentals to the solution of complex problems related to materials engineering

ii. Engineering Problem Analysis: Students will be able to identify, formulate, research literature and analyze complex engineering problems related to materials reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences

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

iv. Investigation: Students will be able to investigate complex materials related problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions

v. Modern Tool Usage: Students will be able 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: Students will be able to apply reasoning informed by contextual knowledge to assess safety, health, legal, societal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems

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

viii. Ethics: Students will be able to apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice

ix. Individual & Team Work: Students will be able to work effectively, as an individual or in a team, on multifaceted and/or multi-disciplinary settings

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

xi. Project Management: Students will be able 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

xii. Life Long Learning: Students will be able to recognize importance of, and pursue life-long learning in the broader context of innovation and technological developments

## Freshman

Semester - 1

| Code | Subject | Cr. Hr. |
|---|---|---|
| 111101 | Introduction to Engineering Materials | 3-0 |
| 123201 | Calculus | 3-0 |
| 108402 | Introduction to Information Technology | 2-0 |
| 108403 | Introduction to Information Technology Lab | 0-1 |
| 100301 | English Composition | 3-0 |
| 117419 | Physics of Materials | 3-0 |
| 100101 | Religious Studies | 2-0 |
| 117101 | Introduction to Space Science | 1-0 |
| **Total** | | 17-1 |

## Sophomore

Semester - 3

| Code | Subject | Cr. Hr. |
|---|---|---|
| 214301 | Materials Thermodynamics | 3-0 |
| 108101 | Circuits and Electronics | 3-0 |
| 214203 | Mechanics of Materials | 3-0 |
| 214239 | Mechanics of Materials Lab | 0-1 |
| 211109 | Crystal Structure and Analysis | 3-0 |
| 114501 | Workshop Practice | 1-1 |
| 123401 | Probability Methods in Engineering | 2-0 |
| **Total** | | 15-2 |

Semester - 2

| Code | Subject | Cr. Hr. |
|---|---|---|
| 311207 | Extraction of Materials | 2-0 |
| 223203 | Differential Equations | 3-0 |
| 108408 | Programming Language | 2-0 |
| 108404 | Programming Language Lab | 0-1 |
| 111501 | Industrial Chemistry | 3-0 |
| 115203 | Computer Aided Drafting | 0-2 |
| 211167 | Introduction to Aerospace Materials | 2-0 |
| 100102 | Pakistan Studies | 2-0 |
| 100229 | Health, Safety and Environment | 1-0 |
| **Total** | | 15-3 |

Semester - 4

| Code | Subject | Cr. Hr. |
|---|---|---|
| 211201 | Metals and Alloys | 3-0 |
| 211202 | Metals and Alloys Lab | 0-1 |
| 211401 | Ceramics | 3-0 |
| 211402 | Ceramics Lab | 0-1 |
| 211302 | Polymers | 3-0 |
| 211303 | Polymers Lab | 0-1 |
| 200302 | Communication Skills | 3-0 |
| 123202 | Engineering Mathematics | 3-0 |
| **Total** | | 15-3 |

## Junior

### Semester - 5

| Code | Subject | Cr. Hr. |
|---|---|---|
| 311106 | Inspection and Tasting of Materials | 3-0 |
| 311107 | Inspection and Tasting of Materials Lab | 0-1 |
| 411305 | Composite Materials | 3-0 |
| 411306 | Composite Materials Lab | 0-1 |
| 323301 | Numerical Analysis | 3-0 |
| 311203 | Heat Treatment and Phase Transformation | 3-0 |
| 311204 | Heat Treatment and Phase Transformation Lab | 0-1 |
| 411110 | Nanomaterials | 3-0 |
| **Total** | | **15-3** |

### Semester - 6

| Code | Subject | Cr. Hr. |
|---|---|---|
| 311208 | Welding and Joining Processes | 3-0 |
| 311209 | Welding and Joining Processes Lab | 0-1 |
| 311131 | Corrosion and Materials' Protection | 3-0 |
| 300303 | Technical Writing | 3-0 |
| 411113 | Materials Characterization Techniques | 3-0 |
| 311205 | Manufacturing and Casting Technologies | 3-0 |
| 311206 | Manufacturing and Casting Technologies Lab | 0-1 |
| **Total** | | **15-2** |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| 499901 | Project Design-I | 3-0 |
| | Engineering Elective-I | 3-0 |
| 400401 | Engineering Management | 3-0 |
| | Humanities Elective I | 3-0 |
| 311108 | Surface Engineering | 3-0 |
| 400412 | Business and Enterpreneurship | 2-0 |
| **Total** | | **17-0** |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| 411112 | Computational Tools in Materials Lab | 0-2 |
| | Engineering Elective-II* | 3-0 |
| 499902 | Project Design-II | 3-0 |
| 400212 | Professional Practice | 2-0 |
| | Humanities Elective II | 3-0 |
| **Total** | | **11-2** |

**Total No of Credit Hours** **135**

## Engineering Subjects
### (Mandatory Courses)

**Probability Methods in Engineering**
Random variables, presentation of data, measurement of central tendency & dispersion, elements of probability & statistics, probability distribution function, applications, probability, correlations

**Workshop Technology**
Maintenance and fitting of tools, measuring instruments, forging, wood work, metal forming, foundry practice, safety and care

**Introduction to Engineering Materials**
Introduction to engineering materials, scope and role in industrial development. Raw materials for engineering materials, availability and demand. Atomic bonding, Crystal structures of metals, properties of materials. Introduction to polymers, ceramics and composite materials. Processing, properties and applications of metallic, polymeric, ceramic and composite materials

**Metals and Alloys**
Introduction, various types of metals and their alloys. Iron-Iron carbide phase diagram. Definition of structures in steels, invariant reactions like monotectic, Eutectic, Eutectoid, Peritectic etc. Pearlite, bainite and martensite formation and their microstructures. Effect of alloying elements, low alloyed and microalloyed steels. Stainless steels and their production. Duplex steels, Cast irons. Various non-ferrous materials like Al, Mg, Cu, Ti, Ni, Cr, Be and Li etc. and their alloy developments. Special purpose materials including Radar Absorbing (RAM) and shape memory alloys (SMA). Metals and alloys for aerospace applications.

**Ceramics**
History, classification - traditional vs modern ceramics, bonding and structural principles, processing of ceramics, raw materials & powder processing, shape-forming, densification, sintering and grain growth; Formation, structure and properties of glasses.

**Materials Thermodynamics**
Laws of thermodynamics, Gibbs and Helmoltz free energies. Use of thermodynamic data. Equilibrium, quasi-static equilibrium. Relationship between heat and work. Measurement of heat of reactions, phase equillibria in single and multicomponent systems. Applications of thermodynamics in materials science & engineering. Thermodynamic basis for binary alloy phase diagram, Nernst equation, thermodynamics of electrochemical cells, thermodynamics of surfaces, thermodynamics of defects in solids

**Mechanics of Materials**
Mechanical properties of materials, elastic constants and their relationships, tensile, compressive and shear stress and strain, compound bars, thermal stresses. Moments of inertia, shearing force and bending moment, simple bending theory, shear stresses in beams, deflection of beams. Torsion of circular bars, hollow and compound shafts. Plane stress and strain, principal stresses and strains, Mohr's circle for stress and strain, theories of failure. Yield, fatigue and creep. Thin and thick walled pressure vessels. Photo-elasticity. Strain gauges

**Circuits and Electronics**
Electrical quantities, circuit theorems, Thevenins's and Norton's equivalent, maximum power transfer, components, transient analysis, ac analysis, semiconductors, PN diode, transistors, FETs, Op-amps, amplifiers, frequency response, regulators, analog filters

**Crystal Structure and Analysis**
Crystallography; Unit cell, Space lattice, Bravais lattices, crystal systems, packing density, coordination number,

Symmetries, space group, crystal planes and directions, Miller Indices, reciprocal lattice, Diffraction and Bragg's Law, Crystalline defects, twining, ordered and disordered solution, grain boundaries, X-ray diffractometry and lattice parameter determination, texture, electron diffraction, Amorphous materials, Single & poly-crystals.

**Polymers**
Polymer classes and applications: Thermoplastics, thermo-settings, elastomers, biopolymers, ionomers (conducting polymers) polyelectrolytes, crystallinities and liquid crystalline polymers. Polymer structure/property relations: Molecular weight and distribution, polymer phase transition, glass transition temperature. Polymer synthesis: free radical, cationic, anionic, condensation, oxidative, and ring opening polymerization, in bulk, solution and microemulsion media. Polymer characterization by thermal, spectroscopic, surface, and imaging methods, polymers degradation and stabilization. Applications of polymers. Polymers for aerospace applications.

**Extraction of Materials**
Different types of ferrous and non-ferrous ores. Ore dressings, various equipment, operations/processes like size reduction, concentration, froth floatation, direct/indirect reduction, hydrometallurgy, pyro-metallurgy smelting, roasting and calcinations etc. used in the extraction of metals. Production of pig iron, wrought iron and steels using blast and allied furnaces. Extraction and production of various non-ferrous metals like Al, Mg, Ti, Cu, Ni, Cr, Ag, Be and refractory metals etc. from their respective ores. Raw materials for polymers, ceramics and composite material production.

**Heat Treatment and Phase Transformations**
Introduction to heat treatment and its importance. Cooling curves and phase diagrams.
Phase diagrams of pure substances, binary isomorphous alloy systems, concept of tie line and lever rule. Non-equilibrium solidification of alloys. Binary eutectic alloy system. Numerical problems. Phase diagrams with intermediate phases and compounds, eutectoid, eutectic and peritectic reactions. Heat treatment processes, heat treatment of carbon steel and alloy steel. Time, Temperature Transformation and Continuous Cooling Transformation diagrams, various transformation products of steel and their mechanism of formation, annealing, types of annealing, normalizing, quenching, quenching medium, spheroidizing, hardening and hardenability, Jominy-quench test, tempering, austempering and martempering processes, subzero treatment, surface heat treatment, case hardening, heat treatment after carburizing, residual stresses. Heat treating equipment, furnace atmospheres, heat treatment of nonferrous metals/alloys, solution heat treatment mechanism, defects due to heat treatment processes, surface finish after heat treatment

**Inspection and Testing of Materials**
Properties of Materials: Scope and importance, tensile, compression, hardness, bending, impact testing, their equipment and specimens. Brinell, Rockwell, Vickers, nano indentation, determination of strength and ductility parameters from tensile testing, interpretation of tensile test results. Impact, fatigue and creep testing and their importance from application point of view. Non-destructive testing; dye penetrant testing, radiography, tomography, thermography, borescope, general inspection and testing; store items inspection, pre-dispatch inspection, documentation, procurement and audit reports, inspection reports, safety protocols during inspection and testing of materials

**Composite Materials**
Introduction to composite materials: classification (MMC, PMC, CMC etc.), structures, characteristics and applications, commonly used fabrication techniques,

important reinforcement phases, interfacial bonding, control and measurement of interfacial strength, formulation and relationship between elastic properties and geometrical parameters in laminae, laminates and short fiber composites, fracture and energy absorption mechanism in composites. Composites for aerospace applications.

**Manufacturing and Casting Technologies**
Scope and importance of manufacturing technology in Pakistan, classification of mechanical working processes, sheet metal forming, stamping, stretching and deep drawing. Weld-ability, forging, tube drawing, machining, rolling principles, rolling of ingot, bloom, billets, thermo-mechanical treatment, rolling mills design and calculations.

**Welding and Joining Processes**
Introduction to welding and joining. Welding processes and their selection, effect of heat on metals, pre-heating , stress, strain, weld-ability , type of joints, types of welds, filler metals, welding problems, welding defects. Gas arc, TIG & MIG, spot, atomic hydrogen, plasma arc, and electro slag welding. Welding under water shielded metals, friction stir welding, vapor shielded metal arc welding, resistance spot, multiple spot, flash and upset, and percussion welding, the weld inspection, other welding processes include: laser, electron beam, pressure and ultrasonic welding. Soldering, brazing, joining of dissimilar materials, welding of plastics, adhesive bonding, bonding materials, inspection, testing and quality assurance of welded joints/structures

**Nanomaterials**
Introduction; Properties of materials at nanoscale; Importance of nanomaterials; History; Moore's Law; Quantum Physics and mechanics and nano scale; Impact of nanomaterials on information technology, Materials and manufacturing, health and medicine, energy and environment, space exploration; Bio inspired nanomaterials, Misconception and big promises about nanomaterials; Silicon technology, CZ and FZ process; Clean room; Nanofabrication techniques, Photolithography, PVD, CVD, PLD, Soft-lithography, Sol-gel technology; Ethics in nanotechnology, Dangers of nanomaterials.

**Corrosion and Materials Protection**
Introduction of materials degradation, basic concepts of corrosion engineering, cost of corrosion, corrosion environments, corrosion damage, corrosion principles, electrochemical aspects of corrosion, polarization, passivity, variables affecting corrosion rate, Nernst equation, pourbaix diagrams, Standard reduction potential (EMF) series, Galvanic series, types of corrosion, High temperature degradation, types of scale, mechanism of scale protection, corrosion testing and monitoring, NACE standards of corrosion monitoring, corrosion in petrochemical industries along with case studies, cathodic and anodic protection, corrosion inhibitors, protective coatings, , corrosion resistant materials, crevice corrosion, pitting corrosion, corrosion of biomaterials, corrosion of steel, stainless steel and Titanium alloys.

**Computational Tools in Materials**
Basic modeling and simulation techniques. Modeling of diffusion processes including Heat and Mass Transfer, Steady state and unsteady state. Numerical solution of such problems will be discussed. Handling chemical reactions. Modeling of blast furnace operation. Modeling of microstructures, Phase transformation, Mechanical properties and Material processing such as Casting and Plastic Deformation, Solidification, moving boundary and coring/segregation, Extrusion, HAZ, Nucleation and Growth.

**Materials Characterization Techniques**
Optical microscopy, scanning electron microscopy, energy dispersive spectroscopy (EDS), X-ray diffraction (XRD), fluorescent microscopy, Surface analysis (X-ray photoelectron spectroscopy), Thermal analysis (TGA, DSC, DTA, TMA), Atomic force microscopy. In SITU, In-vitro and In-vivo characterization techniques

**Surface Engineering**
Basis and motivation for surface engineering, surfaces, interfaces and inter phases,surface energy, thermodynamics of surfaces. Introduction to vacuum, Kinetic theory, mean free path, vacuum chambers, pumps (rotary, diffusion, turbo, ion etc.). Classification of surface coatings, Oxidation protective coatings, aluminum anodizing, plasma spraying, thin films, PVD, CVD and PECVD techniques, Thermal spray coatings, HVOF, Electro and electroless plating. Coating characterization and applications. Laser treatment of materials. Surface modification and melting by laser treatment. Analysis based on adsorption, surface interactions with ion beams, electron beams and radiations. Coatings for mechanical applications, high temperature coating systems, Coatings for aerospace applications.

**Project Design - I & II**
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.

## Electives

**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 & bioglasses, adhesives &sealants, degradable materials application in drug delivery.

**High Temperature Materials**
Classification and applications of high temperature ferrous & non-ferrous alloys; Intermetallics; High-temperature composites; Control of properties, coatings and lubrications for high temperatures applications

**Nuclear Materials**
Nuclear Energy; overview of reactor components and their materials. Mining and extraction of nuclear materials. Uranium purification, enrichment, reprocessing of irradiated fuels, fuel fabrication. Structural nuclear materials and their performance. Failure modes and radiation effects

**Advanced Materials**
Advanced materials for structural applications and manufacturing processes; Thermodynamics and physical metallurgy of amorphous alloys; high temperature

materials, shape memory alloys, and functional graded materials; Advanced ceramics for abrasives, cutting tools and aerospace applications

**Electrical Ceramics**
Dielectrics and capacitors, charge displacement (polarization), dielectrics in alternating electric fields, dielectric, strength, prototype ferroelectrics; BaTiO3, Domain structure and Curie temperature, E-P hysteresis, piezoelectric crystals, electrostrictive effect, Rleaxers, pyroelectrics and opto-electrics, birefringence. Magnetic materials, weiss domains, B-H hysteresis, shape memory alloys

**Electronic Materials I**
Energy bands and carrier concentration in thermal equilibrium, carrier transport phenomenon, p-n junction, bipolar transistors, MOSFETS & MESFET, Microwave diodes. Quantum-effects and hot-electron devices

**Electronic Materials II**
Crystal growth and epitaxy, Film formation, lithography and etching, impurity doping, photonic devices, integrated devices

**Polymer Synthesis and Structure**
Polymerization processes, industrial Polymers, vinyl cationic, anionic, Free radical and Controlled/living radical polymerization: atom transfer radical polymerization (ATRP) and group transfer radical polymerization (GTP), Vinyl polymerization with complex coordination catalysts, ring-forming reactions, crosslinking, block and graft copolymer formation, and polymer degradation. Step-reaction and ring-opening polymerization, Inorganic and partially inorganic polymers, organic and Natural polymers

**Powder Metallurgy**
Advanced theory of powder metallurgy, Atomization theory and industrial practice. Consolidation theory of metal powders, Powder metallurgy materials, Design of powder metallurgy processes and parts production, advanced analytical method for powder metallurgy, Hot isostatic processing (HIP) and sintering

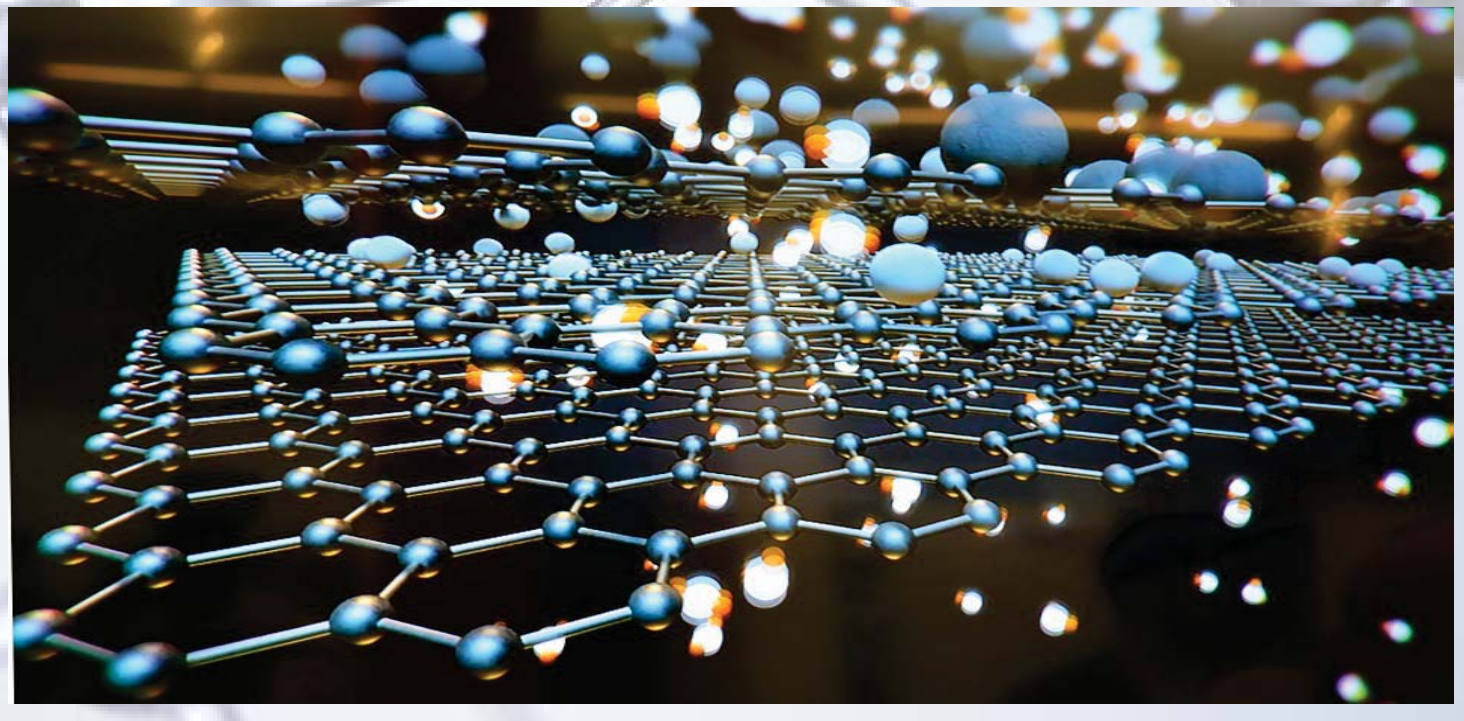
**Polymer Physical Chemistry**
Macromolecules synthesis, configuration, Stereochemistry and isomerism, Solubility and thermodynamics of dilute solutions, Phase separation behavior, Concentrated solutions, Diffusion and permeability, Chain conformation, Kinetics of crystallization, viscoelasticity, Deformation and fracture in polymers, Cyclic deformations, Molecular aspects of fracture and healing in polymers

**Advanced Composite Materials**
Advanced composites (high temp/high performance) their designing and manufacturing, use of composite tooling; fastening, machining and adhesive bonding, composite repair. Failure behavior and performance of composites in different environments. Testing and inspection methods, composites of the future

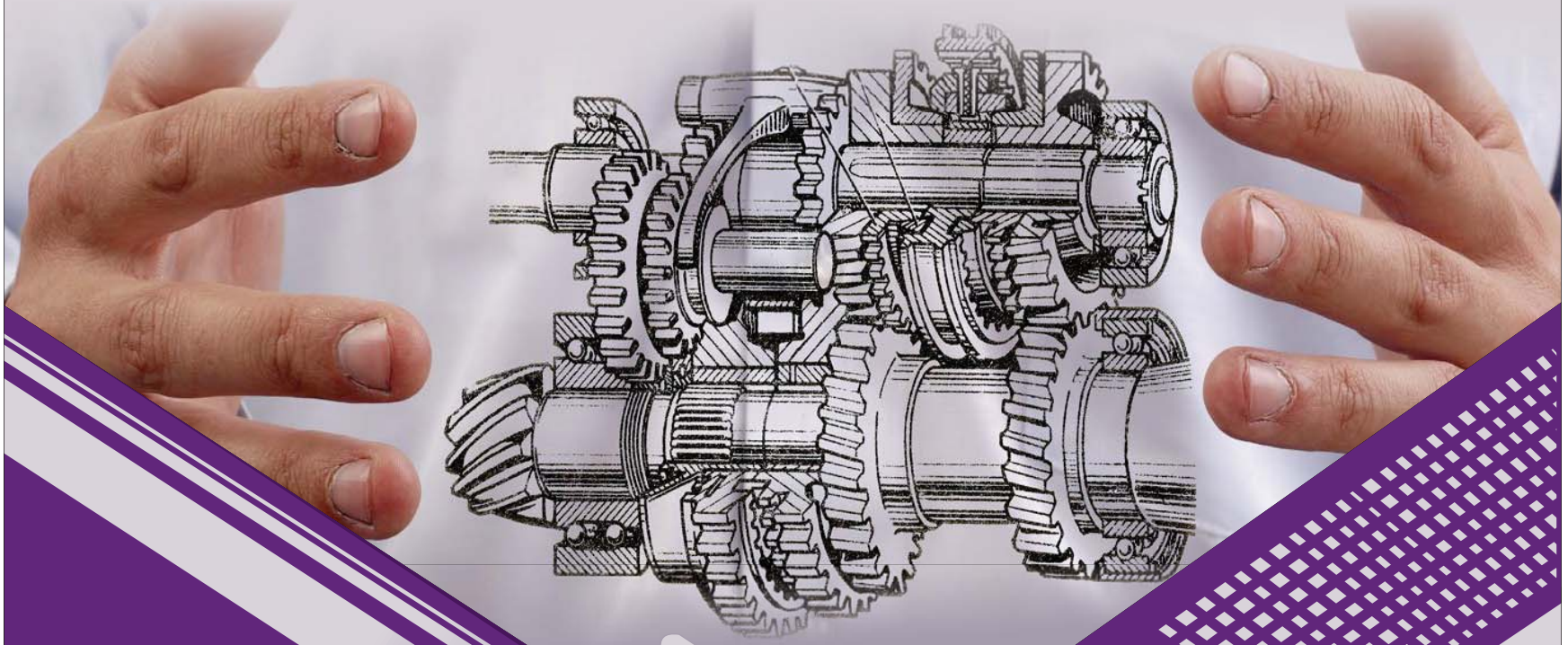
**Electron Microscopy**
Electron sources and electron lenses, The transmission electron microscope, theory of operation, scanning electron microscope, theory of operation, specimen beam interactions, specimen preparation for TEM and SEM, X-ray analysis, construction of the EDS detector system, artifacts, quantitative analysis, coating for conductivity

**Failure Analysis of Materials**
Failure analysis in engineering applications, fracture mechanics. fatigue, creep, corrosion and high temperature failures; Case studies

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



# MECHANICAL ENGINEERING



# Department of Mechanical Engineering

The Department of Mechanical Engineering provides a firm foundation in basic sciences, mathematics and design methodology in the area of mechanical structures, fluids, manufacturing and thermal systems. Engines, ships, trains, air & space vehicles, steam & gas turbines, machine tools, robots etc are examples of few systems and devices that need the knowledge of mechanical engineering. The curriculum includes the methodological tools, innovative thoughts, communication skills, management tools, and provide students the opportunities to work efficiently as individuals and as teams members. In the senior year of the program, students are required to apply the theoretical knowledge to real world problems and gain hands-on engineering experiences that require problem designing, team work, communication, time management and economic analysis. The department encourages students to pursue internships that link academic knowledge to lifelong work experiences. The department also offers the opportunity for the students to participate in professional societies such as the American Society of Mechanical Engineers (ASME), Institution of Mechanical Engineers (IMechE) and American Institute of Aeronautics & Astronautics (AIAA) etc.

The reason for offering mechanical engineering is to prepare students for a wide range of exciting industrial opportunities including aerospace, manufacturing, automotive, chemical, biomedical, nuclear power, robotics, and textiles. Mechanical Engineers find employment in the field of research & development, production & manufacturing, design, operation & maintenance, and administration.

## Vision

To be recognized as a leader in Mechanical Engineering through high quality education, research and to be renowned for its graduates who are creative, entrepreneurial and capable of meeting industrial demands and important societal needs.

## Mission Statement

The mission of Mechanical Engineering Department is to serve the engineering profession by offering high quality education to create professionals and contribute towards society by providing innovative solutions with focus on research and development in Mechanical and allied disciplines.

## Program Educational Objectives

The Department of Mechanical Engineering has developed and maintained a well-defined set of educational objectives and desired program outcomes. The educational objectives of the Mechanical Engineering program relate to all of our communities such as students, employers, alumni and faculty. The department ensures, that these objectives and desired outcomes are met through different assessment instruments. The educational objectives are listed below:

- Apply mechanical engineering knowledge to identify and address the technical and societal problems
- Enhance intellectual and analytical abilities in taking initiatives and/or develop innovative ideas for technological and professional growth in mechanical and allied disciplines
- Work effectively as a team member or lead multidisciplinary teams while demonstrating the interpersonal & management skills and ethical responsibilities

## Program Learning Outcomes

The Department of Mechanical Engineering has developed program learning outcomes that are supported by our defined Program Education Objectives. Program Learning outcomes relate to the aptitude,

awareness and performance that students acquire as the program progresses.

i. Engineering Knowledge: An ability to apply knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solutions of complex engineering problems

ii. Problems 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/ 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 investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data and synthesis of information to derive 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. The 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 and solution to complex engineering problems

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: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice

ix. Individual and Team work: An ability to work effectively as an individual or in a team on multifaceted and/or multidisciplinary settings

x. Communication: An ability to communicate effectively, orally as well as in writing 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 documentations, 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

xii. Life-long Learning: An ability to recognize importance of and pursue lifelong learning in the broader context of innovation and technological developments

## Freshman

### Semester - 1

| Code | Subject | Cr. Hr. |
|---|---|---|
| 115208 | Engineering Drawing & Graphics Lab | 0–2 |
| 123201 | Calculus-I | 3–0 |
| 117418 | Applied Physics | 2–0 |
| 100301 | English Composition | 3–0 |
| 108420 | Computer Systems & Programming | 2–0 |
| 117101 | Intro to Space Science | 1–0 |
| 117402 | Applied Physics Lab | 0–1 |
| 100101 | Religious Studies | 2–0 |
| 108424 | Computer Systems & Programming Lab | 0–1 |
| Total | | 17–5 |

### Semester - 2

| Code | Subject | Cr. Hr. |
|---|---|---|
| 211104 | Engineering Materials | 3–0 |
| 114201 | Statics | 3–0 |
| 114503 | Workshop Technology | 0–2 |
| 111508 | Applied Chemistry | 2–0 |
| 123202 | Engineering Mathematics | 3–0 |
| 100306 | Communication Skills | 3–0 |
| 115211 | CAD | 0–1 |
| Total | | 14–3 |

## Sophomore

### Semester - 3

| Code | Subject | Cr. Hr. |
|---|---|---|
| 108113 | Electrical Technology | 2–0 |
| 214341 | Thermodynamics-I | 3–0 |
| 214202 | Dynamics | 3–0 |
| 214242 | Mechanics of Materials-I | 3–0 |
| 223216 | Linear Algebra and Differential Equations | 3–0 |
| 214238 | Engineering Mechanics Lab | 0–1 |
| 108114 | Electrical Technology Lab | 0–1 |
| 100102 | Pakistan Studies | 2–0 |
| Total | | 16–2 |

### Semester - 4

| Code | Subject | Cr. Hr. |
|---|---|---|
| 214204 | Mechanics of Materials-II | 3–0 |
| 214420 | Fluid Mechanics-I | 3–0 |
| 208148 | Electronics | 2–0 |
| 214239 | Mechanics of Materials Lab | 0–1 |
| 323301 | Numerical Methods | 3–0 |
| 214303 | Thermodynamics-II | 3–0 |
| 214302 | Thermodynamics Lab | 0–1 |
| 208149 | Electronics Lab | 0–1 |
| Total | | 14–3 |

## Junior

### Semester - 5

| Code | Subject | Cr. Hr. |
|---|---|---|
| 314403 | Fluid Mechanics-II | 3–0 |
| 314305 | Heat & Mass Transfer | 3–0 |
| 308152 | Instrumentation & Measurement | 2–0 |
| 314820 | Machine Design-I | 3–0 |
| 323402 | Probability and Random Variables | 2–0 |
| 314402 | Fluid Mechanics Lab | 0–1 |
| 314306 | Heat & Mass Transfer Lab | 0–1 |
| 300304 | Technical Writing | 2–0 |
| 308153 | Instrumentation & Measurement Lab | 0–1 |
| **Total** | | 15–3 |

### Semester - 6

| Code | Subject | Cr. Hr. |
|---|---|---|
| 308301 | Control Systems | 3–0 |
| 314515 | Manufacturing Processes | 3–0 |
| 314804 | Intro to Finite Element Methods | 2–0 |
| 314205 | Mechanics of Machines | 3–0 |
| 308302 | Control Systems Lab | 0–1 |
| 314515 | Manufacturing Processes Lab | 0–1 |
| 314805 | Intro to Finite Element Methods Lab | 0–1 |
| - | Management Elective-I | 2–0 |
| 314802 | Machine Design-II | 2–0 |
| **Total** | | 15–3 |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| 499901 | Design Project-I | 3–0 |
| 414601 | Mechanical Vibrations | 3–0 |
| 414309 | IC Engines | 2–0 |
| 414210 | Mechanism & Mechanical Vibrations Lab | 0–1 |
| 414310 | IC Engines Lab | 0–1 |
| 414311 | Refrigeration and Air-Conditioning | 3–0 |
| – | Social Sciences Elective-I | 2–0 |
| – | Management Elective-II | 2–0 |
| 414314 | Refrigeration and Air-Conditioning Lab | 0–1 |
| **Total** | | 12–6 |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| - | Engineering Elective-I | 2–0 |
| - | Engineering Elective-II | 2–0 |
| 400412 | Business & Entrepreneurship | 2–0 |
| 400226 | Health, Safety and Environment | 1–0 |
| 499902 | Design Project-II | 0–3 |
| 414313 | Power Plants | 3–0 |
| **Total** | | 10–3 |
| **Total No of Credit Hours** | | **136** |

## Electives Major

**Mechanical Design & Analysis**

- Mechanical Behavior of Materials
- An introduction to Experimental Stress Analysis
- Engineering Mechanics of Composite Structures
- Intro to Fracture Mechanics
- Maintaining Engineering

**Fluid & Thermal Systems**

- Gas Dynamics
- Thermo Fluid Application & Design
- Computational Fluid Dynamics
- Gas Turbines for Propulsion and Power Generation
- Power Plants
- Turbo Machinery

**Manufacturing Systems**

- Advanced Manufacturing Processes
- Industrial Engineering
- Production Planning & Control

## Elective (General)

- Intro to Robotics
- Renewable Energy
- Automobiles Technology
- Aerodynamics

## Social Sciences Electives

- Sociology
- Anthropology
- Psychology
- Globalization
- Professional Ethics
- Organizational Behavior
- Critical Thinking
- Philosophy

## Management Science Electives

- Professional Practice
- Engineering Management
- TQM
- Engineering Economics & Optimization
- Project Management
- Operations Research

## Engineering Subjects (Mandatory)

**115208 Engineering Drawing and Graphics (0-2)**
Sheet Layout and Free-Hand Sketching, Line, Lettering and Scaling, Geometric Construction, Dimensioning & Pictorial Views, Curves Used in Engineering, Introduction to Mechanical Elements, Projection Method, Geometric tolerance, Sectional Views, Projections of Sectional Views, Hatching Lines, Drawing Sectional Views of Machine Parts, Types of Sectional Views.

**114503 Workshop Technology (0-2)**
Introduction to Workshop Technology, Classification of Shops, Introduction to Carpentry Shop, Measuring Tools, Marking Tools, Cutting Tools, Planning Tools, Drilling Tools, Holding Tools, Measurement Tools, Fitting & forging Shop, Filling, Drilling, forging Tools, Power Transmission, Belt Drives, Pulley Drives, Gears, Welding Shop, Pipes and Pipe Fittings, Pipe Joints, Machine Shop, Machine Tools and Operations, Study of Lathe Machine, Turning, Cutting, Electric Shop, Basic Electric Circuits, Symbols, Introduction to Foundry Shop, Theoretical Introduction to Molding Tools.

**115211 CAD (0-1)**
Introduction to Software, Sketching, Part Modeling (Draft, Revolve, Extrude, Chamfer, Shell, Ribs, Mirror, Pattern, Merge, Trim, Sweep, Blend, Helical Sweep, Sweep Blend, Variable Section Sweep, Boundary Blend), Surface Modeling.

**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, Wedges, Screws.

**114202 Dynamics (3-0)**
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 –Acceleration, 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.

**108113 Electrical Technology (2-0)**
Introduction to DC Circuits: Series and Parallel Circuits, DC Circuit Theorems. Theory of AC: Series and Parallel Circuits, Resistance, Inductance and Capacitance of AC Circuits. Introduction to Transformers: House Hold and industrial Wiring: Elements of House and Power Wiring, Testing of House and industrial Wiring. Basic Electronics: Semiconductors, P-Type and N-Type Materials, Electrons and Holes, P-N Junction, Diodes, Diode Circuits, Transistors, Use of Transistor as A Switch, Operational Amplifiers, and Their Use in Circuits.

**211104 Engineering Materials (3-0)**
Introduction to Advanced Materials, Atomic Structure and interatomic Bonding, Crystal Struc-ture, Unit Cells, Metallic Crystal Structures, Crystalline and Non-Crystalline Materials, Polycrys-talline 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.

**214341 Thermodynamics I (3-0)**
Introduction to First Law of Thermodynamics, Working Fluid, Reversible and Irreversible Processes, Second Law of Thermodynamics, Heat Engine Cycle.

**214303 Thermodynamics II (3-0)**
Steam Cycles, Gas Turbine Cycles, Combined Cycles and Boilers, Exergy, Compressible Flows, Mixtures, Rotodynamic Machinery.

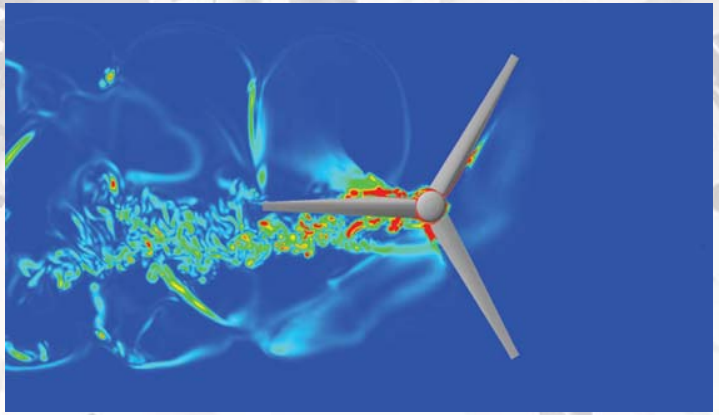
**214203 Mechanics of Materials I (3-0)**
Stress, Equilibrium of A Deformable Body, Design of Simple Connections, Strain, Mechanical Properties of Materials, The Tension and Compression Test, The Stress-Strain Diagram, Stress-Strain Behavior of Ductile and Brittle Materials, The Shear Stress-Strain Diagram, 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.

**214204 Mechanics of Materials II (3-0)**
Stress and Strain Analysis, Equilibrium, Compatibility and Strain Relations, Analysis of Torsion. Saint Venant's Theory. Thick Walled Cylinders, Thin Shells, Rotating Disks and Flat Plates. Symmetrical and Asymmetrical Loading, Secondary Stresses, Energy Theorems, Statically indeterminate Problems. Photo-Elasticity. Strain Gauges. Castiglione's Theorem. Introduction to Fracture Mechanics. Toughness, Critical Stress intensity Factor. Impact and Shock Load, Energy Stored in Body Under Impact Loading Stress Due to Impact Loading.

**208148 Electronics (2-0)**
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, Analogue and Digital Signals.

**214420 Fluid Mechanics I (3-0)**
Introduction, Kinematics of Particle, Fluid Mechanics and 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, Langrangian 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.

**314403 Fluid Mechanics II (3-0)**
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.

**314820 Machine Design I (3-0)**
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.

**314802 Machine Design II (3-0)**
Gears, Types of Gear, Spur and Helical Gears, Bevel and Worm Gears, Clutches, Brakes, Couplings and Flywheels, Flexible Mechanical Elements. Belt, Ropes and Pulleys.

**323402 Probability & Random Variables (3-0)**
Frequency Distribution, Simple and Conditional Probability, Random Variables & Mathematical Expectation, Distribution (Binomial, Poisson, Uniform and Normal Distributions).

**308301 Control Systems (3-1)**
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.

**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 & Fluids, Design of Jigs and Fixtures, Fundamentals of Cutting Tools, Non-Traditional Cutting Operations, Rapid Prototyping.

**314205 Mechanics of Machines (3-0)**
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 & Development of Slider Crank Mechanism, Crank Rocker Mechanism, CAM, Governors, Balance of Revolving Masses, Effect On Engine of Reciprocating Mass, Partial Primary Balance, Gears.

**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.

**314804 Intro to Finite Element Methods (2-0)**
Part (A): Introduction to Finite Element Methods (FEM), Truss Analysis, Variational and Weighted Residual formulations, Shape Functions, Stress Analysis for One & Two-Dimensional Problems of Structures, Beam Analysis. Part (B): 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 in Fluent.

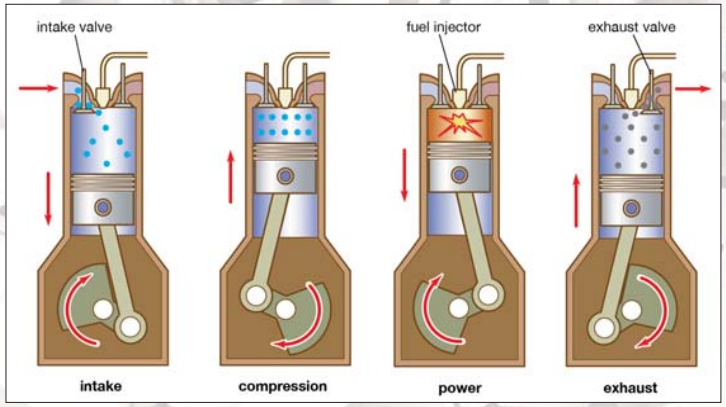
**414311 Refrigeration and Air-Conditioning (3-0)**
Vapor Compression System: Heat Pump, Refrigerants, H-S and P-H Charts. Vapor Absorption System. Psychometric of Air-Conditioning Processes, Summer Air-

Conditioning, Compressors, Reciprocating, Rotary, Screw and Centrifugal Compressors, Condensers and Evaporators.

**499902 Design Project (0-6)**
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.

**414601 Mechanical Vibrations (3-0)**
Introduction to Vibrations, Degree of Freedom, Simple Harmonic Motion, Vibration Analysis Procedure, Free Vibratory Systems, Newton's Method, Energy Method, Viscously Damped Free Vibration, Critical Speed of The Shaft, Logarithmic Decrement, forced Vibratory Systems, Rotating Unbalance, Base Excitation, Vibration Isolation, Systems With Two Degree of Freedom, Multi Degree of Freedom Systems, Dunkerley's Method, Rayleigh's Method, Influence Coefficient, Iteration Method, Eigen Values and Eigen Vectors, Stodola's Method, Holzer's Method.

**414309 IC Engines (3-0)**
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.




**400226 Health Safety and Environment (1-0)**
Introduction of Health and Safety, Techniques of Safety Management, Legal, Humanitarian and Economic Reason for Action, Safety Inspection Procedures, Safety Training, Atmospheric Pollution, Causes and Effects On Human Health, Available Technologies for Controlling Pollution, industrial Waste, Noise Pollution.

**400226 Business and Entrepreneurship (2-0)**
The Entrepreneurial Perspective, The Nature and Importance of Entrepreneurs, The Entrepreneurial and Intrapreneurial Mind, The Individual Entrepreneur, International Entrepreneurship Opportunities Creativity and The Business Idea, Legal Issues, The Business Plan, Entrepreneurial Strategy.

## Mechanical Design & Analysis

**514106 Mechanical Behavior of Materials (2-0)**
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 (2-0)**
Basic Fracture Mechanics Concepts, Stress Concentrations, Crack Stress and Displacements, Stress intensity Factor, Crack Growth and Energy Relationship, Crack Tip Plasticity, Crack Growth Prediction Models, Experimental Methods in Fracture and Fatigue.

**An Introduction to Experimental 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 (2-0)**
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.

## Fluids & Thermal Systems

**414313 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.

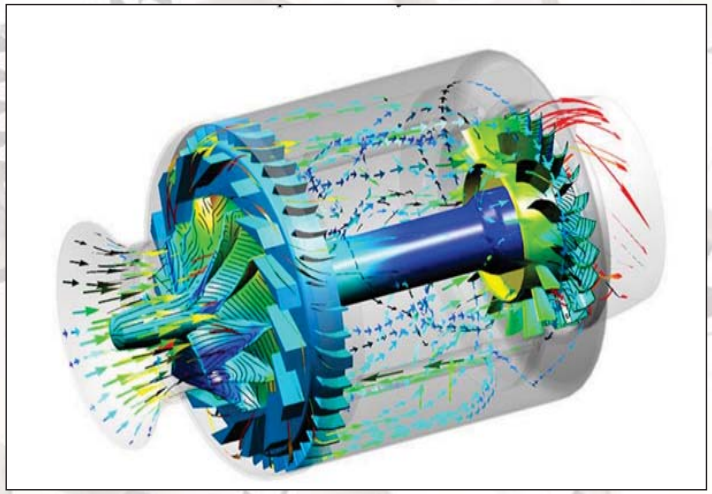
**514107 Gas Dynamics (2-0)**
Basic Governing Laws of Conservation of Mass, Momentum and Energy, Limitations. Sub-Sonic and Supersonic Gas Flow. Isentropic Flow and Applications. Normal and Oblique Shocks, Prandtl-Meyer Compression and Expansion with Applications. Rayleigh Flow and Fanno Flow, Busemann's Shock Polar Diagram.

**514108 Computational Fluid Dynamics (2-0)**
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 (2-0)**
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 & 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.

**Turbo Machinery (2-0)**
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.

## Manufacturing Systems

**Advanced Manufacturing Processes (2-0)**
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 (2-0)**
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 (2-0)**
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.

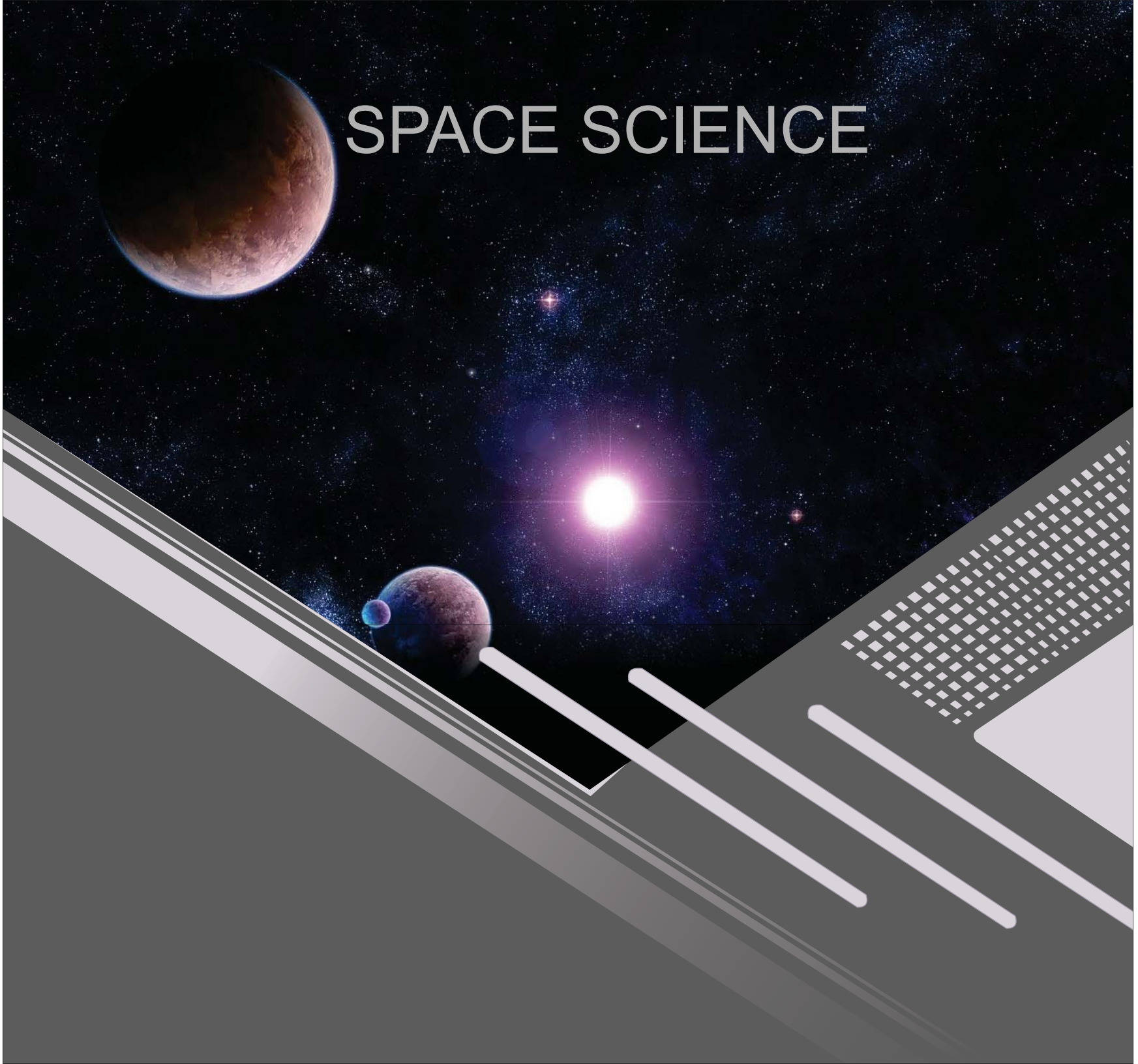
## Electives (General)

**Intro to Robotics (2-0)**
Introduction, Drive Methods, Sensors. Spatial Description and Transformation, forward Kinematics, Inverse Kinematics Jacobean, Denavit-Hartenherg Coordinate Transformations, force/torque Relations, Trajectory Planning, Dynamics, Position Control, PID Control, Inverse Dynamics Feed forward Control, Nonlinear and Two Parts Control. Open-Loop Manipulators, Closed Loop Linkages, Tendon Driven Robotics Hands. Robotics Applications.

**Renewable Energy (2-0)**
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.

**Automobiles Technology (2-0)**
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 (2-0)**
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 |

### 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 |

## 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 - 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 |

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 |

## 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 - 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, premain-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 Alfven 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, Electronprocesses, Light sources, Photonprocesses, Optical detectors, Photonprocesses 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 Mosiacing 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, Frontogensis General Circulation of Atmosphere, Weather Systems; Monsoon (Fontal 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, windchild, 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 in2000, 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**

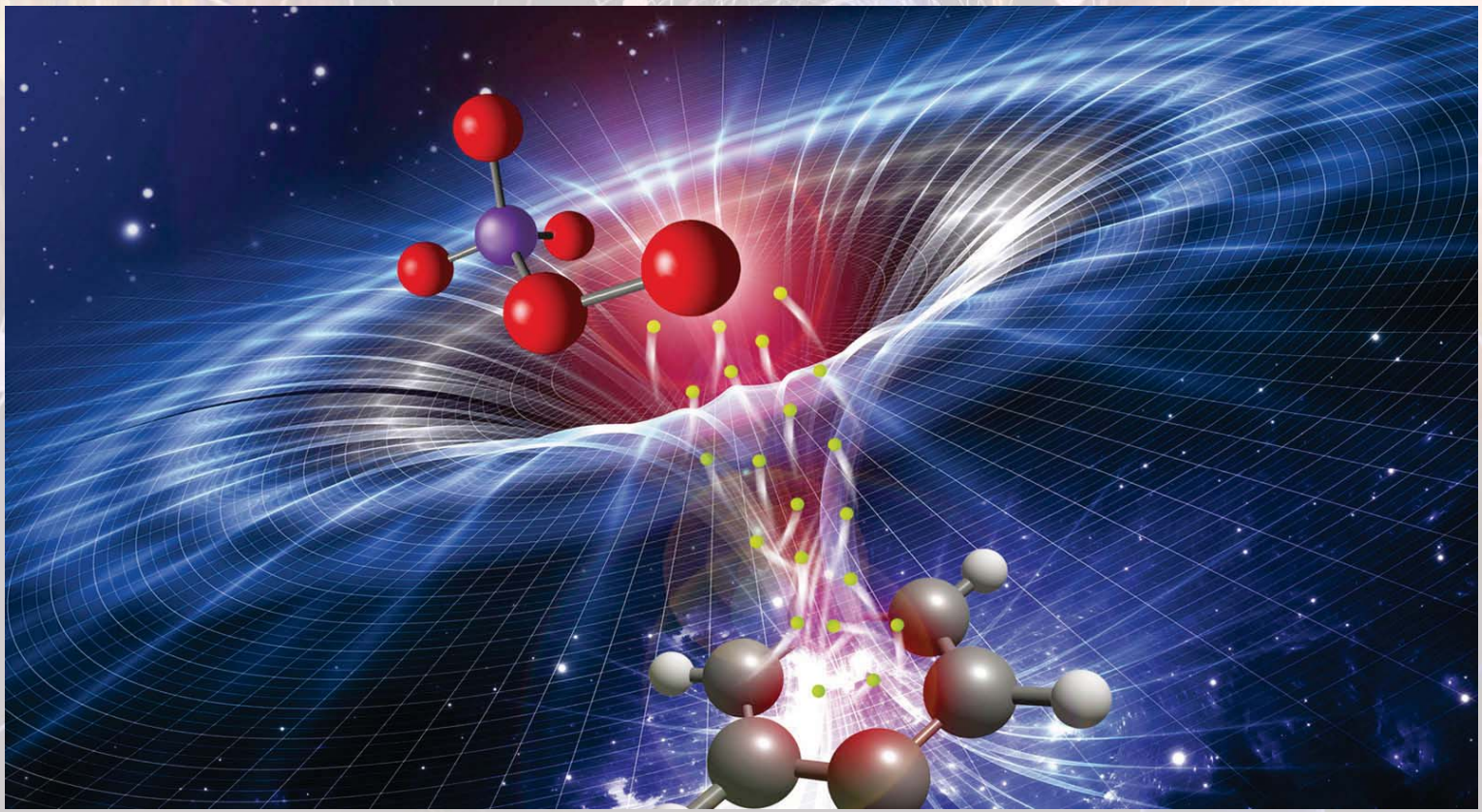
BS Space Science program is crafted to enhance the knowledge breadth while combining the emerging technologies and domains of Astronomy & Astrophysics, Remote Sensing & Geographical Information Science, Environment & Climate Science and Astrodynamics. The integration of wide diversity in curriculum coverage 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

# Physics

Physics investigates the laws of nature and is indispensable not only for our understanding of the world but also for the solution of the technological and ecological problems. As a fundamental 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 and the future to come.



## Freshman

Semester - 1

| Code | Subject | Cr. Hr. |
|---|---|---|
| XXXXXX | 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 |
| | Mechanics | 3-0 |
| | Mechanics 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 |

## 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 - 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** |

### 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** |

## Senior

### Semester - 7

| Code | Subject | Cr. Hr. |
|---|---|---|
| XXXXXX | Advanced Experiments in Physics-I | 0-1 |
| | Solid State Physics-II | 3-0 |
| | Relativity & Cosmology Elective | 3-0 |
| | Materials Physics Elective | 3-0 |
| | Electronics Elective | 3-0 |
| | Astronomy & Astrophysics Elective | 3-0 |
| | Plasma Physics Elective | 3-0 |
| | High Energy Physics Elective | 3-0 |
| | Solar Physics Elective | 3-0 |
| | Thesis I | 0-3 |
| **Total** | | **24-4** |

### Semester - 8

| Code | Subject | Cr. Hr. |
|---|---|---|
| XXXXXX | Advanced Experiments in Physics-II | 0-1 |
| | Project Management Relativity | 3-0 |
| | Cosmology Elective | 3-0 |
| | Materials Physics Elective | 3-0 |
| | Electronics Elective | 3-0 |
| | Astronomy & Astrophysics Elective | 3-0 |
| | Plasma Physics Elective | 3-0 |
| | High Energy Physics Elective | 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) $E^2 = c^2 p^2 + m^2 o c^4$

**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, Seabeck'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. Wace-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/r2, the one -dimensional and the three-dimensional Dirac delta functions. The theory of vector fields: the Helmoholtz 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, multi-pole 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 co-ordinate 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 ∏ filter, the ∏-R filter, the voltage doubling rectifier circuit, rectifying AC voltmeters, diode wave clippers, diode clampers. 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 Ai and Av, 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 corrdinates, 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 cevita, 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 the $\{|r\rangle\}$ and $\{|P\rangle\}$ 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 ½ And Two-Level. Quantum Systems: Spin ½ particles, quantization of the angular momentum, illustration of the postulates in the case of a spin ½, general study of two-level systems, Pauli matrices, diagonalization of a $2\times2$ hermitian matrix, System of two spin ½ particles, Spin ½ density matrix, Spin ½ 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 $|\varphi_n\rangle$, Some examples of harmonic oscillators, study of the 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 $\{|P\rangle\}$ 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, Colpitis 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 ½ angular momenta, addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, sddition of spherical harmonics, vector operators, Wigner-Eckart theorem, electric Multi-pole moments, Evolution of two angular momenta J1 and J2 coupled by an interaction aJ1 . J2. 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 ½ 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, Ooscillations 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, H2+ and H2, 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, ferro electricity 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, Tow fluid model, London equations, BCS and Ginzburg Landau Theory, Vortex Behaviour, Critical Current Density, Josephson effect and applications.

**Nuclear Physics**

History: Starting from Bacqurel's discovery of radioactivity to Chedwick'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 nucleolus 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: Throughout, 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, Perini gauges, The McLoad 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 unduling 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, EAPROM, 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 Tg, 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-optimizing-visualizing-documenting production chain, Fortran95. Numerical Programming: Functions: approximation and fitting, Numerical calculus. Ordinary differential equations, Matrices, Spectral analysis, Partial differential equations.

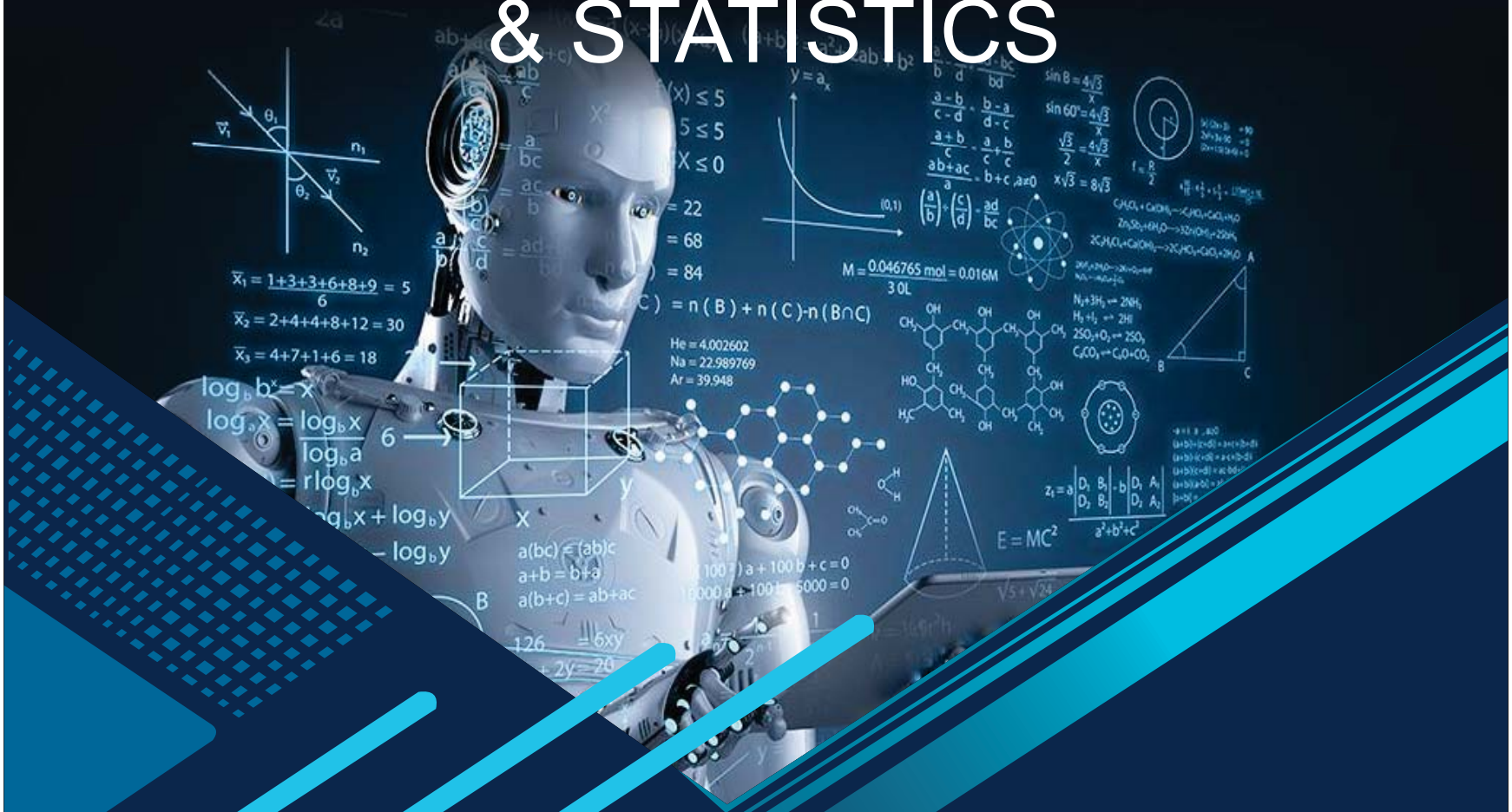
Modelling and Simulation: Molecular dynamics simulations, modelling continuous media Monte Carlo simulations. Project: A project will be chosen by the student in consultation with the instructor. Selection of the project should be done soon after the module on modelling and simulation starts and continues 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

# APPLIED MATHEMATICS & STATISTICS



# 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:

i. 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

ii. 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 |

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 |

## 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 - 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 |

### 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 |

## 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 - 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, convergance 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, Christo fell'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 Ricaati 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: Rouche'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, Involutes and Evolutes, 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, Equimomental 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'n metrizablity 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 (Z, Q). R is not countable. R, RxR, RxRxR 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: N, Z, 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-requsits of Leader of Islamic state, Role of Ijtehad in islamic political theories, A Pschyco Emotional study of Quran, Selected Verses from Surah Maryam, al-Aaraaf, Qaaf,, Study of An Islamic Historical Figures, Pschological 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 modelds 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 Managment**
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 applicance, 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 specifies, 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 connecter, 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 programing, 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, Seabeck'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 sigma. 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, GraphVocabulary, 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.)

# AVIATION CENTER

# Aircraft Maintenance Engineering License (AMEL)

## Introduction

The Aviation Center at Institute of Space Technology is offering internationally recognized academic program Aircraft Maintenance Engineering (AME) License with specialization in the fields of Aerospace (B1.1 & B1.2) and Aionics (B2).

## Aircraft Maintenance Engineering License (AMEL) Program

The Aircraft Maintenance Engineering License program is a balanced theory and practical-based course for acquiring a license to work on an aircraft for maintenance, recovery and overhaul. This aircraft maintenance course is recognized by the European Aviation Safety Agency (EASA) and gives you access to the real aircraft experience. We are the only university in Pakistan that has integrated the industry-standard aircraft maintenance qualification 'EASA Part-66' to be delivered on campus.

Primarily, after passing the Aircraft Maintenance License (AML) Category : B1 (Aerospace) or B2 (Avionics) Modules courses and completing the required Practical and On-Job Experience, you will be able to obtain a Part/ANO-66 Aircraft Maintenance Engineer License from PCAA or EASA NAA's with high prospects of job in global aviation engineering. The University has a unique partnership with Heinze Akademie, Germany through Aviation Center to meet EASA standards for quality education.

Our courses have the reputation for Outcome Based Education (OBE) viz-a-viz excellence due to the emphasis

placed on students achieving high standards of theoretical knowledge to pass European Aviation Safety Agency (EASA) approved examination.

At Aviation Center our learning focuses on practical technical abilities developed through hands-on training on in-house ground worthy aircraft, Aero-Engines & related equipment.

## Why Enroll in this Program?

### Career Prospect

#### National

Air transport in Pakistan is forecast to grow in the next 20 years under the ":current trends" scenario. This would result in an additional 22.8 million passenger departures by 2038. If met, this increased demand would support approx. US $9.3 billion of GDP and around 786,300 jobs.

#### International

Based on the Boeing pilot technician outlook respected industry forecast, in the next 20 years, airlines will add 44,040 new aircraft to the current 17,000 strong commercial fleet. By 2038, the industry will need 769,000 new technicians to maintain these aircrafts. Clearly, the international market has a huge requirement of Air Maintenance Engineers.

AMEL graduates enjoy a high employability rate. With a career path tailored towards becoming Licensed Aircraft Maintenance Engineers, they mainly work with airline engineering departments or support aircraft maintenance organizations.

## Practical Experience

Not only students learn comprehensive theory, ATH also provide the means to gain practical experience in well-equipped on-site laboratories and workshops. During the course, ATH also endeavor to provide hands on experience in real workplace environments (subject to availability) through its partner initiatives in aviation sector resulting in possible internship and on job training opportunities.

## Aviation Center Mission Statement

The Aviation Center aims to provide high quality education and skills in the discipline of aircraft maintenance

engineering; and provide competent and sufficient manpower to the airline industry and hence participate in socio-economic development of the nation.

## Program Mission Statement

The mission of Aircraft Maintenance Engineering License program is to train high quality young professional with strong foundations of Mathematics, Aerodynamics, Propulsion, Aviation Legislation, Human Factor, Avionics and Safety Management; and equip them with efficient maintenance, repair and overhaul capabilities and skills to work on aircraft keeping in mind its airworthiness and the safety standards of aviation.

## Program Education Objectives

- To equip maintenance engineers with knowledge, skills and ability to investigate complex maintenance problems using available tools
- To crop ethically, socially and environmentally responsible and safety-conscious engineers who would feel the need and participate in the sustainable development and implementation of maintenance standards
- To develop maintenance engineers with good communication and technical write-up skills for utilization in complex situations, either individually or as part of a team
- To develop management skills and an aptitude of life-long learning especially safe practices

## Aircraft Maintenance Engineering License (AMEL) Curriculum

### Core Modules

| Code | Subject |
|---|---|
| M1 | Mathematics |
| M2 | Physics |
| M3 | Electrical Fundamentals |
| M4 | Electronic Fundamental |
| M5 | Digital Techniques |
| M6 | Materials & Hardware |
| M7 | Maintenance Practices |
| M8 | Basic Aerodynamics |
| M9 | Human Factors |
| M10 | Aviation Legislation |

### B1(Aerospace)

| Code | Subject |
|---|---|
| M11 | Turbine Aeroplane Aerodynamics Structures and Systems |
| M15 | Gas Turbine Engine |
| M17 | Propeller |

### B2(Avionics)

| Code | Subject |
|---|---|
| M13 | Aeroplane Aerodynamics Structure and Systems |
| M14 | Propulsion |

## Courses & Description

**M1. Mathematics**
The mathematics module, required for all licenses, starts with very simple topics to build your confidence before moving on to more complicated topics of the syllabus. The module covers three chapters, Arithmetic, Algebra and Geometry. Although the chapters are quite large they have been broken down to smaller sections for simplicity. This is an ideal module to begin studying for your license as it will ease you into studying and build up your mathematical skills to meet any requirements in further modules.

**M2. Physics**
The physics module is required for all licenses and includes five chapters matter, mechanics, thermodynamics, optics (light) and wave motion & sound. The basic physics contained in this module is applied in more detail in advance, more specialized modules. Also, as u learn laws and equations this involves applying theoretical concepts to real life situations making it the ideal companion, or follow-on, for the mathematics module.

**M3. Electrical Fundamentals**
This module is required for all licenses and covers the spectrum of aircraft's power generation that includes electricity, magnetism, generators, transformers and motors. This module provides a basis for electrical modules required for the license, especially for Module 4: Electronic Fundamentals.

**M4. Electronic Fundamentals**
This module is required for B1 and B2 licenses. It comprises of the basic avionics of the aircraft that includes semiconductors, printed circuit boards and servomechanisms. Although this module is to be studied by B1 and B2 but there is substantially more work for the B2 license at a higher level than for B1. This module provides an excellent follow on from Module 3: Electrical Fundamentals

**M5. Digital Techniques/Electronic Displays**
The modern airlines procure artificially intelligent aircraft where everything is automated and stress on pilot is decreasing day by day. One of the important aspects of a modern aircraft is to show real time data during flight. This module covers all topics in this regard but specifically emphasizes on the avionics systems related to sensors and displays.

**M6. Materials & Hardware's**
The variety of materials and hardware used in aircraft engineering is vast, and this module only deals with a broad group of materials, their main characteristics, identification and uses.

**M7. Maintenance Practices**
All the tools used for aircraft maintenance have to be of the highest quality to ensure expert maintenance of an aircraft to the level prescribed by the manufacturer. Theoretical and practical aspects of maintenance practices are covered in this module and required for both B1 and B2.

**M8. Basic Aerodynamics**
The theory of how an aircraft is able to fly in air is covered in this module from atmospheric aspects to stability of the aircraft. Since it's a fundamental module for every aircraft maintenance engineer so its required for both, B1 and B2

**M9. Human Factors**
Aircraft maintenance engineer has a vital part in flight safety. To gain this understanding, we must know about how human body works, how the brain processes information, a little psychology, how we interact with others through effective communication and learn the types of human error and ways of avoiding these errors. Ultimately saving lives by prevention

**M10. Aviation Legislation**
Airlines throughout the world are committed to maintain high standards of safety. International laws in aviation are developed to enforce safety standards and efficient working of the worldwide aviation. It's necessary for every engineer to understand and implement international aviation laws.

**M11. Aeroplane Aerodynamics Structure and Systems**
The various systems and subsystems of an aircraft all are interlinked to work harmoniously to produce a stable flight. This module deals with the in-depth study of all the systems and their linkages together. This is required for the AML Cat: A1 and B1.1 licenses

**M13. Aircraft Aerodynamics Structures and Systems**
It is same as M11 but here emphasis is given to the study of aircraft systems and subsystems from avionics point of view. It is required for the AML Cat: B2 license

**M14. Propulsion**
Constructional arrangement and operation of turbojet, turbofan and turbo-shaft engines is covered in this module. It is required for the AML Cat: B2 license.

**M15. Gas Turbine Engine**
Power plant of the aircraft is responsible for thrust during flight. This module deals with the study and practical experience of an engineer particularly in regard to the aircraft engine. It is required for AML Cat: A1, A3, B1.1 and B1.3 licenses.

**M16. Piston Engine**
Fundamentals, Engine Performance, Engine Construction, Engine Fuel systems Carburetors, Starting and Ignition Systems, Induction, Lubricants and Fuels, Lubrication Systems, Engine Indication Systems, Engine Monitoring and Ground operation, Engine Storage and Preservation.

**M17. Propeller**
Many modern aircrafts still use propeller engines for power, from light recreational aircrafts to heavy C-130 cargo aircraft. Practical study and theoretical knowledge is imparted to engineers in this module. It is required for AML Cat: A1, A2, B1.1 and B1.2 licenses

**On Job Training (OJT)**
Our students would get On-Job Training (OJT)/Internship in inland civil maintenance setup as per prescribed schedule

## Eligibility Requirement-AMEL Program:

- SSC/ O-Level with 70% marks
- FSc/ A-Level with 60% marks

## Application:

For AMEL Program, apply online on https://athorg.uk

## Program Duration:

2 years (6 semesters)

## Fee Schedule for Dedicated AMEL Program

**Fee Schedule (Local Students)**

| Fee Schedule | (Pak Rs.) |
|---|---|
| **Admission Fee** (One Time) | 150,000 |
| **Semester Fee** | 1,40,000 |
| **Per Paper Fee** (16 Papers) | 115 Euro |
| **OJT Fee** (Per month) | 8,000 |
| **International Certification fee** (Paid annually) | £300 |

**Optional Charges**

**Fee Schedule (Local Students)**

| Hostel Charges | (Pak Rs.) |
|---|---|
| Dormitory Charges | 50,000 |

**Fee Schedule (International Students)**

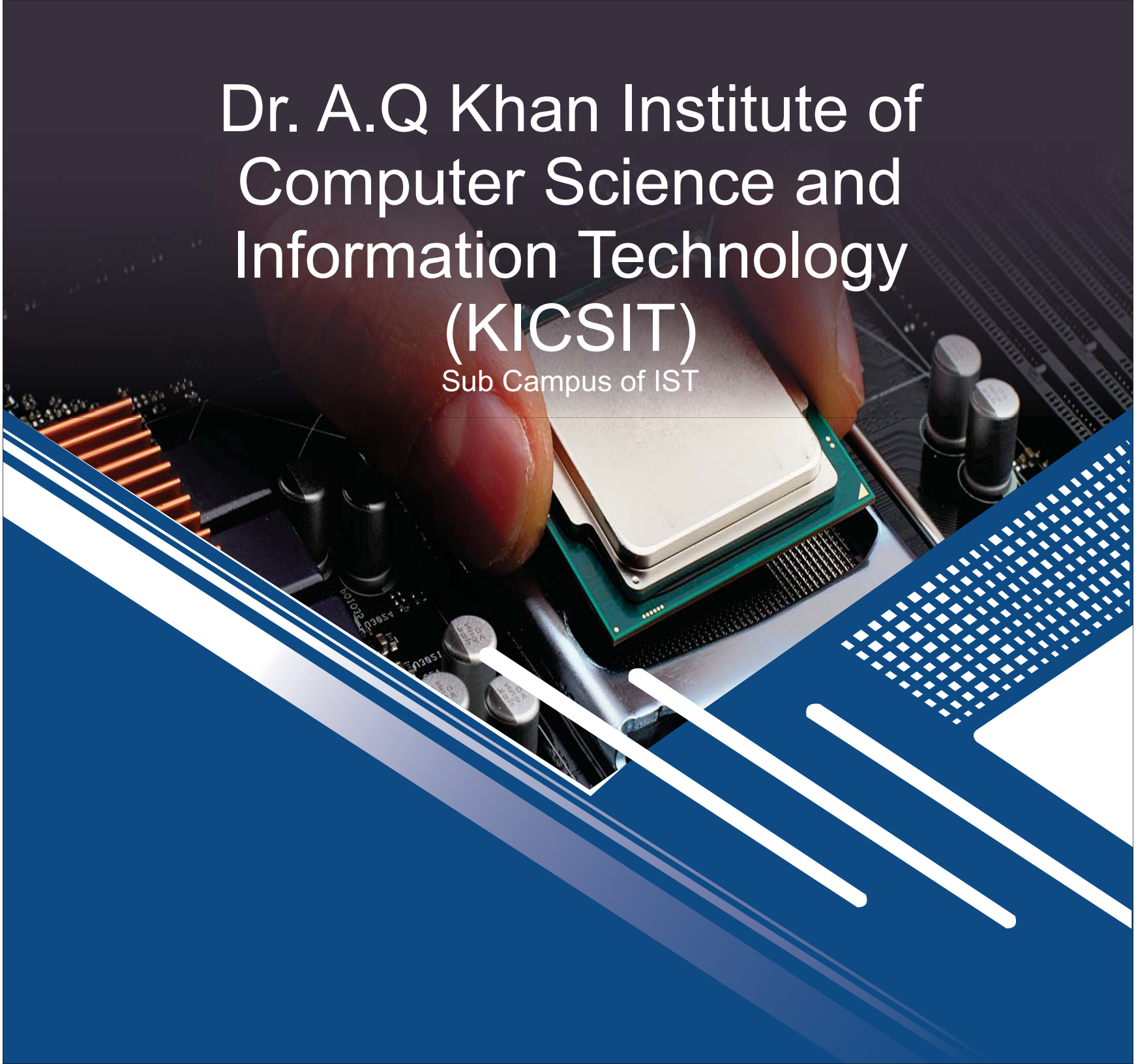
| Fee Schedule | (US $) |
|---|---|
| **Admission Fee** (One Time) | 5,000 |
| Annual Fee (Tution fee+Exams Fee +Parctical Fee) (3 Years) | 10,000 |
| International English Course (One Time Payable at the time of Admission) | 1,500 |

**Fee Schedule (International Students)**

| Hostel Charges | (US $) |
|---|---|
| Dormitory Charges | 825 |
| Washing Charges | 30 |
| Dormitory Charges for air-conditioned rooms | 1200 |
| Transport Charges | 195 |
| Locker Rent Charges | 6 |

# 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 (JRPs). 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, TTSF, 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:

a. Matric/ Equivalent Certificate (Science) with 60% marks

b. FSc Pre-Engineering/ ICS/ DAE/ Equivalent Certificate with minimum 60% overall marks

c. Obtained Marks in Entry Test

### For Computer Science/ Data Science/ Artificial Intelligence:

a. Matric/ Equivalent Certificate

b. HSSC/ Equivalent with Mathematics with minimum 50% overall marks OR HSSC Pre-Medical/ Equivalent with minimum 50% overall marks*

c. No Entry Test Required

*Candidates with FSc Pre-Medical / equivalent qualification enrolled in BS Computer Science program will have to clear deficient Mathematics courses of 6 credit hours, within one year

### For Physics/ Space Science:

a. Matric/ Equivalent Certificate

b. FSc Pre-Engineering/ ICS/ Equivalent Certificate with Mathematics & Physics

c. No Entry Test Required

### For Mathematics:

a. Matric/ Equivalent Certificate

b. FSc/ Equivalent with Mathematics, securing at least 50% marks in aggregate OR Diploma of Associate Engineering Examination, securing at least 60% marks in aggregate

c. 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:

a. Matric/ Equivalent Certificate (Science) with 60% marks

b. DAE (Aggregate) with 60% overall marks

c. 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, 2023 to last date of admissions of Fall 2024 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, 2023 to last date of admissions of Fall 2024 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, 2023 to July 2024 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 2024 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 2024 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 2024 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 2024 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, 2023 to September 30, 2024 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/- 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% |

## 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 Concerned Board and submit the copy of the same in Admissions Office during first semester If any document received by admissions office found to be false or forged later on, the applicant shall not be considered for admission, and if already a student at the Institute, he/she shall immediately be expelled and a fine as decided by concerned committee will be charged
- 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) | MS&E | CS/ AI /DS | Space Science | Mathematics 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 | 137,759/- | 131,769/- | 116,329/- | 111,272/- | 73,205/- |
| Service Charges | 7700/- | 7,700/- | 7,700/- | 7,700/- | 7,700/- |
| Safe/Smart Campus Charges | 2200/- | 2,200/- | 2,200/- | 2,200/- | 2,200/- |
| **Total of Per Semester Dues** | **147,659/-** | **141,669/-** | **126,229/-** | **121,172/-** | **83,105/-** |

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 + 1 Cr. Hr. Fee + Fee of any Registered Course
(Rs. 9,000 + Rs. 22,500 = Rs. 31,500 + 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) | MS&E | CS/ AI/ DS | Space Science | Mathematics 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/-** | **5,612/-** | **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
- 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 15 days of convene of classes on a pro rata basis as given below. No refund shall be admissible after 15 days of convene of classes either one joins IST/avails facilities or not.

| Timeline for Refund of Compulsory Fees | %age of Refund |
|---|---|
| Up to 7th day of convene of classes | 100 % |
| From 8th – 15th day of convene of classes | 50 % |
| From 16th day of convene of classes | 0 % |

- If admission is offered after commencement of classes, date of commencement of classes will be considered as mentioned in offer letter.
- Adjustment of student liability from 2nd Semester and onward will be based on classes attendance & facility will be charged as per actual. Application 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. However Optional Charges will be deducted as per actual usage of facility based on 4.5 Month/Semester. This policy is applicable on fresh admission only.
- In case of semester freeze, fee once deposited will be adjusted in next semester as per freeze policy after re-joining the student. If student wants to leave the institute after freezing his/her semester, then dues will be refunded according to refund policy present at the time of freezing the semester.
- 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 |
|---|---|
| From 1st 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, students are required to register themselves. Registration encompasses approval of course from respective academic department/advisor and payment of all dues. A student shall not be considered to have been registered for the semester unless all dues have been paid.
- Hostel accommodation 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

Fine will be charged on late payment of fee after due date as per following timeline:

| Timeline | %age of Fine |
|---|---|
| From 1st – 15th day after due date | 5 % |
| From 16th day after due date | 10 % |

Note: A Students will only be allowed to sit in classes/exams after clearance all outstanding dues along with fine if any.

## 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 years degree program. There shall be two regular semesters in each academic year, for a total of eight semesters. Each semester shall be of 19 weeks' duration. There shall be 17 weeks of classes. Final examinations shall be held in the 18th & 19th week.

## Summer Semester

Undergrad 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 "W", "WSA" and "WMI" 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 from Dean IST. Maximum 'B' grade is awarded in the Summer semester.

## Degree Requirement

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-year (total seven years). Extension of one-year has to be approved by the Academic Council Meeting (ACM) on a case to case basis. 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 9th semester will be charged "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.

| Discipline | Credit hours* |
|---|---|
| Aerospace Engineering | 135 |
| Avionics Engineering | 135 |
| Electrical Engineering | 136 |
| Materials Science & Engineering | 136 |
| Mechanical Engineering | 135 |
| Computer Science | 130 |
| Artificial Intelligence | 130 |
| Data Science | 130 |
| Mathematics | 131 |
| Space Science | 136 |
| Physics | 133 |

## Student Evaluation

A student's academic progress and standing is determined and monitored through the following modes of evaluation: -

Assignments: At least one assignment per credit hour
Quizzes: At least two unannounced quizzes per credit hour of up to 10 - 15 minutes
Lab Reports: Minimum 13 lab reports in each lab
Oral Exams: As per instructor's requirement
One Hour Tests: Two OHTs per semester
Projects: As per instructor's requirement
Finals: One announced final of up to three hours'

duration
A typical break-up of weightage assigned to each mode of evaluation for a course and that for a laboratory is as follows: -

At least 80% attendance is mandatory to appear in the

| Course | |
|---|---|
| Assignments | 5% |
| Quizzes | 15% |
| Hour Tests | 30% |
| Project | 0%-10% |
| Final | 40%-50% |

| Lab | |
|---|---|
| One Hour Test/Experimental Part | 60% |
| Oral Exam | 20% |
| Lab Reports | 20% |

final exam of a course, whether it is a normal or repeat/improve course.
There will be no choice of questions in quizzes, one-hour tests and final exams. Retake of OHTs 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 will be conducted under the supervision of the theory course instructors. Grades awarded to students in lab exams shall be approved from the theory course instructors.

## Grading System

IST, as a matter of rule, follows a relative grading system by default (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 by looking at the class average and its standard deviation.
The labs, however, are graded according to the absolute grading system, delineated below:

| Intrpretation | Grades | Marks |
|---|---|---|
| Excellent | A | 85 ≤ marks ≤ 100 |
| | A- | 81 ≤ marks < 85 |
| Very Good | B+ | 77 ≤ marks < 81 |
| | B | 73 ≤ marks < 77 |
| Good | B- | 69 ≤ marks < 73 |
| | C+ | 65 ≤ marks < 69 |
| Average | C | 61 ≤ marks < 65 |
| | C- | 57 ≤ marks < 61 |
| Poor | D+ | 52 ≤ marks < 57 |
| | D | 50 ≤ marks < 52 |
| Fail | F | marks < 50 |

FYP-1 in 7th semester will be awarded as deferred grade against the course and the final grade will be awarded in 8th semester. The deferred grade in 7th semester shall not appear in the final transcript.

## Grading Criteria for Summer Semester:

The grading criteria for Summer semester is different than the regular semester. Maximum 'B' grade is awarded in the Summer semester. Relative Grading System is followed in regular as well as Summer semester except in labs.

### '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

## Grade Point Average (GPA)

GPA is calculated by using following formula:

$$GPA = \frac{\text{Sum of (credit hours x grade points)}}{\text{Sum of credit hours}}$$

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.

- Students can repeat a maximum of 12 credit hours of coursework and only one attempt per course is allowed
- 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
- In case of course repetition, the earned GPA of the repeated course will be considered for the calculation of CGPA (even if the earned grade in the revised course is lower than the first attempted course). A letter "R" will be affixed against the course attempted first time and symbol of # will be affixed with the grade earned in the repeated course (last attempted)
- 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 academic medals and merit certificates

## Rule for Improvement of Grades for Graduating Students

The graduating students must submit the application for improvement of grades to departments within 15 days of result announcement. After due date no such case will be entertained.

## Repeat of Course for Grade Improvement with Theory and Lab Part

A student repeating a course to improve the grade will have to enroll/register the entire course in totality (Theory + Lab) in a semester.

## 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 their probationary status:

- This provision of availing additional chances for grade improvement (excluding "F" will remain valid for final year students (7th & 8th semesters) till the completion of their degree program (6 years) with following instructions: -
  - Students can avail maximum chances of grade improvement excluding the "F" grade
  - Only courses with below "C" grade can be repeated
  - Only one repeat per course will be allowed, therefore, getting "F" grade in the repeat course will lead to degree termination
  - The grade earned in last (repeat) attempted course will be calculated in CGPA
  - The limit of repeat chances for "F" grade will remain same i.e. 12 credit hours

## Non-Credit Course

A non-credit course will be registered by the student in 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

Bachelor's 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. 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.

## 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 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 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

"WIC" grade would be awarded in Lab course if student fails or get withdrawn from the Theory course due to any reason. If Theory course is passed and Lab course is failed/debarred, then only Lab course will be

repeated. Theory and Lab course of a particular subject shall be conducted in the same semester. It is applicable from Fall 2017.

| Intrpretation | 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 |

## "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.

## 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 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 repeat/non-credit/extra course as well.

## 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

Academic integrity is maintained strictly. A zero tolerance policy is enforced for academic dishonesty. Any such case is referred to the Disciplinary Committee. The student has the right to appeal against the decision of disciplinary committee to VC (IST), within 15 days of serving of written decision of disciplinary committee. The decision taken by the VC (IST) will be 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 address, shown in student portal at the start of every semester.

## Conduct and Discipline

Good conduct and discipline is expected of all students of the Institute. Any case of misbehavior or indiscipline is dealt strictly. If a student's registration is ever

cancelled on disciplinary grounds, the student shall be 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.

## Academic Standards

GPA will be the primary measure of academic performance and standing:

- A copy of the advisory note will be sent to sponsor

| 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 |

  or parents of academically deficient student
- A student with a Dropout standing will lose student status and will have to leave the institute
- Dropout condition will be applicable from Spring 2023.

## 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 pending 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 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 for necessary corrections.
- A student shall not be considered to have been

registered for the semester unless all outstanding dues including current semester 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.
- A student may add a course up to second week from the commencement of classes. Similarly a student may drop a course up to fourth week from the commencement of classes.
- A student may withdraw a course up to the 14 week from the start of the semester; however he/she has to pay the fee for the course when he/she applies again for the course. Students will be awarded 'W' grade for that semester in the course.
- Attendance at lectures is governed by the Attendance Regulations.
- If the registration is ever cancelled on disciplinary grounds, the student shall be ineligible for readmission to the institute.
- Registration must be completed prior to the first day of classes and is a prerequisite for attending the classes. Every student must update his/her profile on every new registration of the semester.

## Enrollment Cancellation

Students enrollment will be cancelled if the following conditions are true:

- If student do not pay semester dues before the start of a semester and;
- If student do not attend any class of a course in the first 4 weeks of the semester and;
- 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).
    - Of particular notified student(s) for 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 Northwestern Polytechnical University, Xi'an, China
Area of Specialization: Structural Design & Analysis

**Jamshed Riaz**
Professor (Adjunct Faculty)
PhD Georgia Institute of Technology, USA
Area of Specialization: Flight Mechanics, Automatic Control

**Muhammad Naeem**
Professor
PhD Cranfield University, UK.
Area of Specialization: Gas Turbines Performance (Modelling & Simulation)

**Gohar Majeed**
Assistant Professor
MS Iowa State University, USA
Area of Specialization: Aerospace Structures, Mechanics of Composite materials, Damage tolerance analysis, Finite Element modeling and analysis

**Hayat Muhammad Khan**
Assistant Professor
PhD Northwestern Polytechnical University, China
Area of Specialization: Controls, Automation and Robotics

**Izhar Hussain Kazmi**
Assistant Professor
M. Phil ENSHM, INPG, France
Area of Specialization: Fluid Dynamics

**Saad Rifat Qurashi**
Assistant Professor
Phd University of Dayton, OHIO USA
Area of Specialization: Fluid Dynamics

**Umer Sohail**
Assistant Professor
Phd Institute of Space Technology
Area of Specialization: Computational Fluid Dynamics (CFD) Turbo machinery Machine Learning Artificial Neural Networks

**Dr Muhammad Wasim**
Assistant Professor
PhD University of Engineering and Technology Taxila, Pakistan
Area of Specialization: Control Systems

**Dr Mariyam Sattar**
Assistant Professor
PhD Beihang University of Aeronautics & Astronautics (BUAA), China
Area of Specialization: Solid Mechanics

**Sajid Hussain**
Lecturer
MS National University of Sciences and Technology, Pakistan
Area of Specialization: Micro Electromechanical Systems (MEMS).

**Fatima Hira**
Lecturer
MS Capital University of Science and Technology, Pakistan
Area of Specialization: Engineering Management

**Asad Mehmood**
Lecturer
MS Institute of Space Technology, Islamabad
Area of Specialization: Experimental Aerodynamics, Renewable Energy

**Shuja Ur Rehman**
Lecturer
MS Northwestern Polytechnical University, China
Area of Specialization: Aero Vehicle Design

## Faculty of Avionics

**Dr Israr Hussain**
Professor/ Head of Department
PhD University of Manchester- UK
Area of Specialization: Signal and Image Processing

**Dr Abdul Waheed**
Associate Professor
PhD The Hong Kong University of Science and Technology
Area of Specialization: Modelling Simulation and Control

**Dr Suhail Akhtar**
Professor
PhD University of Michigan, Ann Arbor
Area of Specialization: Flight Dynamics & Control

**Dr Muhammad Amin**
Professor
PhD Queen's University Belfast, UK
Area of Specialization: Antennas for Space and Land Communications

**Dr Muhammad Abdul Rehman Khan**
Professor
PhD Beihang University, China
Area of Specialization: Information and Communication Systems, Spread Spectrum Communication System

**Engr Irfan Majid**
Assistant Professor
MS NUST CAE
Area of Specialization: Avionics

**Engr Sardar Ahmed**
Assistant Professor
MS NUST Islamabad
Area of Specialization: Avionics

**Engr Muhammad Zahid Sheikh**
Assistant Professor
MS George Washington University, USA
Area of Specialization: Data and Computer Communications

**Engr Lal Said**
Lecturer
MS Institute of Space Technology
Area of Specialization: Computer Vision, Pattern Recognition

**Engr Shifa Nadeem**
Lecturer
MS Institute of Space Technology
Area of Specialization: Wireless Communication

**Engr Hamail Sultan**
Lecturer
MS Institute of Space Technology
Area of Specialization: Wireless Communication

**Anila Ali Ahmed**
Lecturer
MS COMSAT University of Science and Technology, Islamabad
Area of Specialization: Control Systems

**Engr Hafiz Ali Ahmad**
Lecturer
MS National University of Science & Technology
Area of Specialization: Control Systems, Power Electronics, Electric Machines & Drives, Electric Vehicles

## Faculty of Electrical Engineering and Computer Science

**Dr Khurram Khurshid**
Professor/ Head of Computer Science
PhD Paris Descartes University, France
Area of Specialization: Machine Learning, Hyper-spectral Image Analysis, Document Image Processing

**Dr Adnan Zafar**
Assistant Professor/ Head of Electrical Engineering
PhD University of Surrey, UK
Area of Specialization: Signal Processing for Wireless Communication

**Dr Qamar-Ul-Islam**
Professor
Phd. University of Surrey, UK
Area of Specialization: Satellite Communications/ Space Systems

**Dr Amena Ejaz Aziz**
Assistant Professor
PhD Hong Kong Polytechnic University
Area of Specialization: Visible light communication

**Dr Benish Amin**
Assistant Professor
PhD NUST Pakistan
Area of Specialization: Digital Image Processing

**Dr Komal Nain Sukhia**
Assistant Professor
PhD NUST Pakistan
Area of Specialization: Digital Image Processing

**Dr Rehan Mahmood**
Assistant Professor
PhD Beihang University, China
Area of Specialization: Spacecraft Engineering

**Dr Syed Ali Irtaza**
Assistant Professor
PhD Hanyang University, South Korea
Area of Specialization: Compressed Sensing, Wireless & Mobile Communication

**Dr Madiha Tahir**
Assistant Professor
PhD GIKI University, Swabi
Area of Specialization: Deep Learning and Evolutionary Algorithms

**Dr Bilal Ahmed Khan**
Assistant Professor
PhD Bahria University, Islamabad
Area of Specialization: Networks, Technology and Innovation Management

**Dr Salma Zaineb Farooq**
Assistant Professor
PhD BUAA, Beijing
Area of Specialization:Communication and Information Systems, GNSS

**Muhammad Ghayas Uddin**
Assistant Professor
M. Phil Punjab University, Pakistan
Area of Specialization: VLSI Design & Fabrication

**Saima Siddiqui**
Assistant Professor
MS CASE, Islamabad
Area of Specialization: Electronics/ Engineering Management

**Tariq Mahmood** (Adjunct Faculty)
Assistant Professor
MSc Cranfield UK
Area of Specialization: Computer Design

**Engr Ahmed Raheeq Sultan**
Lecturer
MS NUST Pakistan
Area of Specialization: Electronic Design, Network Security, Forensics and Cryptography

**Engr Faran Mahmood**
Lecturer
M.Phil University of Cambridge
Area of Specialization: Systems Engineering, Product Design

**Engr Haroon Ibrahim**
Lecturer
MS IST, Pakistan
Area of Specialization: Communications, Signal Image Processing

**Engr Muhammad Asad** (Abroad for PhD)
Lecturer
MS GIK Institute, Pakistan
Area of Specialization: Data Science, Machine Learning and Feature Engineering

**Engr Muhammad Jaleed Khan** (Abroad for PhD)
Lecturer
MS IST Islamabad
Area of Specialization: Deep Learning, Hyperspectral Image Analysis, Computer Vision

**Ali Fahim Khan** (Abroad for PhD)
Lecturer
MS NUST Pakistan
Area of Specialization: Signal Processing

**Engr Saniya Zafar**
Lecturer
MS IST Pakistan
Area of Specialization: Wireless Communications

**Tufail Sajjad Shah Hashmi**
Lecturer
MS NUST, Islamabad
Area of Specialization: Computer Vision and Artificial Intelligence

**Muhammad Nadeem**
Lecturer
MS GIKI University, Swabi
Area of Specialization: Artificial Intelligence and Cyber Security

**Zil-E-Huma**
Lecturer
MS SEECS (NUST), Islamabad
Area of Specialization: Electronics and Control Systems

**Muddser Qamer Raja**
Lecturer
MS ABASYN University, Islamabad
Area of Specialization: Electrical Power

**Usman Ali Afzal**
Lecturer
MS SEECS NUST, Islamabad
Area of Specialization: Control Systems and Power Electronics

**Aima Zahid**
Lecturer
MS Electrical Engineering
Information Technology University of the Punjab
Area of Specialization: RF and Microwave, Nanotechnology

**Ammara Yaseen**
Lecturer
MS (Data Science)
NED University of Engineering and Technology
Area of Specialization: Data science and Data Visualization

**Asia Aman**
Lecturer
MS Electrical Engineering
Institute of Space Technology
Area of Specialization: Signals and Image processing

**Muhammad Hamza Rafique Bhatti**
Lecturer
MS Software Engineering
COMSATS University, ISLAMABAD
Area of Specialization: Deep Learning and Machine Learning

**Natiqa Gul**
Lecturer
MS Computer Engineering, GIKI
Area of Specialization: Advanced Machine learning and Computer Vision

**Reeda Saeed**
Lecturer
Masters in Computer Science
Ghulam Ishaq Khan Institute (GIKI)
Area of Specialization: AI in Healthcare

**Tayyaba Arshad**
Lecturer
MS Data Science
FAST-NUCES ISLAMABAD
Area of Specialization: Natural Language processing & Medical Image processing

## Faculty of Materials Science & Engineering

**Dr Abdul Wadood**
Head of Department
PhD Tokyo Institute of Technology, Japan
Area of Specialization: Shape memory alloys, Biomaterials

**Dr Ibrahim Qazi**
Professor
PhD University of Sheffield, UK
Area of Specialization: Electro Ceramics

**Dr Syed Wilayat Husain**
Professor
PhD University of Connecticut, USA
Area of Specialization: Physical Metallurgy

**Dr Anjum Tauqir**
Professor
PhD University of Connecticut (USA)
Area of Specialization: Alloy Development

**Dr Sajid Ullah Khan**
Professor
PhD Univerisity of Twente, Netherlands
Area of Specialization: Nanotechnology

**Dr Saima Shabbir**
Professor
PhD Quaid-i-Azam University, Islamabad
Area of Specialization: Polymer Chemistry

**Dr Saad Nauman**
Professor
PhD Universite des Sciences et Technologies de Lille 1 Lille, France
Area of Specialization: Carbon Composites

**Dr Abdul Faheem Khan**
Professor
PhD Pakistan Institute of Engineering and Applied Sciences, Islamabad
Area of Specialization: Thin Film Materials

**Dr Muhammad Abdul Basit**
Associate Professor
PhD Hanyang University, South Korea
Area of Specialization: Thin Film Development for solar Cell Applications

**Dr Muhammad Yasir**
Associate Professor
PhD Huazhong University of Science & Technology, China
Area of Specialization: Amorphous Coatings

**Dr Muhammad Atiq ur Rehman**
Assistant Professor
PhD University of Erlangen Nuremberg
Area of Specialization: Biomaterials

**Engr Kashif Naveed**
Assistant Professor
MS UMIST, UK
Area of Specialization: Corrosion Engineering

**Engr Muhammad Abdul Qadir**
Lecturer
MS UET, Lahore
Area of Specialization: Coatings and surface engineering

**Engr Muhammad Awais**
Lecturer
MS PU, Lahore
Area of Specialization: Composites

**Engr Zeeshan Khan**
Lecturer
MS PIEAS, Islamabad
Area of Specialization: Materials Science & Engineering

## Faculty of Mechanical Engineering

**Dr Asif Israr**
Professor/Head of Department
PhD University of Glasgow, UK
Area of Specialization: Dynamics

**Dr Muhammad Zubair Khan**
Professor
PhD Burnel University, UK
Area of Specialization: Applied Mechanics

**Dr Owais ur Rahman Shah**
Associate Professor
PhD University of BREST, France
Area of Specialization: Failure in Composites

**Dr Muhammad Anwar**
Assistant Professor
PhD University of Luxembourg, Luxembourg
Area of Specialization: Fluid and Thermal System

**Dr Usama Waleed Qazi**
Assistant Professor
PhD UET, Taxila
Area of Specialization: Engineering Management

**Dr Muhammad Umer**
Assistant Professor
PhD Politecnico Di Torino, Italy
Area of Specialization: Non linear Vibration Dynamics and Machine Design

**Dr Talha Irfan Khan**
Assistant Professor
PhD KoC University, Turkey
Area of Specialization: CFD and Biomedical

**Dr Yumna Qureshi**
Assistant Professor
PhD ENSTA Bretagne, France
Area of Specialization: Real Time Structural Health Monitoring

**Dr Naseem Ahmad**
Assistant Professor
PhD Harbin Engineering University, China
Area of Specialization: Aerodynamics of Turbomachinery, Turbine Blade Cooling, Flutter and Computational Fluid Dynamics

**Engr Muhammad Azfar Jamal**
Lecturer
MS IST, Islamabad
Area of Specialization: Mechanical Design and Additive Manufacturing

**Engr Ruqia Ikram**
Lecturer
MS IST, Islamabad
Area of Specialization: Mechanical Design and Analysis

**Engr Sahibzada Shahroze Umar**
Lecturer
MS University of Houston, USA
Area of Specialization: Computational Fluid Dynamics

**Engr Syed Muhammad Mansoob Bukhari**
Lecturer
MS IST, Islamabad
Area of Specialization: Mechanical Design and Analysis

**Engr Saad Akram**
Lecturer
MS IST, Islamabad
Area of Specialization: Mechanical Design and Analysis

**Engr Babar Ashfaq**
Lecturer
MS International Islamic University, Islamabad
Area of Specialization: Mechanical Design and Analysis

**Engr Samia Fida** (Abroad for PhD)
Lecturer
MS IST, Islamabad
Area of Specialization: Mechanical Design & Analysis

## Faculty of Space Science

**Dr Mujtaba Hassan**
Assistant Professor / Head of Department
PhD TSINGHUA University, China
Area of Specialization: Climate Variability and Change; Extreme Events; South Asian Summer Monsoon Dynamics; Regional Climate Modeling; Hydrological Modeling; Climate Change Impact Assessment on Water Resources; Air Pollution Monitoring; Aerosol Climate Interaction

**Dr Ali Hussain** (Abroad for Postdoc)
Professor
PhD University of Ulsan, South Korea
Area of Specialization: Piezoelectric materials, synthesis, characterization and their applications

**Dr Najam Abbas Naqvi**
Associate Professor
PhD Northwestern Polytechnical University (NPU), China
Area of Specialization: Spacecraft Dynamics and Controls, Global Navigation Satellite System (GNSS)

**Dr Saleem Ullah** (Abroad for Postdoc)
Associate Professor
Postdoc University of California Santa Barbara (UCSB), USA
Area of Specialization: (Remote Sensing of Vegetation) Remote sensing/GIS, Multispectral and Hyperspectral Remote Sensing

**Dr Sajid Ghuffar**
Associate Professor
Postdoc University of St Andrews, UK
Area of Specialization: Photogrammetry, Computer Vision, Remote Sensing, Machine Learning, Cubesats

**Dr Sajid Butt**
Associate Professor
PhD Tsinghua University, Beijing, China
Area of Specialization: Energy Materials, Functional Materials, Physics of Materials, Advanced Characterization Techniques

**Dr Muhammad Shakir**
Associate Professor
PhD Institute of Remote Sensing and Digital Earth Chinese Academy of Sciences Beijing China
Area of Specialization: Agriculture Remote Sensing, Forestry

**Dr Munawar Shah** (Abroad for Postdoc)
Assistant Professor
PhD Shanghai Astronomical Observatory, CAS, China
Area of Specialization: GNSS ionosphere modelling; GNSS-R; Earthquake Precursors in atmosphere and ionosphere; GNSS Space Weather

**Abdul Kabir**
Assistant Professor
PhD GIK Institute of Engineering Sciences and Technology, Pakistan
Area of Specialization: (Theoretical Nuclear Astrophysics) Nucleosynthesis problem (r-, s-, p- and rp-process), Evolution phases of stars and supernova explosions, Nuclear cross-section, Quantum many bodies interaction, Nuclear abundances, Low and Heavy ions interaction in nuclear physics.

**Imran Ali Khan**
Assistant Professor
PhD GC University Lahore, Pakistan
Area of Specialization: Applications of Electromagnetic Waves in Space Plasmas

**Dr Muhammad Usman**
Assistant Professor
PhD NUST, Islamabad
Area of Specialization: Particle Astrophysics and Cosmology

**Dr Saeeda Sajjad**
Assistant Professor
PhD University of Montpellier, France
Area of Specialization: Physics (Gamma-ray astronomy, High energy astronomy and astrophysics, Imaging Atmospheric Cherenkov Telescopes, Monte Carlo simulations, Gamma-ray bursts)

**Ibtehaj Hassan**
Lecturer
MS Institute of Space Technology, Islamabad
Area of Specialization: Plasma Physics

**Maham Siddiqi**
Lecturer
MS Sultan Qaboos University, Muscat, Oman
Area of Specialization: Gravitational Waves, X-ray Binaries

**Waheed Ahmed**
Lecturer
MS University of Innsbruck, Austria / University of Goettingen, Germany
Area of Specialization: Astronomy and cosmology

**Adnan Ashraf**
Lab Engineer
MS Institute of Space Technology, Islamabad
Area of Specialization: Global Navigation Satellite Systems, Physics

**Asad Munir**
Lab Associate
MPhil Quaid-I-Azam University, Islamabad
Area of Specialization: Particle Physics, Radiation Physics

**Shahanshah Abbas**
Lab Engineer
MS Institute of Space Technology Islamabad
Area of Specialization: Remote Sensing and Geographic Information Science, Computer Engineering

**Usama Ahmad**
Lab Engineer
MS Institute of Space Technology, Islamabad
Area of Specialization: Global Navigation Satellite System (GNSS)

## Faculty of Applied Mathematics & Statistics

**Dr Muhammad Nawaz**
Associate Professor/Head of Department
PhD Quaid-i-Azam University, Islamabad
Area of Specialization: Applied Mathematics

**Dr Salman Ahmad**
Professor
PhD Beijing Institute of Technology, China
Area of Specialization: General & Fundamental Mechanics

**Dr Asad Ali**
Professor
PhD The University of Auckland, New Zealand
Area of Specialization: (Statistics) Inference, MCMC Methods, Gravitational Radiation, Bayesian Spectrum Analysis, Parallel Computing

**Dr Maryiam Javed**
Associate Professor
PhD Quaid-i-Azam University, Islamabad
Area of Specialization: Applied Mathematics

**Dr Muhammad Aqeel**
Associate Professor
PhD Beijing Institute of Technology, China
Area of Specialization: General & Fundamental Mechanics

**Dr Rahila Naz**
Associate Professor
PhD Quaid-i-Azam University, Islamabad
Area of Specialization: Applied Mathematics

**Dr Waqas Ashraf**
Associate Professor
PhD COMSATS Institute of Information Technology, Islamabad
Area of Specialization: Applied Mathematics

**Dr Majid Khan**
Associate Professor
PhD Quaid-i-Azam University, Islamabad
Area of Specialization: Cryptography

**Dr Ayesha Rafiq**
Assistant Professor
PhD Quaid-i-Azam University, Islamabad
Area of Specialization: Group Theory and Generalizations

**Dr Danish Ali Sunny**
Assistant Professor
PhD University of Stuttgart Germany
Area of Specialization: Applied Analysis/Nonlinear Partial Differential Equations

**Dr Salma Riaz**
Assistant Professor
PhD Quid-i-Azam University
Area of Specialization: Bayesian Control Charts

**Dr Sadia Saeed**
Assistant Professor
PhD Comsats University, Islamabad
Area of Specialization: Computational Mathematics

**Dr Erum Zahid**
Assistant Professor
PhD Quid-i-Azam University
Area of Specialization: Survey Sampling & Geostatistics

**Dr Khawar Mehmood**
Assistant Professor
PhD Abdus Salam School of Mathematical Sciences, GC University Lahore
Area of Specialization: Singularity Theory, Computer Algebra, Commutative Algebra

**Dr Umair Ali**
Assistant Professor
PhD University of Science, Malaysia
Area of Specialization: Fractional Computational Mathematics

**Dr Javeria Ayub**
Lecturer
PhD Institute of Space Technology, Islamabad
Area of Specialization: Applied Mathematics & Statistics

**Zaheer Ahmed** (On study leave)
Lecturer
M. Phil Quaid-i-Azam University, Islamabad
Area of Specialization: Statistics

**Amir Rahim**
Lecturer
MS NUST
Area of Specialization: Applied Mathematics

## Faculty of Humanities & Sciences

**Dr Ausima Sultan Malik**
Assistant Professor/Head of Department
PhD Foundation University, Islamabad
Area of Specialization: Applied Linguistics and Literature

**Dr Syeda Aysha Bokhari**
Assistant Professor
PhD Foundation University, Islamabad
Area of Specialization: Applied Linguistics and Literature

**Uzma Nasir**
Assistant Professor
M. Phil Air University, Islamabad
Area of Specialization: Applied Linguistics and Literature

**Syed Ubaidullah Jamil**
Assistant Professor/Academic Coordinator
MS International Islamic University, Islamabad
Area of Specialization: Aqeedah & Philosophy

**Sadia Zaheer**
Lecturer
M. Phil National Institute of Pakistan Studies (NIPS), Quaid-e Azam University
Area of Specialization: Water Resource Management and Freedom Movement in Punjab

**Tamkeen Zehra Shah**
Lecturer
MS Foundation University, Islamabad
Area of Specialization: Argumentation Theory and Critical Discourse Analysis

**Tehreem Ali**
Lecturer
M.Phil Fatima Jinnah Women University, Rawalpindi
Area of Specialization: English Literature

**Qurat-ul-Ain**
Lecturer
M.Phil Quaid-i-Azam University, Islamabad
Area of Specialization: English Linguistics and Literature

**Ifrah Jamil**
Lecturer
M.Phil Fatima Jinnah Women University, Rawalpindi
Area of Specialization: Critical discourse analysis

## Faculty of Aircraft Maintenance Engineering License

**Engr Shoaib Farid**
Training Manager
MS Institute of Space Technology, Islamabad
Area of Specialization: Mechanical Engineering

**Naveed Ahmed**
Quality Manager
B.Sc. Mathematics
Area of Specialization: Aircraft Maintenance Engineering

**Engr Sajid Akram**
Senior Engineering Instructor
BE University of Ukraine
Area of Specialization: Maintenance Engineering

**Engr Raja Nauman Kiani**
Senior Engineering Instructor
MS Institute of Space Technology, Islamabad
Area of Specialization: Mechanical Engineering

**Engr Mehreen Khan**
Senior Engineering Instructor
MS Institute of Space Technology, Islamabad
Area of Specialization: Electrical Engineering

**Engr Bakhtawar Javed**
Engineering Instructor
BS Fatima Jinnah Women University, Rawalpindi
Area of Specialization: Software Engineering

**Engr Saqib Raza**
Engineering Instructor
BS Institute of Space Technology, Islamabad
Area of Specialization: Avionics Engineering

**Imran Muhammad Aslam**
Engineering Instructor
Area of Specialization: Aircraft Maintenance Engineering

**Sami-Ur-Rehman Baig**
Engineering Instructor
Area of Specialization: Aircraft Maintenance Engineering

**Zain Ul Abideen**
Practical Instructor
Area of Specialization: Aircraft Maintenance Engineering

**Haroon Rasheed Akhar**
Practical Instructor
Area of Specialization: Aircraft Maintenance Engineering

**Hafiz Saud-Ur-Rehman**
Practical Instructor
Area of Specialization: Aircraft Maintenance Engineering

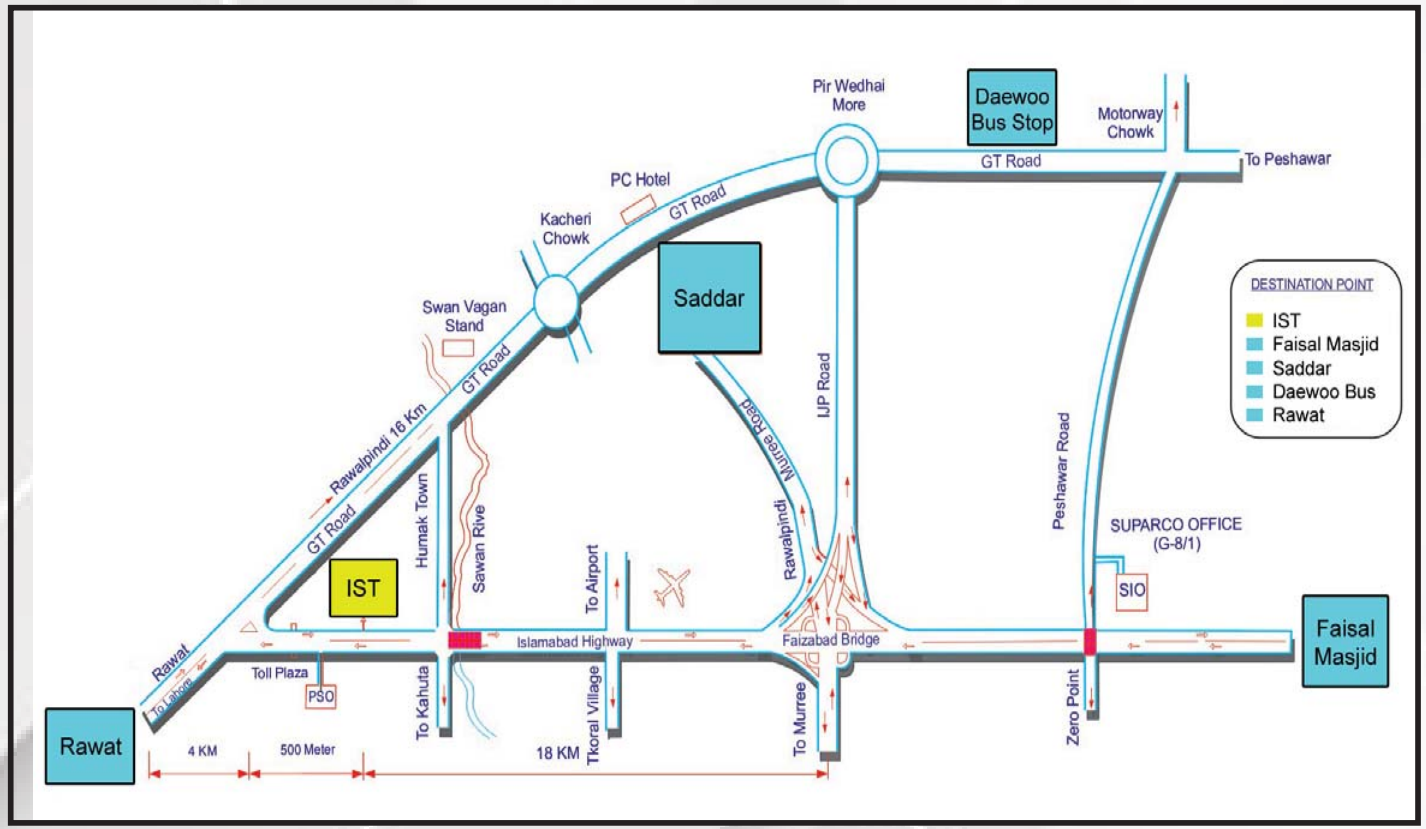
**Saqib Amin**
Practical Instructor
Area of Specialization: Aircraft Maintenance Engineering

**Saqib Amin**
Senior OJT Instructor
Area of Specialization: Aircraft Maintenance Engineering

| | |
|---|---|
| Maj. Gen. Rehan Abdul Baqi, HI (M), (Retd) | Vice Chancellor |
| Dr Ibrahim Qazi | Dean |
| Abdul Waheed Kandhro | Acting Registrar |
| Dr Raees Fida Swati | HOD - Aeronautics & Astronautics |
| Dr Abdul Wadood | HOD - Materials Science & Engineering |
| Dr Asif Israr | HOD - Mechanical Engineering |
| Dr Mujtaba Hassan | HOD - Space Science |
| Dr Khurram Khurshid | HOD - Computer Science |
| Dr Adnan Zafar | HOD - Electrical Engineering |
| Dr Muhammad Nawaz | HOD - Applied Mathematics & Statistics |
| Dr Ateeq Qureshi | HOD - National Center for Remote Sensing & Geo- Informatics |
| Dr Israr Hussain | HOD - Avionics Engineering |
| Farooq Ahmad | Additional Director Administration |
| Zia Ahmad | Senior Director Human Resource |
| Engr Hamid Amir SI (M) | Controller of Examinations |
| Dr Anjum Tauqir | Acting Director National Centre for Failure Analysis |
| Dr Abdul Waheed | Director ORIC and QEC |
| Tariq Anees Malik | Additional Director Security |
| Raees Ahmed | Incharge Transport |
| Waqas Ahmed Malik | Additional Director QEC |
| Raza Butt | Incharge Student Affairs |
| Dr Israr Ahmad | Incharge Admissions |
| Hafiz Muhammad Usman | Deputy Director Hostel |
| Arshad Minhas | Deputy Director (Acad. Coord) |
| Syed Muhammad Ali | Incharge Library |

# IST ISLAMABAD CAMPUS

Institute of Space Technology
1, Islamabad Highway
Near CDA Toll Plaza
Islamabad

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**Admissions Office**
Institute of Space Technology
1, Islamabad Highway; Islamabad

Email: admissions@ist.edu.pk
Website: www.ist.edu.pk

Tel: +92-51-9075100
Fax: +92-51-9273310