# CURRICULUM

## OF

# SPACE SCIENCES

## FOR

## BS
## MS

(Revised 2012)

**HIGHER EDUCATION COMMISSION,**
**ISLAMABAD**

# CURRICULUM DIVISION, HEC

| | |
|---|---|
| Dr. Syed Sohail H. Naqvi | Executive Director |
| Mr. Muhammad Javed Khan | Adviser (Academic) |
| Malik Arshad Mahmood | Director (Curri) |
| Dr. M. Tahir Ali Shah | Deputy Director (Curri) |
| Mr. Farrukh Raza | Assist. Director (Curri) |
| Mr. Abdul Fatah Bhatti | Assist. Director (Curri) |

Composed by: Mr. Zulfiqar Ali, HEC, Islamabad

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# PREFACE

The curriculum of subject is described as a throbbing pulse of a nation. By viewing curriculum one can judge the stage of development and its pace of socio-economic development of a nation. With the advent of new technology, the world has turned into a global village. In view of tremendous research taking place world over new ideas and information pours in like of a stream of fresh water, making it imperative to update the curricula after regular intervals, for introducing latest development and innovation in the relevant field of knowledge.

In exercise of the powers conferred under Section 3 Sub-Section 2 (ii) of Act of Parliament No. X of 1976 titled **"Supervision of Curricula and Textbooks and Maintenance of Standard of Education"** the erstwhile University Grants Commission was designated as competent authority to develop, review and revise curricula beyond Class-XII. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission under its Ordinance of 2002 Section 10 Sub-Section 1 (v).

In compliance with the above provisions, the HEC undertakes revamping and refurbishing of curricula after regular intervals in a democratic manner involving universities/DAIs, research and development institutions and local Chamber of Commerce and Industry. The intellectual inputs by expatriate Pakistanis working in universities and R&D institutions of technically advanced countries are also invited to contribute and their views are incorporated where considered appropriate by the National Curriculum Revision Committee (NCRC).

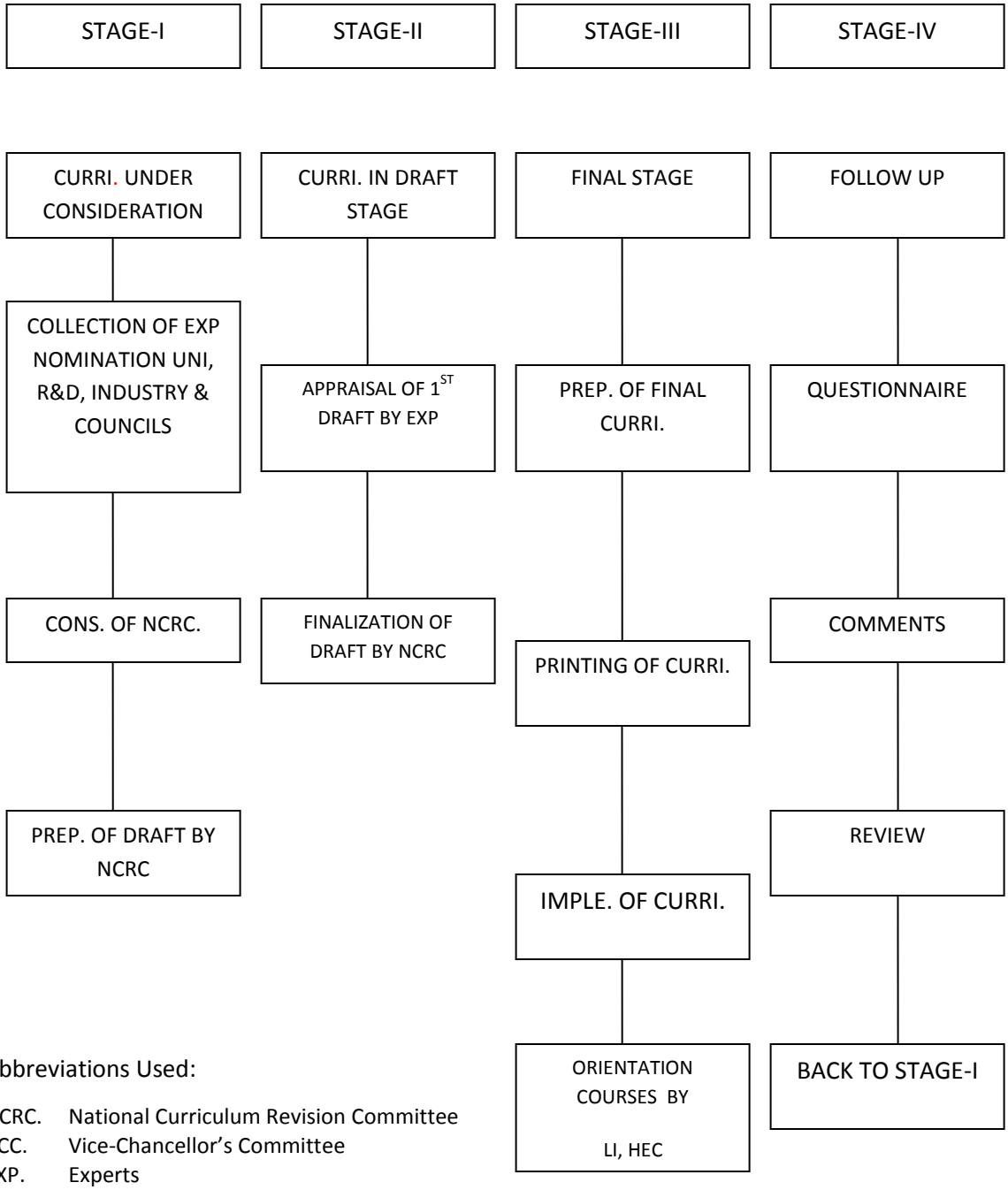
A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours.

In line with above, NCRC comprising senior university faculty and experts from various stakeholders and the respective accreditation councils has revised the curriculum for Space Sciences. The same is being recommended for adoption by the universities/DAIs channelizing through relevant statutory bodies of the universities.

**MUHAMMAD JAVED KHAN**
**Adviser Academics**

**April, 2012**

# CURRICULUM DEVELOPMENT




Abbreviations Used:

| | |
|---|---|
| NCRC. | National Curriculum Revision Committee |
| VCC. | Vice-Chancellor's Committee |
| EXP. | Experts |
| COL. | Colleges |
| UNI. | Universities |
| PREP. | Preparation |
| REC. | Recommendations |
| LI | Learning Innovation |
| R&D | Research & Development Organization |
| HEC | Higher Education Commission |

## INTRODUCTION

The final meeting of National Curriculum Revision Committee on Space Sciences was held at HEC Regional Centre, Karachi from January 30- Feb 01, 2012 to review the BS and MS Space Sciences Curriculum 2004. The following members attended the meeting:

Prof. Dr. Badar Ghauri — Convener
Head, Department of RS&GIS
Institute of Space Technology, Karachi Campus
National Centre for Remote Sensing and Geo-informatics, SUPARCO HQs. Sector 28, Gulzar-e-Hijri
Off University Road, P. O. Box 8402,
Karachi-75270.

Mr. Javed Sami — Secretary
Assistant Professor
Department of Space Sciences
University of the Punjab
Lahore-54590.

Prof. Dr. Muhammad Ayub Khan Yousufzai — Member
Department of Applied Physics
Institute of Space Science & Planetary Atmosphere
University of Karachi, Karachi.

Dr. Ghulam Jaffer — Member
Assistant Professor
Department of Electrical Engineering
Institute of Space Technology (IST)
Islamabad 44000.

Prof. Dr. Rashid Kamal Ansari — Member
Director, Mathematical Sciences
Research Centre, Federal Urdu University of Arts,
Sciences & Technology, Karachi.

Dr. Nazish Rubab — Member
Assistant Professor
Department of Material Science & Engineering
Institute of Space Technology (IST)
Islamabad 44000.

Dr. Sheikh Saeed Ahmad — Member
Assistant Professor
Department of Environmental Sciences
Fatima Jinnah Women University, The Mall,
Rawalpindi.

Dr. M. Jawed Iqbal — Member
Incharge
Institute of Space and Planetary Astrophysics
University of Karachi, Karachi.

Mr. Shahid Parvez — Member
Assistant Professor
Department of Space Sciences
University of the Punjab
Lahore-54590.

The meeting started with recitation from the Holy Quran by Dr. Muhammad Ayub Yousuf Zai. Mr. Muhammad Javed Khan, adviser (Acad.) welcomed the participants and briefed the participants on the aim and objectives of the meeting with a particular focus on revising the course outlines of BS (4-year) and MS Space Sciences to make them compatible with international standards and demands as well as ensuring the uniformity of academic standard within the country.

Dr Muhammad Ali, Professor Department of Space Science, University of Punjab who attended as Secretary during the preliminary meeting could not attend the final meeting due to his pre-occupation at Lahore. As such the committee unanimously agreed that Mr. Javed Sami, Assistant Professor Department of Space Sciences, University of Punjab should act as a secretary of the final meeting. The Adviser (Acad.) then requested the convener and secretary to conduct proceedings of all technical sessions of meeting for three days. On the request of the convener all members gave their perspective on the implementation of the BS (4-year) and MS programme in their respective universities/institutions.

The committee during its deliberation, considered the following objectives**:**

1. Finalize the curriculum in the discipline of Space Sciences and to bring it at par with international standards.
2. Incorporate latest reading & writing material against each course.
3. Bring uniformity and develop minimum baseline courses in each and every course of study.
4. Consider and incorporate the inputs given by the expatriate Pakistani in the discipline of Space Science where necessary
5. Make recommendations for promotion/development of the discipline.

After three day long deliberation the committee unanimously approved the draft final curriculum of the BS (4-year) and MS Space Sciences degree programmes. Malik Arshad Mahmood, Director Curriculum, HEC thanked the Convener, Secretary and all members of the Committee for sparing their valuable time and for their quality contribution towards preparation of the preliminary draft curriculum of the BS (4-year) and MS Space Sciences

programme. He acknowledged that their efforts will go long way in developing workable, useful and comprehensive degree programmes in Space Sciences.

The committee appreciated the contributions of Dr. Mahmood Khalid (foreign expert from Canada) for critical review of the first draft of the revised curriculum. The committee, after thorough discussions, incorporated his suggestions in the final curriculum.

The committee highly admired the efforts made by the officials of HEC Regional Centre, Karachi, and Malik Arshad Mahmood, Director Curriculum for making excellent arrangements to facilitate the forming of the committee and their accommodation at Karachi.

The meeting ended with the vote of thanks to the HEC officials for providing an ideal environment to discuss the agenda. The convener of the NCRC also thanked the members for their inputs in re-engineering the teaching/learning landscape of the country to make it more practical, competitive and effective.

# Mission Statements

Rapidly growing subjects of Space Sciences in the present era of information technology are in process of evolution from the state of infancy to the advanced levels in academic and research institutions. The significant subjects falling under the umbrella of Space Science comprise Remote Sensing, Satellite Applications, Space Physics, Astrodynamics, Atmospheric Sciences etc. Most of the courses have been retailored by enhancing scope and flexibility through introduction of specialized/ elective courses and modules. The courses recently introduced are main building blocks of Space Sciences. Emphasis has also been given to research and applications oriented areas such as Flight Dynamics and Control, Space Mission Design and Analysis, Space Data Processing and Geoinformatics, Guidance, Navigation and Control (GNC), Space Propulsion, Meteorology/ Environmental Sciences, Astronomy and Astrophysics. The Space Science uses new space-age technologies like satellite positioning, space data visualizations, analysis tools and space data interpretation to greatly advance scientific understanding of Earth and beyond. With the launch of Earth resource exploration satellites such as micro & nano satellites in Low Earth Orbit and Communication Satellites in Geostationary orbits around the Earth. The last decade has witnessed a wide spectrum of applications in diverse fields subject to the need and quality of imagery datasets acquired from the Earth orbiting satellites. The advances in computing technology and techniques have also contributed a lot in the development of more sophisticated sensors capable of observing the Earth with the help of satellite constellations.

The recommended curricula have been designed in a manner to significantly enhance our understanding of natural processes, resources, space mission analysis and data processing techniques for the betterment of mankind.

# SCHEME OF STUDIES
# BS (4-YEAR) SPACE SCIENCES

**Duration:** 4-year (8-semester)

**Eligibility Criteria**
Intermediate (12-year education) with Physics and Math or equivalent (A-level)

**Credit Hours**
Committee proposes 124-136 Credit Hours for the award of BS (Space Sciences) degree.

## Course Contents for BS

| Semester /Year | Name of Subject | Lec-CH | Lab-CH | Total CH |
|---|---|---|---|---|
| First | English-I (Grammar and Composition) | 3 | 0 | 3 |
| | Pakistan Studies | 2 | 0 | 2 |
| | Algebra | 3 | 0 | 3 |
| | Social Science-I (Geography) | 3 | 0 | 3 |
| | Computer Programing | 1 | 2 | 3 |
| | Mechanics and Thermodynamics | 2 | 1 | 3 |
| | | | | **17** |
| Second | English-II (Communication/Presentation Skills) | 3 | 0 | 3 |
| | Islamic Studies/Ethics | 2 | 0 | 2 |
| | Calculus | 3 | 0 | 3 |
| | Elective-I (Astrobiology/ Chemistry/ Environmental Sc ) | 2 | 1 | 3 |
| | Statistical Analysis | 2 | 1 | 3 |
| | Electromagnetic Theory | 3 | 0 | 3 |
| | | | | **17** |
| Third | English-III (Technical Writing) | 3 | 0 | 3 |
| | Fundamentals of Remote Sensing | 2 | 1 | 3 |
| | Geometry and Vector Analysis | 3 | 0 | 3 |
| | Atmospheric Sciences | 3 | 0 | 3 |
| | Classical Mechanics and Modern Physics | 2 | 1 | 3 |
| | Spherical Astronomy and Geodesy | 3 | 0 | 3 |
| | | | | **18** |
| Fourth | Mathematical Methods | 3 | 0 | 3 |
| | Geographical Information System (GIS) | 2 | 1 | 3 |
| | Gravitational Physics | 3 | 0 | 3 |
| | Astronomy | 2 | 1 | 3 |

| | | | | |
|---|---|---|---|---|
| | Numerical Computing | 2 | 1 | 3 |
| | | | | **15** |
| **Fifth** | Statistical and Space Plasma Physics | 3 | 0 | 3 |
| | Space Flight Dynamics-I | 3 | 0 | 3 |
| | Solar and Ionospheric Physics | 3 | 0 | 3 |
| | Computer Applications in Project Design | 1 | 2 | 3 |
| | Digital Image Processing | 2 | 1 | 3 |
| | Meteorology | 2 | 1 | 3 |
| | | | | **18** |
| **Sixth** | Quantum Mechanics | 3 | 0 | 3 |
| | Astrophysics | 3 | 0 | 3 |
| | Space Flight Dynamics-II | 3 | 0 | 3 |
| | Analog and Digital Electronics | 3 | 1 | 4 |
| | Navigation and Space Instrumentation | 2 | 1 | 3 |
| | Research Methodology | 2 | 0 | 2 |
| | | | | **18** |
| **Seventh** | Space Mission Design | 3 | 0 | 3 |
| | Semiconductor Device Fabrication | 2 | 1 | 3 |
| | ELECTIVE-I | 2 | 1 | 3 |
| | ELECTIVE-II | 2 | 1 | 3 |
| | Projects / Thesis | 0 | 3 | 3 |
| | | | | **15** |
| **Eighth** | Seminar | 0 | 3 | 3 |
| | Social Science-II (Elective-II/ Foreign Language/ Space Law) | 3 | 0 | 3 |
| | ELECTIVE-III | 3 | 0 | 3 |
| | ELECTIVE-IV | 3 | 0 | 3 |
| | Projects / Thesis | 0 | 3 | 3 |
| | | | | **15** |
| Total | | | | 133 |

# DETAIL OF COURSES
# SEMESTER-WISE

## First Semester

| | |
|---|---|
| **English-I (Grammar and Composition) [Annex-A]** | **3-0** |
| **Pakistan Studies [Annex-C]** | **2-0** |
| **Algebra** | **3-0** |

*Group Theory* : Groups, group of residue classes, cyclic group, order of a group, subgroup, coset, Lagrange's theorem, introduction to permutation, cycles, length of cycles, transpositions, symmetric group, alternating groups. Rings, fields, vector space, subspace, linear dependence and independence, bases and dimension of a vector space, kernel space, image space.

*Linear Algebra*: Linear transformation and Matrices, algebra of matrices, determinants of matrices, various kind of matrices, Matrix of a linear transformation, elementary row and column operations on matrices, rank of a matrix, inverse of matrices, solution of homogeneous and non-homogeneous equations, orthogonal transformation and orthogonal matrices, eigenvalue and eigenvector.

*Linear Programing*: Concept of mathematical modeling and formulation of linear programing (LP), graphical solution of LP and Simplex method. Transportation models and networks.

## Recommended Books:


- Anton H. (2000), *Elementary Linear Algebra*, *8 / e*, John Wiley and Sons, New York
- Fraleigh J. B. (2002), *A First Course in Abstract Algebra, Seventh Edition*, Addison and Wesley.
- Hadley G. (1973), *Linear Algebra*
- Jänich K. (1994), *Linear Algebra*, Springer-Verlag, Berlin
- Taha H. A. (2003), *Operations Research: An introduction*, 7/e, Maxwell Macmillan International, New York
- Luenberger D. G. (1973), *Introduction to Linear and Non-Linear Programing*, Addison-Wseley, Reading, Mass.
- Wisniewski M. (1991), *Introductory Mathematical Methods in Economics*, McGraw-Hill, London

## Social Science-I (Geography) 3-0

Definitions and scope of geography, climate: an introduction to atmosphere, solar and terrestrial radiation, temperature (vertical and horizontal distribution), moisture and atmospheric stability, forms of condensation and precipitation, air pressure and wind circulation, air masses, disturbances, climatic regions, natural vegetation: major types of vegetation, world pattern of natural vegetation, ocean: global oceans and seas, structure of the ocean floor, salinity and its distribution, Sea temperature, oceanic surface and subsurface currents, tides, oceanic deposits. The dynamic planet: internal structure of the earth, earthquakes, plate tectonics, major landforms.

## Recommended Books:


- Christopherson, W. R. (1997). Geosystems: An Introduction to the Physical Geography, 3rd Edition, Prentice Hall: New Jersey
- De Blij, H. J. (1995). The Earth: An Introduction to its Physical and Human Geography, 4th Edition, John Wiley & Sons: New York.
- Fellmann, J. D., Getis, A. and Getis, J. (2010). Human Geography: Landscapes of Human Activities, 8th Edition, McGraw-Hill: New York.
- Hamblin, K. W. (1985). The Earth's Dynamic Systems, 5th Edition, Macmillan Publishing Company and Collier Macmillan Publishers: New York.
- Lutgens, K. F. and Tarbuck, J. E. (1995). The Atmosphere, 6th Edition, Prentice Hall: New Jersey.
- McKnight, L. T. (1987). Physical Geography: Landscape Appreciation, 2nd Edition, Prentice-Hall: New Jersey.
- Pellant, C. and Pellant, H. (1993). Rocks and Minerals, A Dorling Kindersely Book: London.
- Pluijm, B. A. V. and Marshak, S. (2004). Earth Structure: An Introduction to Structural Geology and Scott, C. R. (1989). Physical Geography, West Publication Company: St. Paul.
- Strahler, N. Arthur and Strahler, H. Alan, (1987). Modern Physical Geography, 3rd Edition John Wiley & Sons: New York.
- Tarbuck, J. E. and Lutgens, K. F. (2008). Earth Science, 11th Edition, Prentice Hall: New Jersey.
- Tectonics, 2nd edition, W. W. Norton and Company: New York.


## Computer Programing 1-2

Introduction to operating System, Exploring print, building blocks, variables, input/output, operators, loops: for loops, while loop, do while loop, decisions, if statement, if else statement, else if construct switch statement, conditional statement, function, function that return a value using argument to pass data to a function, external variable, arrays and strings, pointers, structure, files and Introduction to $C^{++}$ concepts, introduction to database management system.

## Recommended Books:

- Lafore R. (1990), C Programming Using Turbo C., Howard and W. Sams
- Microsoft Disk Operating System Manual
- Shildt H., Turbo C/C++
- Bloom E. P., Turbo C++
- Hein J. L. (1996), Theory of Computation: An Introduction

## Mechanics and Thermodynamics 2-1

### *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 energy of rotation; Moment of inertia. Parallel axis theorem, perpendicular axis. Determination of moment of inertia of various shapes. Angular Momentum**:** Angular Velocity.

### *Thermodynamics*

Review of previous concepts. First law of Thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reveriable and irreversible processes. Second law of thermodynamics, Carnot Theorem, Carnot engines. Heat engine. Thermodynamic temperature scale. Entropy in reversible process. Entropy in irreversible process. Thermodynamic functions. Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions). Maxwell relations, Tds equations, energy equations and their applications. Low Temperature Physics. Thermoelectricity, Thermocouple, Seabeck's effect, Thomson effect.

## Recommended Books:

- Resnick H. and Krane P., (2002), 5$^{th}$ Edition "Physics" Vol. I, John Wiley & Sons, New York.
- Sears, Zemansky and Young, (2000), 8$^{th}$ Ed., "University Physics", Aiddison-Wesley, Reading 8$^{th}$ Edition, USA.
- Alonso and Finn, (1999), "Physics", Addison-Wesley, Reading, USA.

# SECOND SEMESTER

## English-II (Communication/Presentation Skills) 3-0
## [Annex-A]

## Islamic Studies/Ethics 2-0
## [Annex-B]

## Calculus 3-0

A review of real number system and complex numbers (De Moivre's theorem), upper and lower bound of sequence, Limit of a sequence, functions and their graphical representation, logarithmic, exponential and hyperbolic functions, limit and continuity of a function, derivative of a function and its applications, optimization problems, mean value theorem, Taylor series of a function, indeterminate forms, Integration of a function, fundamental theorem of calculus, definite integral and its application, technique of integration: reduction formulae, beta and gamma functions, vector valued, improper integrals. Function of several variables, partial derivatives, chain rule, Euler's theorem and implicit functions, Maxima and minima of two variables functions, relative extrema, Lagrange multipliers, double and multiple integrals, volume and area of surface revolution.

## Recommended Books:


- Anton H. (1999), *Calculus: A New Horizon*, *6 / e*, John Wiley and Sons, New York.
- Thomas Jr., G. B. and Finney R. L. (2002), *Calculus*, *10 / e*, Addison Wesley, Reading, Massachusetts.
- Swokoski E. H. (Latest edition) *Calculus and Analytical Geometry*, Prentice Hall Inc.
- Kosmala W. (1999), *Advanced Calculus: A Friendly Approach*, Prentice Hall Inc.


## Elective-I (Astrobiology/Chemistry/Environmental Sc.) 2-1

## Statistical Analysis 2-1

Statistical measure, statistical description and graphical representation of data set, introduction to probability theory, permutation and combinations, random variables, probability distributions, mean, standard deviation, variance, expectation, Expectation Binomial, Poisson, hyper-geometric and normal distributions, conditional and joint distribution. Sampling analysis, inferential statistics for one and two population mean, hypothesis testing for one sample and two samples, Chi-square distribution, test of normality: Chi-square test and Kolmogrov test, test of randomization, test of homogeneity. Regression analysis, correlation analysis, inferential method in regression and correlation, analysis of variance.

**Labs:**
Data analysis using statistical packages (i.e. MINITAB, SPSS, SAS, R, ITSM, STATISTICA etc).

## Recommended Books:


- Ross S., (*Latest Ed.*), "Introduction to Probability Models", Academic, New York.
- Cowan G. (1998), "Statistical Data Analysis", Clarendon, Oxford.
- Stark H. and Woods J. W., (1986), "Probability, Random Processes and Estimation", Prentice-Hall, Englewood Cliffs, New Jersey.
- Stirzaker D. (1994), "Elementary Probability", University Press, Cambridge.
- Krzanowski W. J. (1998), "Statistical Data Analysis", Arnold, London.
- Larson H. J. and Shubert B. O. (1979), "Probabilistic Models in Engineering Sciences" Wiley & Sons, New York.
- Thomas J. B. (*Latest Ed.*), "An Introduction to Applied Probability and Random Processes", Wiley, New York.


## Electromagnetic Theory 3-0

Electrostatics, Dielectric Materials, Electric Polarization, Charge and Current Density, Electric Potential, Magnetic Induction, Vector Potential and its Applications, Gauss's Law, Ampere's Law and Faraday's Law of Magnetic Induction, Four–Dimensional Operator, The Conservation of Electric Charge, Maxwell's Equations, Characteristics of Electromagnetic Waves, Covariant form of Maxwell's Equations, Wave Equations in terms of Electromagnetic Potential and their Solutions, Plane Electromagnetic Waves in Free Space and their Solutions, Propagation of Electromagnetic Waves in Conducting and Non-Conducting Media, Modes of Propagation, Poynting Theorem, Plane Wave Between Two Parallel Conducting Plates, TE-Mode, TM-Mode, TEM-Mode, Laser Light, Light in Cavities, Einstein Theory of Light-Matter Interaction, Laser Applications.

## Recommended Books:


- Fawwaz.T. Ulaby, (2010), Fundamentals of Applied Electromagnetics, Prentice Hall,
- John. Reitz, Fredeick J. Milford (1990), Foundations of Electromagnetic Theory, Narosa Publishing House, New Delhi, 6th Reprint.
- Edward. E. Jorden and Keith Balmaiv, (1991), Electromagnetic Waves and Radiating System by Prentice Hall of India, 2nd Edition.
- Paul Lorrain and Dal Carson, (1986) Electromagnetic Fields and Waves by. CBS Publishers and Distributors, Delhi.

# THIRD SEMESTER

## English-III (Technical Writing) 3-0

**[Annex-A]**

## Fundamentals of Remote Sensing 2-1

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 (Spectral, Spatial, Temporal and Radiometric), Colours and Human Vision, Colour Models, Types of Photographic Films, Sensors and their types, optical, microwave, hyper spectral and ultraspectral sensors, imaging systems (RBV, MSS, TM, HRV, HRPT/APT/AVHRR, ETM, HRV, QuickBird, GeoEye, EO-1 etc.) non-imaging systems (Radarsat, SAR, SIR,etc.), satellites: types and functions, unmanned satellites (generations, meteorological satellites, earth resources satellites, telecommunication satellites, spy satellites, scientific satellites) manned satellites, space shuttles, platforms, ground receiving stations and reception of data, Data Acquisition (Ground Receiving Stations), Image Processing (Continuous and Discrete), Image Interpretation and Analysis

### Labs:

Introduction to labs, single band image interpretation, false color predictions, false color composite images interpretation, visual interpretation of aerial photographs, various sensors data comparison, thermal infrared image interpretation, introduction to image processing software (e.g. ERDAS IMAGINE), display, geo-linking, zooming, identification of targets, field trip.

## Recommended Books:


- Campbell and James, B. (2006). Introduction to Remote Sensing, 3rd Edition, The Guilford Press: New York.
- Floyd F. Sabins Jr., (1996), "Remote Sensing, Principles and Interpretation", W. H. Freeman Electronic Publishing Centre, San Francisco.
- Gibson Paul J. (2000), "Introductory Remote Sensing: Principles and Concepts", Routledge, USA.
- Gibson, P. J. (2000). Introductory Remote Sensing: Principles and Concepts, Routledge: London.
- Jensen, J. (2006). Remote Sensing of the Environment: An Earth Resources Perspective, Prentice Hall: London.
- Lillesand and Kiefer, (1987), 2nd Ed., "Remote Sensing and Image Interpretation", John Wiley, USA.
- Lillesand, K. and R. W. (2004). Remote Sensing and Image Interpretation, 5th Edition, John Wiley & Sons

- Mather, P. M. (2004). Computer Processing of Remotely Sensed Images, 3rd Edition, John Wiley & Sons: New York.
- Patel, Surindra S., (1992), 2nd Ed., "Principles of Remote Sensing", World Scientific, Singapore.
- Paul J. Curran, (1985), "Principles of Remote Sensing", Longman Inc., New York.
- Rees W. G., (2001), 2nd Ed., "Physical Principles of Remote Sensing", Cambridge University Press.
- Sabins, F. F. (2004). Remote Sensing: Principles and Interpretation, 3rd Edition, W. H. Freeman and Co:
- Thomas, D. Rabenhorst and Paul D. McDermott, (1989), "Introduction to Remote Sensing", Merrill Publishing Co.


## Geometry and Vector Analysis 3-0

*Vector Analysis*: Three dimensional vectors, coordinate systems and their bases, scalar and vector triple products, differentiation and integration of vectors, scalar and vector point functions, concepts of gradient, divergence and curl operator along with their applications.

*Geometry*: Two dimensional analytical geometry; Tangent Lines and Arc Length for Parametric and Polar Curves, Area in Polar Coordinate, general equation of the second degree and classification of conic section, conic section in polar coordinates. Three-dimensional geometry; rectangular coordinate system, parametric equations of lines, planes in 3-space. Curve Theory, change of parameter, Unit tangent, Normal and Binomial Vectors, curvature and Torsion. Motion along a curve. spherical and cylindrical coordinate systems, standard form of the equation of a sphere, cylinder, cone ellipsoid, paraboloid and hyperboloid, symmetry, intercepts and sections of a surface, tangent plane and normals.

## Recommended Books:


- Coulson A. E. (Latest edition), *An Introduction to Vectors*, Longman Green & Co.
- Smith G. D. (Latest edition), *Vector Analysis*, Oxford University Press.
- Anton H. (Latest edition)), *Calculus: A New Horizon*, *6 / e*, John Wiley and Sons, New York.
- Thomas Jr., G. B. and Finney R. L. (2002), *Calculus*, *10 / e*, Addison Wesley, Reading. Massachusetts.
- Swokoski E. H. (Latest edition) *Calculus and Analytical Geometry*, Prentice Hall Inc.
- Lang S. (2010), Undergraduate Algebra (Paperback), Springer.
- Lang S. (2010), Linear Algebra (Paperback), Springer.
- Robert Vanderbei (2007) Linear Programming: Foundations and Extensions, Springer.

## Atmospheric Sciences 3-0

Components of Earth System, Hydrologic Cycle, Carbon Cycle, Oxygen in the Earth System. Atmospheric Thermodynamics; Gas Laws, Hydrostatic Equation, First Law of Thermodynamics, Adiabatic Process, Water Vapor in Air, Static Stability, Second Law of Thermodynamics and Entropy. Radiative Transfer; Spectrum of Radiation, Quantitative Description of Radiation, Blackbody Radiation, Physics of Scattering and Absorption, Radiative Transfer in Planetary Atmospheres. Atmospheric Chemistry; Composition of Troposphere Air, Sources, Transport and Sink of Trace Gases, Tropospheric Trace Gases, Tropospheric Aerosol, Air Pollution, Tropospheric Chemical Cycles and Stratospheric Chemistry. Cloud Microphysics; Nucleation of Water Vapor Condensation, Microstructure of Warm Cloud, Growth of Cloud Droplets in Warm Clouds, Microphysics of Cold Clouds

## Books Recommended:

- Wallace J. and P. Hobbs, (2006), Atmospheric Sciences: An Introductory Survey, Elsevier
- Frederick J. E. (2008), Principles of Atmospheric Sciences, Jones and Bartlett Publisher
- Holton J. R. (2004), An Introduction to Dynamics Meteorology, Elsevier
- John H. Seinfeld and Spyros N. Pandis, (2006), Atmospheric Chemistry and Physics from Air Pollution to Climate Change, John Wiley.

## Classical Mechanics and Modern Physics 2-1

### 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.

### *Modern Physics:*

Bohr's theory (review) Fank. 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.

## Recommended Books:

- Fawwaz. J. Ulaby, (1997), "Fundamentals of Applied Electromagnetic", Prentice Hall, USA.
- H. Goldstein, P. Charles, (*Latest Ed.*), "Classical Mechanics"
- T. Chow, (1995), "Classical Mechanics"

- Resnick H. and Krane P., (2002), 5th Edition "Physics" Vol. I, John Wiley & Sons, New York.
- Sears, Zemansky and Young, (2000), 8th Ed., "University Physics",
- Addison-Wesley, Reading 8th Edition, USA.
- Alonso and Finn, (1999), "Physics", Addison-Wesley, Reading, USA.
- Resnick, Halliday and Crane, (*Latest Ed*), "Fundamental of Physics",
- H. Young, R. Freedman and A. Ford, (2011), "University Physics with Modern Physics with Mastering Physics".


## Spherical Astronomy and Geodesy 3-0

### 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.

### Geodesy

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, leveling, traversing and topographic surveying. Principles of global positioning system (GPS) and its applications.

## Books Recommended:


- Ball R. S. (2011), A treatise on Spherical Astronomy, Nabu Press.
- Greene D. (2010), An introduction to Spherical and Practical Astronomy, Nabu Press.
- Anderson J. M. and Mikhail E. M. (1998), Surveying Theory and Practice, Seventh Edition, MCB/McGraw-Hill.
- Wolf P. R. and Ghilani C. D. (2005), Elementary Surveying-An Introduction to Geomatics, Eleventh Edition, Prentice Hall.
- Kavanagh B. F. (2006), Surveying: Principles and Applications, Seventh Edition, Prentice Hall.
- Taff L. G. (1991), Computational Spherical Astronomy, Krieger Publication Co.
- Chauvenet W. (2007), A Manual of Spherical And Practical Astronomy V2: Theory and Use of Astronomical Instruments, Kessinger Publishing, LLC.
- Brunnow F. (2011), Spherical Astronomy (Classic Reprint), Forgotten Books.
- Main R. (2010), Practical and Spherical Astronomy, Nabu Press.
- Green R. M. (1985), Spherical Astronomy, Cambridge University Press.
- Woolard E. W. and Clemence G. M. (1966) Spherical Astronomy, Academic, Boston

- Smart W. M. and Green (1990) Textbook on Spherical Astronomy, 6/e, Cambridge University Press, Cambridge.
- Anderson, J. M., Mikhail E. M., (1998), Surveying Theory and Practice, 7th Ed., MCB/McGraw Hill.
- Paul R. Wolf and Charles D. Ghilani, (2005). Elementary Surveying-An Introduction to Geomatics, 11/e, Prentice Hall
- Barry F. Kavanagh, (2006). Surveying: Principles and Applications, 7/e, Prentice Hall.


# FOURTH SEMESTER

## Mathematical Methods 3-0

*Infinite Series*: Sequences of numbers and their convergence, algebra of convergent sequences, infinite series and their convergence, convergence tests for infinite series.

*Fourier series*: Periodic and piecewise continuous functions, Fourier series, Fourier sine and cosine series, Fourier integrals and Laplace transform.
*Differential Equations*: Introduction to differential equations, modeling and solution of first order differential equations, Bernoulli, Riccati and Clairaut equations, Application of first order differential equations and higher order differential equations with constant coefficients and their methods of solutions, Cauchy Euler equations, System of second order linear equations, method of indeterminate coefficient, method of variation of parameter, Second order differential equations with variable coefficient, series solution.

## Recommended Books:


- Anton H. (Latest Edition), *Calculus: A New Horizon*, *6 / e*, John Wiley and Sons, New York.
- Thomas Jr., G. B. and Finney R L (2002), *Calculus*, *10 / e*, Addison Wesley, Reading. Massachusetts.
- Zill D. G., Cullen M. R. (Latest Edition), *Differential Equations with boundary value problems*, PWS Publishing Company.
- Williamson R. E.(1997), *Introduction to Differential Equations and Dynamical Systems*, McGraw-Hill, New York.
- Goldberg J. and Potter M. C. (1998), *Differential Equations*: *A System Approach*, Prentice Hall.


## Geographical Information System 2-1

Introduction and overview of GIS: introduction, definitions, components, functional sub-science. Evolution and application of GIS, data models (raster data model, vector data model, attribute data model), data acquisition techniques (data sources, map and data sources in Pakistan, data capturing

techniques and procedures), data transformation, visualization of spatial data (layers and projections), map design: (symbols to portray points, lines and volumes, graphic variables, visual hierarchy), data classification graphic approach, mathematical approach spatial relationships (topology), spatial analysis: overlay analysis, spatial analysis, neighborhood functions, network and overlay analysis, buffering, spatial data quality: components of data quality, micro level, components, macro level components, usage components, sources of error, and accuracy. 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 (GPS), Future of GIS, GIS in Pakistan (Data Sources and Applications)

**Labs:**

The lab, exercises based on hands-on desktop GIS state-of-art software (e.g. MapInfo and ArcGIS) will provide extensive training in data collection, database development and image processing for any real world example, following are the activities involved: introduction to GIS lab. (hardware/software), introduction to GIS software, raster/vector/attribute data display, scanning, digitization, co-ordinate based point mapping, raster/vector conversion, data layer integration and display of different projections, map layout, data classification and thematic mapping, handling with topological errors, overlay analysis, network analysis.

## Recommended Books:


- Arctur, D. K. (2004). Designing Geodatabases: Case Studies in GIS Data Modeling, ESRI Press: California.
- Aronoff, S. (2009). Geographic Information Sciences: A Management Perspective (6th Edition), WDL Publications: Ottawa. Canada.
- Chang, K. T. (2010), Introduction to GIS, 2nd Edition, McGraw-Hill and Tata: New Delhi
- Clarke, K. (2004). Getting started with Geographic Information Science (second edition), Prentice Hall: New Jersey.
- Heywood, I. Cornelius, S. and Carver. S. (2003). An introduction to Geographic Information Science, Second Edition, Addison Wesley: Lognman, New York.
- Jankowski, P. and Nyerges, T. (2001). Geographic Information Sciences for Group Decision Making, Taylor and Francies.
- Jensen J R, (1998), 3rd Ed., “Manual of Remote Sensing, Principles and Applications of Imaging Radar”, Wiley, USA.
- Langley, P. A., Goodchild, M. F and Rhind, D. W. (2005). Geographic Information Science: Principles and Applications, 2nd Edition, ESRI Press: California.
- Lillesand and Kiefer, (2000), “Remote Sensing and Image Interpretation”, Wiley, New York.
- Longley P. A. (2003). Advanced Spatial Analysis, ESRI Press: California.
- Michael N. and DeMers, G, (2001), “GIS Modeling in Raster”, Wiley, USA.

- Paul A., Longley, Michael F., Goodchild, David J., David W, (2002), "Geographic Information Systems and Science", Wiley, USA.
- Philippe Rigaux, Michel O., Scholl, Agnes V., Morgan K, (2001), 1st Ed., "Spatial Databases: with Application to GIS", Wiley, USA.
- Rafael C., Gonzalez, Richard E. W., (2001), 2nd Ed., "Digital Image Processing", Addison-Wesley, USA.


## Gravitational Physics 3-0

Galilean Transformations, Lorentz Transformations, Consequences of Lorentz Transformations, Transformation Law for Velocity and Acceleration, Minkowski Space, Four-Vectors, Intervals and Light Cone, Proper Time, Position 4-Vector, 4-Velocity and 4- Momentum, 4-Force and Equation of Motion, Motion under a Constant Force, Time Dilation, Length Contraction, Mass Variation, Einstein's Mass-Energy Relationship and its Practical Examples, Motion of a Charged Particle in Transverse Electric and Magnetic Fields, Particles of Zero Rest Mass, Compton Effect, Pair Production, Matter Annihilation , Emission of a Photon from an Excited Nucleus, Variable Proper Mass, Relativistic Optics, Doppler Effect, Aberration of Light, Transformations of Electromagnetic field, Non-inertial Frames Consequences, Tachyons, Manifolds and Coordinates, Parallel Transport, Tensors, Covariant Derivatives of a Vector and Tensor, Geodesic Equations, Affine Parameters, Bianchi Identity, Equivalence Principle, Riemann Tensor, Ricci Tensor, Energy-Momentum Tensor, Einstein Field Equations, Schwarz Shield Solution of Einstein Field Equations, Advance of Perihelion, Deflection of light ray, Gravitational Waves,

## Recommended Books:


- W. H. Freeman, New York, (1992). Space Time Physics: Introduction to Special Relativity, 2nd Ed., Taylor and Wheeler
- Woodhouse, (1992), Special relativity, Springer-Verlag, Berlin
- M. Saleem and M. Rafique, (1992), Special Relativity, Ellis Horwood, London, Redwood Press Melksham
- Synge, (1965), Relativity: the special theory, 2nd Ed., North-Holland, Amsterdam.
- Rindler, (1982) Introduction to special relativity, Clarendon Press, Oxford
- Resnick, (1968) Introduction to special relativity, Wiley, New York
- C. W. Misner, K. S. Thorn and J. A. Willer, (1973), "Gravitation"
- Stephani H. (1982), General Relativity and Introduction to Gravitation Fields, Cambridge Press.

## Astronomy 2-1

Solar system, Planets and minor objects, planetary data, Nature of radiations from cosmos, Interaction of light with matter, Blackbody Radiations, Telescopes and their types, Telescopes function, Data gathering and handling, H-R diagrams, Dwarf Stars, Red Giant Stars, Supergiant Stars, Brown Dwarf, Nebulae, Formations of Stars in Nebula, Protostars, Stellar structure and evolution, pre-main-sequence and main-sequence stars, Sources of stellar energy, The Sun and solar neutrino puzzle, Stellar magnitudes, Colours and temperatures, Binary stars, Visual, spectroscopic and eclipsing binaries, Variable stars, Novae, Supernovae, Compact stars, White dwarfs and neutron stars, Pulsars, quasars, galaxies and their types, Active galaxies.

## Recommended Books:


- Seeds M. (2010), “Foundation of Astronomy”.
- Allen C. W. (2001), “Astrophysical Quantities”, Athlone London.
- Backman, D. (2010), “The Solar System”,
- Kuiper G. P. and Middlehurst B. M. (Ed.), (1974), “Stars and Stellar Systems”.
- Vols. 1-9, Chicago University Press, USA.
- Abell G. O. (1975), 3rd Ed., “Exploration of the Universe”, Holt, Rinehart and Winston, New York.
- Barbieri B. (2007), Fundamentals of Astronomy, Taylor and Francis, New York.


## Numerical Computing 2-1

Error analysis, Round-Off Error; Absolute, Relative and Percentage Error; Significant Digits; Propagated Error; Error in Original Data, etc. Truncation Errors. Solution of Nonlinear Equations, Approximation of Functions, Bisection Method, Linear Interpolation, Newton's Method, Quasi-Linearisation. Solving System of Linear Equations, Gaussian Elimination, Crout's Decomposition Scheme, QD-Algorithm, Efficient Computation and Use of Determinants; Matrix Inversion; Iterative Methods. System of Nonlinear Equations.

Interpolation: Interpolating Polynomials; Extrapolation; Divided Differences and Finite Differences of Various Orders, Difference Tables, Forward, Backward and Central Differences. Symbolic Derivatives. Interpolation with Unequal Intervals. Inverse Interpolation. Curve Fitting by Various Methods: Splines, Cubic Spline Curves; Least Squares Approximation. Numerical Differentiation, Higher Order Numerical Derivatives. Numerical Integration, Simpson’s Rule. Numerical Solution of Ordinary Differential Equations: Initial Value Problem; Solving Ordinary Differential Equations, Various Order Runge-Kutta Methods. Boundary Value Problems.

**Lab:**
Solving and implementing Numerical Algorithms using Matlab.

## Recommended Books:


- Bowers R. L., (1991), *Numerical Modeling in Applied Physics and Astrophysics*
- Burden R. L. and Faires J. D., (Latest Edition) *Numerical Analysis*, *5 / e*, PWS, Boston.
- Gerald C. F. and Wheatley Patrick O. (Latest Edition), *Applied Numerical Analysis,* Addison-Wesley, Reading, Mass.
- Atkinson K. E. (1989), *An Introduction to Numerical Analysis*, John Wiley & Sons, New York.
- Palm, (2004) Introduction to MATLAB 7 for Engineers
- Martin H. Trauth, (2007) MATLAB Recipes for Earth Sciences.


# FIFTH SEMESTER

## Statistical and Space Plasma Physics 3-0

### Statistical Physics

Statistical probability, canonical and micro canonical ensemble, partition function, Entropy, equipartition theorem, free energy, 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, Qualitative description. Diffusion, Conduction and Viscosity. Liouville's equation.

### Space Plasma Physics

Introduction to Plasmas, Single-Particle Motions, Plasmas as Fluids, Elementary Plasma Waves, Diffusion and Resistivity, Dusty Plasmas.

## Books Recommended:


- F. F. Chen, (1984) Introduction to Plasma Physics and controlled fusion by Vol. 1. Springer; 2nd Ed. Corr. 2nd printing edition
- Robert J. Goldston and Paul H. Rutherford, (1995) Introduction to Plasma Physics, IOP Plublishing Ltd.
- J. A. Bittencourt, (2004) Fundamentals of Plasma Physics, 3rd Ed. Springer-Verlag NewYork, Inc.
- P. K. Shukla and A. A. Mamun, (2000) Introduction to Dusty Plasma Physics
- F. Reif, (2008), Statistical Physics
- Sears K, Zemansky B and Young C, (2000), 5th Ed., "College Physics", Wiley, New York.
- Giancoli E., Serway , (1998), "Physics", Oxford University Press, UK.

- Corson D. R. and Loran. P., (1989), “Introduction to Electromagnetic Field and Waves,”Toppan Co. Tokyo.
- Rafique A, (2000), “Mechanics”, National Book Foundation, Lahore.


## Space Flight Dynamics-I 3-0

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, Space Debris, Rocket Propulsion; Rocket Equation and Staging, Optimal Rocket. Planetary Atmosphere; Hydrostatic Equilibrium. Element of Aerodynamics; Aerodynamics Force and Moment, Fluid dynamics, Flow regime, Continuum Flow, Continuum Viscous Flow and Boundary Layer, Rarefied Flow. Airbreathing Propulsion; Ideal Momentum Theory, Propeller Engine, Jet Engine.

## Books Recommended:


- Tewari A (2007), Atmospheric and Space Flight Dynamics.
- Etkin C M (1995), Dynamics of Flight: Stability and Control.
- Schmidt L. V. (1998), Introduction to Aircraft Flight Dynamics, AIAA Education Series.
- Francis J, Hale (1994) Introduction to Spaceflight


## Solar and Ionospheric Physics 3-0

### 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.

### Ionospheric Physics

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.

## Books Recommended:

- Silvano Fineschiand Rodney A. Viereck, (2007), Solar Physics and Space Weather Instrumentation, Society of Photo Optical.
- McDougal Littell Science Lab Manual-Earth's Atmosphere, McDougall Littell, (2005).
- Brent Zaprowski, (2005), Earth and Beyond: An Introduction to Earth-Space Science Laboratory Manual, Third Edition, Kendall/Hunt Publishing Company.
- Severny, (2004), Solar Physics, University Press of the Pacific.
- Robert W. Schunkand Andrew F. Nagy, (2004), Ionospheres: Physics, Plasma Physics, and Chemistry, Cambridge University Press.
- Peter F. and John S. (2003), Spacecraft Systems Engineering, John Willey New York.
- Margaret G. Kivelson (Ed.), Christopher T. Russell (Ed.), (Latest Edition), Introduction to Space Physics

## Computer Applications in Project Design **1-2**

Usage of computer software for data analysis, processing and simulation tools such as MATLAB, Simulink, Mathematica, Statistica, Satellite Tool Kit etc.

## Books Recommended:

- Palm, (2004) Introduction to MATLAB 7 for Engineers
- Martin H. Trauth, (2007) MATLAB Recipes for Earth Sciences.
- Bruce F. Torrence and Eve A. Torrence, (Feb 2, 2009), The Student's Introduction to MATHEMATICA ®: A Handbook for Pre-calculus, Calculus, and Linear Algebra.

## Digital Image Processing **(DIP)** **2+1**

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 Re-sampling, 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 & Landcover, Agriculture/Forestry, Geological Phenomenon, Wetlands, Coastal Mapping, Defence Applications, Sea Surface Temperature, and Urban Planning, Hydrology and Water Resources etc.

**Labs:**

- Image Import and Export
- Band Combination
- Compute uni-variate and multivariate statistics of the given data
- Image Enhancement
- Image Filtering
- Band ratios
- Rectification
- Grey level transformation
- Spatial enhancement
- Supervised
- Un-Supervised Classification
- DEM/DTM generation
- Thematic map designing

## Books Recommended:


- Thomas D.Rabenhorst and Paul D.McDermott, (1989), Introduction to Remote Sensing, Merrill Publishing Co,
- Lillesand/Kiefer, (1987), Remote Sensing and Image Interpretation, John Wiley & Sons, 2nd Edition.
- Floyd F. Sabins, (1996), Remote Sensing, Principles and Interpretation, W.H. Freeman Electronic Publishing Centre
- Paul J. Curran, (1985) Principles of Remote Sensing, Longman Inc,
- Gibson Paul. J, (2000), Introductory Remote Sensing: Principles and Concepts
- Surindra Singh, (1992), Principles of Remote Sensing by Patel, Scientific Publishers, 2nd Edition.
- Rees W.G, (2001), Physical Principles of Remote Sensing, Cambridge University Press, 2nd Edition.


## Meteorology **2-1**

Atmosphere: origin, composition and structure. Radiation; electromagnetic radiation, radiation law, solar radiation and atmosphere, ozone shield, greenhouse effect. Heat and Temperature; temperature scale, heat units, transfer of heat, specific heat, windchild. Heat Imbalance, Air Pressure; pressure balance, horizontal variation, highs and lows, gas law. Humidity and Stability, Dew, frost, Fog and Clouds, Wind, Planetary Scale circulation, Air masses, Front, Cyclone and Anticyclone

## Books Recommended:


- Lutgens and Tarbuck (2009), **The Atmosphere: An Introduction to Meteorolog***y, 9/E;* Pearson Education.
- Moran J M and M D Morgan (1994), Meteorology, 4/e, Macmillan

# SIXTH SEMESTER

## Quantum Mechanics 3-0

Origin of Quantum theory, Foundation of wave mechanics, Heisenberg Uncertainty principle, Waves and particles, and wave function, Probability density and probability current density, Orthogonal and Orthonormal Wave functions, Operator Algebra, Schrödinger. Wave equation, Wave function of a free particle. Time dependent and Time independent Schrödinger Wave equation, Applications of Schrödinger Wave equation, Potential wells, potential barrier, and tunneling of particles, Harmonic Oscillator and rigid rotators, Hydrogen Atom, Angular Momentum and Spin of particles, Pauli Exclusion Principle, Wave functions of fermions and bosons, time independent and dependent perturbation theory.

## Books Recommended:


- Levi A. F. J (2003), "Applied Quantum Mechanics", Cambridge University Press, UK
- Randy H (2000), "Non-classical Physics", Addison Wesley, New York
- Sinha S. P. (2001), "Quantum Mechanics" Tata McGraw Hills, New Delhi.


## Astrophysics 3-0

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, Glaxies and expanding Universe, 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, Evolution of Our Galaxy, Classification of Galaxies, Cluster of Galaxies, Dark Matter, Dark Energy, Big Bang Theory, accelerating Universe, fate of the Universe.

## Books Recommended:


- Zeilik M. and Stephen A. Gregory, (1997), Introductory Astronomy and Astrophysics, Sauders.
- Zeilik M, (2002), Astronomy: The Evolving Universe.
- M. Peterson, B. Ryden, (2009), Foundations of Astrophysics.

## Space Flight Dynamics-II 3-0

Euler Angle, Euler Symmetric Parameters, Gibbs Vector, Euler Equation of Rotational Motion, Rotational Kinematic Energy, Principal Body Frame, Torque-Free Rotation of Spacecraft, Spacecraft with Attitude Thrusters, Spacecraft with Rotors. Attitude Control System; Linear System, Basic Colsed-Loop System, Gyroscope Sensors. Six Degree Freedom of Simulation; Wing-Rock Motion of a Fighter Airplane, Trajectories and Attitude of a Ballistic Entry Vehicle. Structure dynamics

## Books Recommended:

- Birhauser Tewari A (2007), Atmospheric and Space Flight Dynamics
- Etkin C. M. (1995), Dynamics of Flight: Stability and Control
- Schmidt L. V. (1998), Introduction to Aircraft Flight Dynamics, AIAA Education Series
- William E. Wiesel (2010), Spaceflight Dynamics
- Martin J. L. Turner (2009), Rocket and Spacecraft Propulsion: Principles, Practice and New Developments.

## Analog and Digital Electronics 3-1

## Analog Electronics

P-N Junction, Diode, Amplifiers, h and y parameters, Oscillators, Op-Amp based filters, FET, MOSFET, IGFET, Transistor, Classification of amplifiers

## Digital Electronics

Different number systems and their inter-conversions, different codes. Basic Logic Gates, Bollean algebra, Truth Tables, Karnaugh Map Minimization, Combinational Logic devices. Combinational Logic Devices: Adder, Subtractor, Decoders, Encoders and Multiplexers-Demultiplexers, Flip Flops, Sequential logic circuits (Registers Counters, A to D and D to A converters), Programmable Logic Devices.

## Recommended Books:

- Thomas L. Floyd, (1997), “Digital Fundamentals” Collier Macmillan, Canada.
- Tocci, (2001), “Digital Electronics”, McGraw-Hill, USA
- Tokheim L R, (1985), “Digital Electronics”, McGraw-Hill, USA
- James B and Robert D, (1985), “Digital Fundamentals”, Delwar Pub. Inc.
- Malvino, (2001), Digital Fundamentals
- Grob, (1998) Basic Electronics
- Floyd, (2001) Fundamentals of Analog Circuits
- Lloyd R. Fortney, (2005), Principles of Electronics: Analog and Digital
- M. Slurberg Osterheld, (1973) Essentials of Communication Electronics.

## Navigation and Space Instrumentation 2-1

Space navigation including inertial and celestial navigation. INS, Gyroscope, accelerometers, GPS, Worldwide Navigational Systems. 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. Process of measurement standards and dimensional units of measurement, sensors, counters, displacement and dimensional measurements, and stress & strain measurement analysis, fluid flow measurement, temperature measurement and motion measurement. Experimental portion includes use of measuring instruments like autocollimator, screw pitch measuring machine, tolerator, horizontal metro scope, interference microscope, interferometer, surface roundness testing machine and Mechanical & Electronic comparators, application of Kalman filtering to recursive navigation theory.

## Recommended Books:

- Anne Tyler, (1996), Celestial Navigation, Ballantine Books.
- Bernhard Hofmann-Wellenhof, Herbert Lichtenegger & Elmar Wasle, (2007), GNSS - Global Navigation Satellite Systems: GPS, GLONASS, Galileo and more, Springer.
- Paul D. Groves, (2007), Principles of GNSS, Inertial, and Multi-Sensor Integrated Navigation Systems, Artech House.
- Amir Abbas Emadzadeh & Jason Lee Speyer, (2011), Navigation in Space by X-ray Pulsars, Springer.
- Michael J. Rycroft, (2003), Satellite Navigation Systems: Policy, Commercial and Technical Interaction, Springer.
- Eduardo Bezerra, (2010), Reconfigurable Systems in Space Instrumentation: Moving from Microprocessors to FPGAs, LAP Lambert Academic Publishing.
- James W. Dally, William F. Riley and Kenneth G. McConnell, (1988), Instrumentation for Engineering Measurements, John Wiley and Sons Ltd.
- Tyler, (1996), Celestial Navigation
- B. Hofmann-Wellenhof and H. Lichtenegger (2007), GNSS
- P. Groves, (2008), Principles of GNSS, Inertial and Multi-sensor integrated navigation systems
- Shmuel Merhav, (Latest Edition), Aerospace Sensor Systems and Applications.

## Research Methodology 2-0

Introduction to Research, Types of Research, Research Problem, Review of Related Literature, Research Hypothesis or Questions, Sampling, Research Instruments, Research Types (Detail Description), Collection and Analysis of Data, Statistics in Science, Writing Research Proposals and Reports, Evaluation Criteria.

## Recommended Books:


- Manian L and Cohen S., (1994), “Research methods in education”, Oxford University Press, UK.
- Anderson K, (1990), “Fundamentals of educational research”, Wiley, New York.
- Best, J. W. and James, (1996), “Research in education”, Narosa Pub. Delhi.
- Fraenkel, J. P. and Norman, (1993), “How to design and evaluate research in education”, Engle Wood, UK.
- Keeves J P, (1988), “Educational research, methodology, and measurement”, Tata McGraw-Hill, New Delhi.
- Wiersma W, (1995), “Research methods in education”, Addison Wesley.
- Scott D. and Usher R., (1996), “Understanding educational research”, Wiley, USA.
- Lumley J. S. P., (1994), “Research: some ground rules”, Oxford University Press.


# SEVENTH SEMESTER

## Space Mission Design 3-0

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 systems 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 tradeoffs, payload design, bus sizing, subsystem definition, system manufacturing, verification and operations.

## Recommended Books:


- W. Larson and J. Wertz, (1999), Space Mission Analysis and Design
- J. J. Pocha (1987), An introduction to mission design for geostationary satellites
- M. Griffin, R. French (2004), Space Vehicle Design
- Dennis Roddy, (2006), Satellite Communications, Fourth Edition (Professional Engineering)
- Rudolph X. Meyer, (1999), Elements of Space Technology
- Charles D. Brown, (2003), Elements of Spacecraft Design (AIAA Education).


## Semiconductor Device Fabrication 2-1

Fabrication Techniques, Formation of Thin Films, Binary, tertiary, ternary compounds, Simple evaporation techniques, Chemical vapor, Molecular Beam Epitaxy (MBE), Molecular Orbital Chemical, Vapor Deposition (MOCVD).

## Recommended Books:

- M. Sze and Ming-Kwei Lee (2012), Semiconductor Devices: Physics and Technology
- Sima Dimitrijev (2011), Principles of Semiconductor Devices
- S. H. Naygi, (2001), Semiconductors
- S. M. Zhe, (1998), Semiconductor Devices
- Robert F. Pierret ( 1996), Semiconductor Device Fundamentals.

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|---|---|
| **Elective-I** | **2-1** |
| **Elective-II** | **2-1** |
| **Projects/Thesis** | **0-3** |

## EIGHTH SEMESTER

| | |
|---|---|
| **Seminar** | **0-3** |
| **Social Science-II (Elective-II/ Foreign Language/ Space Law)** | **3-0** |
| **Elective-III** | **3-0** |
| **Elective-IV** | **3-0** |
| **Project/Thesis** | **0-3** |

## *ELECTIVES:*

### GeoInformatics (GI)

1. Remote Sensing Applications
2. GeoInformatics for Environmental applications
3. GIS Customization for Web Based applications
4. Decision Support System
5. Natural Resource Management
6. GIS for Urban Planning
7. Disaster Monitoring and Management
8. Air and Space-Borne Sensors
9. Photogrammetry Analysis
10. Special Topics in GeoInformatics

### Atmospheric and Environmental Sciences (AES)

1. Weather Analysis and Forecasting
2. Numerical Weather Modeling and Prediction
3. Radar/Satellite Meteorology
4. Atmospheric Dynamics
5. Climate Change
6. Atmosphere Phenomena Modeling
7. Geomagnetism and Seismology
8. Oceanography and Ocean Wave Dynamics
9. Physics and Chemistry of Aerosols
10. Physics and Chemistry of Upper Atmosphere
11. Special Topics in Atmospheric Sciences

### Satellite and Space Communication (SSC)

1. Radar Technology
2. Data Communication and Networks
3. Navigation and Satellite Positioning
4. RF Engineering
5. Analog and Digital Signal Processing
6. Advanced Orbital Mechanics
7. Space Medicines and Life Support Systems
8. Spacecraft System Engineering
9. Satellite Communication Systems
10. Satellite Launch Systems
11. Software Defined Radio
12. Guidance, Navigation and Control Systems
13. Rocket and Spacecraft Propulsion
14. Material Applications for Space Technology
15. Astrobiology and Extraterrestrial Life
16. Special Topics in Space Systems

## Space Physics (SP)

1. Astrophysical Techniques
2. Solar System Astrophysics
3. Stellar Astronomy
4. High Energy Astrophysics
5. Magnetospheric Physics
6. Plasma Dynamics
7. Analysis and Interpretation of Space Data
8. Radio Astronomy
9. Computational Astrophysics
10. Electrodynamics
11. Cosmology
12. Asteroids ,Meteorites, Comets
13. Solar-Terrestrial Physics
14. Magnetohydrodynamics (MHD)
15. Vacuum Science and Technology
16. Special Topics in Astronomy/ Astrophysics: Seminars

**Note:**

- The above curriculum is a guideline. The institutes should prepare their own detailed course contents as per requirement.
- Latest editions of the books/ teaching material should preferably be followed.
- Currency and recency of the literature should be maintained.

# SCHEME OF STUDIES
# MS (2-Year) in Space Sciences

**Duration:** 2-years (4-semesters)

## Eligibility Criteria

- BS (Space Sciences) from any recognized university
- B.S./ B.E. (Electrical/Electronics/Computer Science/Photonics/Optronics/ Mechanical/Mechatronics/Aerospace/Aeronautics/Avionics/Robotics) alongwith Physics and Math.
- MSc. (Space Sciences) with deficiency courses, if any.
- MSc. Physics/Math or any other equivalent having 16-year education with deficiency courses.
- BS Ed. (16-years) with Physics and Math.

## Credit Hours

Committee proposes 30 (24+6) Credit Hours for the award of MS (Space Sciences) degree.

## Scheme of Studies

| Semester/ Year | Name of Subject | Lec-CH | Lab-CH | Total CH |
|---|---|---|---|---|
| First | Modeling and Simulation Techniques | 1 | 2 | 3 |
| | Advanced Research Methods | 3 | 0 | 3 |
| | Core-I | 2 | 1 | 3 |
| | Elective-I | 3 | 0 | 3 |
| | | | | **12** |
| Second | Core-II | 2 | 1 | 3 |
| | Elective-II | 3 | 0 | 3 |
| | Elective-III | 3 | 0 | 3 |
| | Elective-IV | 3 | 0 | 3 |
| | | | | **12** |
| Third | Thesis | 3 | 0 | 3 |
| | | | | **3** |
| Fourth | Thesis | 3 | 0 | 3 |
| | | | | **3** |

**Note:** Maximum “Two Elective Courses” may be opted from any module.

# DETAIL OF COURSES

**Course Contents:**

## Compulsory Courses (6)

## Modeling and Simulation Techniques 1-2

Overview of MATLAB, Simulink and other supporting software tools, Modeling and numerical simulation for deterministic, stochastic, deterministic and stochastic dynamical systems using numerical solution methods, Overview and Definitions; mathematical physical modeling/simulation by means of ordinary and partial physical modeling/simulation by means of ordinary and partial Differential equations, random processes, semi-stochastic equations, discrete differential equations, random processes, semi-discrete stochastic equations, Machines; empirical modeling/simulation using linear regression, weak and Machines; weak empirical modeling/simulation using linear regression and highly non-linear regression, neural networks

## Recommended Books:


- Palm, (2004), Introduction to MATLAB 7 for Engineers.
- Martin H. Trauth, (2007), MATLAB Recipes for Earth Sciences.
- Banker D. Robbert L., (1993), “International Product Research”, American Book Co., New York.
- Buch MB ed., (1991), “Fourth Survey of Research in Education”, NCERT, New Delhi.
- Koul, L., (1995), “Choosing an appropriate statistical technique for analysis of data in experimental research” Tata McGraw-Hill, New Delhi.
- Koul, L., (2000), “Methodology of Education Research”, Vikas Publishing House Delhi.
- Yadav, R. K., (1991), “Research in Comparative Education”, NCERT, New Delhi.


## Advanced Research Methods 3-0

Introduction to Research, Research Problem, Review of Related Literature, Research Hypothesis or Questions, Sampling, Research Instruments, Research Types (Detail Description), Skills and knowledge required to pursue any research/scientific study/investigation, collection and analysis of data, qualitative and quantitative measurement techniques, surveys and sampling procedures, data interpretation and analysis, writing Research Proposals and Reports, Evaluation Criteria. Standards methods and steps followed in any research activity right from the evolution of idea, validation of results and accuracy assessment. Focus on the research undertakings in the field of Space Science.

## Recommended Books:


- Manian L. & Cohen S., (1994), “Research methods in education”, Oxford University Press, UK.
- Anderson K., (1990), “Fundamentals of educational research”, Wiley, New York.
- Best, J. W. and James, (1996), “Research in education”, Narosa Pub. Delhi.
- Fraenkel, J. P. and Norman, (1993), “How to design and evaluate research in education”, Engle Wood, UK.
- Keeves J. P., (1988), “Educational research, methodology, and measurement”, Tata McGraw-Hill, New Delhi.
- Wiersma W., (1995), “Research methods in education”, Addison Wesley.
- Scott D. & Usher R., (1996), “Understanding educational research”, Wiley, USA.
- Lumley J. S. P., (1994), “Research: some ground rules”, Oxford University Press.


# List of Core Courses

## GeoInformatics 2-1

In depth understanding of image processing, analysis and interpretation. Topics include human vision and colour, the construction, arithmetic operations, empirically based image transformations, filtering of images, discrete Fourier transformations, principal components analysis, and spatial modeling, advanced image classifications such as fuzzy classifications, neural classifiers, spatial and spectral segmentation, sub pixel classification. SAR interferometry, applications of SAR interferometry, image spectrometry, Feature Extraction from Hyperspectral data, Image Residuals, Spectral Fingerprints, Absorption-band Parameters, Spectral Derivative Ratio, Classification Algorithms for Hyperspectral Data, radar remote sensing, speckle noise and suppression, texture analysis, data Fusion, DEM extraction from stereo SAR. Computer-based exercises are an essential part of this course, Application of photogrammetry, geographic information systems, and cartography. Theory and techniques for statistical analysis of point patterns, spatially continuous data, and data in spatial zones.

### Lab:

Image Composition Development for Multi Spectral, Image Enhancement and Filters, Image Fusions, Image Classification: Supervised and Unsupervised Classification, Classification Schemes, Indices Development: Normalized Difference Vegetation Index, Leaf Area Index in ERDAS Imagine, Hyperspectral Imaging, Microwave Applications.

## Recommended Books:


- Avery, Thomas E. and Graydon L., (2003), 5th Ed., "Fundamentals of Remote Sensing", Riverside, Publishing Company, Berlin.
- Campbell N. and James B., (2001) 3rd Ed., "Introduction to Remote Sensing", Guilford Press, UK.
- Campbell, B. J. (2006) *Introduction to Remote Sensing*, 4th Ed., The Guilford Press, New York,
- Dansan and Plummer, (1995), "Advances in environmental remote sensing", Wiley, New York.
- Elachi and Charles, (1987), "Introduction to the physics and techniques of remote sensing", John Wiley & Sons, New York.
- Elachi, C. (1988): Spaceborne Radar Remote Sensing: Applications and Techniques, IEEE Press, New York.
- Henderson, F. M. and Lewis, A. J. (1998) Principles and Application Imaging radar/Manual of Remote Sensing/Third Edition, Volume 2, Published in Cooperation with the American Society for Photogrammetry and Remote Sensing, John Wiley and Sons, New York.
- Jensen, John R., (1996), 2nd Ed. "Introductory Digital Image Processing", A Remote Sensing Perspective, Prentice Hall Series in Geographic Information Science, New York.
- Landgrebe, D. A. (2003) Signal Theory Methods in Multispectral Remote Sensing **(**Wiley Series in Remote Sensing and Image Processing**)** Wiley-Interscience; Bkand CD-Rom edition: New York.
- Lillesand and Kieffer, (1998), 3rd Ed. "Remote sensing and image interpretation", John Wiley, New York.
- Mather, P. M. (2009), "Computer Processing of Remotely Sensed Images", Macmillan, New Jersey.
- McCoy, R. (2004) Field Methods in Remote Sensing, The Guilford Press: New York
- Peebles, P. Z. (1998) Radar Principles, Wiley Inter science, New York.
- Sabins M. H., (1999), 4th ed., "Remote Sensing", Principles and Interpretation, Freeman, San Francisco.
- Ulaby, F. T. (1986) Microwave Remote Sensing: Active and Passive, Volume II: Radar Remote Sensing and Surface Scattering and Emission.


## Astrodynamics **(3)**

Two-body problem in three dimensions, orbital elements, orbit types (circular, elliptical, hyperbolic), reference frames and time-keeping, orbit determination, position and velocity, introduction to three-body problem. Earth Orbits: orbital perturbations (earth, environment, third-body effects), orbit lifetime, ballistic trajectories, types and uses of orbits (low, mid, high, sun-synchronous, geosynchronous). Mission Analysis: basic orbital maneuvering, delta-V considerations, interplanetary transfer and rendezvous, method of patched conics. Space-Vehicle Attitude Dynamics: rigid-body motion, typical configurations (non-spinning, spinning, momentum-bias), applications.

Space-Vehicle Attitude Control: typical sensor and actuator devices, strategies for attitude control, application of classical control. Launch Vehicle Considerations: various rocket configurations, staging, ascent to orbit. Additional topics may be covered as time permits.

## Recommended Books:


- Moulton S., (2000), "Introduction to Celestial Mechanics", Wiley, New York.
- William M. K., (2001), "Introduction to Satellite Geodesy", Wiley, New York.
- James R. Wertz (1997), 3rd Ed., "Space Mission Analysis and Design" Mcmillan, UK.
- David A Valado, (2003), 2nd Ed., "Fundamentals of Astrodynamics and Applications", Wiley, New York.
- Thomas P. Sarafin, (2002), "Spacecraft Structures and Mechanisms from Concept to Launch", Mc-Graw-Hill, New York.


## Space and Satellite Communication 2-1

Transmission channels, Linear modulation, Exponential modulation, Noise in analogue carrier wave transmission, Carrier wave systems, Base-band digital transmission, Sampling and pulse coded modulation, Band-pass digital transmission, Error control coding, Information theory, Advanced system applications: Sampling, interpolation, and aliasing, Definition and Role of layered approach, SI and TCP/IP models, Physical layer: Digital transmission Systems. Data Link layer. Local Area Networks (Aloha, slotted Aloha, CSMA), Network layer: Packet Switching and routing.

Principles of Satellite Communication, Electromagnetic Spectrum, Interactions of Microwaves with Atmosphere, Communication Satellite System and Sub-Systems (Attitude and orbit control system), Telemetry, Tracking and Command (TTandC) Power Sub-System, Communication Sub-Systems, Spacecraft Antenna, Satellite Link Design (Basic transmission theory, RF Links, Optimization of RF Link, System Noise Temperature, Noise Figure, G/T Ratio, Down/Uplink Design and Complete Link Budget for LEO, MEO and GEO Satellites), Earth Station Parameters, Base Band Formation, Multiple Access Techniques, Post-launch space operations, Virtual Ground Station Development, Special Purpose Communication Satellites (DBS, INMARSAT, VSAT, SARSAT and LEO Satellites etc.).

## Recommended Books:


- Timothy Pratt, (1986), "Satellite Communication" John Wiley, New York.
- Frenzal K., (1999), 3rd Ed., "Communication Electronics" Mc-Graw-Hill, New York.
- D. C. Agarwal, (1999), "Satellite Communication", McGraw-Hill, New York.

- Brain Ackroyd, (2002), “Satellite Communication”, World Satellite Communication.
- Dennis Roddy, 1991), 3rd Ed., “Electronic Communication”, Prentice Hall,
- John M., (1993), “Satellite Communication”, Prentice Hall, New York.
- C. A. Balanis (2005) “Antenna Theory Analysis and Design”
- C. A. Balanis (*Latest Ed.*) “Advanced Engineering and Electromagnetics
- Maral G., (1993), 4th Ed., “Satellite Communication”, John Wiley, New York.
- Bruce E., Lee S. W. and Lo. Y. T., (2001), “Satellite Communication Ground Segment and Earth Station”, John Wiley, New York.


## Astrophysical Techniques (3)

Positional astronomy: coordinate systems, spherical geometry, precession, time. Statistics: sample and parent population, mean and variance, binomial, Poisson and Gaussian distributions, regression, correlation, chi-squared, nonparametric statistics. Optics: geometric optics, telescope design, aberrations, physical optics. Atmosphere: refraction, seeing, adaptive optics, observatory sites, atmospheric extinction and emission. Detectors: semiconductors, dark current, Johnson noise, photodiodes, bolometric analysis, CCDs, infrared arrays. Data processing: introduction to IDL. Photometry: photometric and radiometric concepts, magnitudes, photometric systems, absolute calibration, signal to noise, practical considerations. Spectroscopy: typical slit spectrometer, prisms, gratings, practical considerations. Radio astronomy: single aperture radio telescopes, brightness and antenna temperatures, interferometry, aperture synthesis. Space astronomy: why do it, technical considerations, residual atmosphere, attitude control and determination. X-ray astronomy: interaction of X-rays with matter, X-ray optics, X-ray detectors. Neutrino astronomy. Gravitational Wave Astronomy.

## Recommended Books:


- C. R. Kitchin, (2003), 4th Ed., “Astrophysical Techniques” Institute of Physics Publishing, UK.
- Seth Shostak, et al, (2003) “Arising the Universe: Perspectives on Extraterrestrial Life”, Wiley, New York.
- Leo Sartori and Donald D., (1987), “Principles of Stellar Evolution and Nucleosynthesis”, Wiley, New York.
- Charles K., Herbert K., (1994), 2nd Ed. “Thermal Physics”, Wiley, New York.

## Atmospheric Sciences (3)

Components of Earth System, Hydrologic Cycle, Carbon Cycle, Oxygen in the Earth System. Atmospheric Thermodynamics; Gas Laws, Hydrostatic Equation, First Law of Thermodynamics, Adiabatic Process, Water Vapor in Air, Static Stability, Second Law of Thermodynamics and Entropy. Radiative Transfer; Spectrum of Radiation, Quantitative Description of Radiation, Blackbody Radiation, Physics of Scattering and Absorption, Radiative Transfer in Planetary Atmospheres. Atmospheric Chemistry; Composition of Troposphere Air, Sources, Transport and Sink of Trace Gases, Tropospheric Trace Gases, Tropospheric Aerosol, Air Pollution, Tropospheric Chemical Cycles and Stratospheric Chemistry. Cloud Microphysics; Nucleation of Water Vapor Condensation, Microstructure of Warm Cloud, Growth of Cloud Droplets in Warm Clouds, Microphysics of Cold Clouds.

### Recommended Books:

- Wallace J. and P. Hobbs (2006), Atmospheric Sciences: An Introductory Survey, Elsevier.
- Frederick J. E. (2008), Principles of Atmospheric Sciences, Jones and Bartlett Publisher.
- Holton J. R. (2004), An Introduction to Dynamics Meteorology, Elsevier.

## Atmospheric Dynamics (3)

Momentum Equation, Scale Analysis of Equation of Motion, Continuity Equation, Thermodynamics Energy Equation, Basic Equation in Isobaric Coordinates, Vertical Motion, Circulation and Vorticity, Planetary Boundary Layer, Quasi Geostrophic Analysis, Atmospheric Waves, Baroclinic Instability, Mesoscale Circulation and General Circulation.

### Recommended Books:

- Holton J. R. (2004), An Introduction to Dynamics Meteorology, Elsevier.
- Lynch A. H. and Cassano (2006). Applied Atmospheric Dynamics, Wiley.

## Advances in Space Plasma Physics (3)

Quasilinear Theory, Non-linear wave interaction, MHD turbulence, Landau Damping, Shocks, Chaos, Vortices, Plasma Diagnostic Techniques

### Books Recommended:

- P. H. Dimond and K. Itoh, (2010), Modern Plasma Physics
- F. Gerard, (2011), Advances in Plasma Physics Research Vol. 7

## Aerospace System and Their Applications (3)

Aerospace Systems Overview, System Elements and Components, System Program and Operational Organization, Space Segment, Post-Launch Requirements, Satellite Composition, Critical Structural Phases, Mission and Satellite Control Activities, Satellite Orbits: Foundation, Equation of Satellite Orbit, Satellite Path in Space, The Two-Body Problem, Classical Orbital Elements, The Geostationary Orbit, Change of Longitudes, Orbital Perturbations, Solar Radiation Pressure, Atmospheric Drag, Types of Orbits, Geometry of Geostationary Orbit, Basics of Communications, Launch of Geostationary Satellite (ELV, Space Shuttle) and concept of Launch Window, The Non-Spherical Earth, Eclipse Geometry, Sun Interference. Launch Vehicles, Rocket Propulsion, Chemical Propulsion, Solid Propellants, Multi Stage Rocket, Injection into Final Orbit, Launch Vehicles for Commercial Satellites, Attitude Control, Propulsion Subsystem, System Reliability, Estimation of Mass, Telemetry Interface Functions, Telecommand Interface Functions, Tracking Interface Functions, Satellite Applications: Communications (Civil and Defence), Navigation (Transit, Navstar GPS), Surveillance (Civil and Military), Meteorology, DMSP, METEOR, FENGYUN, METEOSAT AND GMS. Earth Resources /Imaging Satellite, BADAR I and II, PAKSAT I and II, TERRA, METEOR, and Advanced Satellites, Recent Developments in Space Systems. Search and Rescue: COSPAS-SARSAT, National Missile Defence Program (NMD), Anti-Satellite Weapon System etc.

## Recommended Books:


- J. T.Garner and M. Jones. Ellis Harwood, N.Y, (1990), Satellite Operations.
- W. L. Pritchard, H.G.Suyderhoud and R. A.Nelson, (Latest Edition), Satellite Communication System Engineering
- Mortin. R. Davidoff, (Latest Edition), The Satellite Experimenter's Hand Book, K2UBC.
- James R. Wertz. (*Latest Ed*) Space Attitude Determination and Control, Edited Published by D. Reidel Publishing Company.
- Iyn Ddutton, David de Garis, Richard Winterton, and Richard Harding, (Latest Edition), Military Space.
- Brassy's Air Power, Air Craft, Weapon Systems, and Technology Series Vol. 10 Maxwell Pergamon Publishing Cor. John Wiley and Sons.
- Timodthy Pratt, Charles W. Bostian, (1986), Satellite Communication, John Wiley and Sons, N.Y
- Emanuel Fthenakis, (Latest Edition), Manual of Satellite Communications, McGraw-Hill Co.
- M. Richharia, (Latest Edition), Satellite Communication Systems.

## Electives' Modules (Select 2 courses from any module):

| **Module 1: (Advanced GeoInformatics)** | **CH** |
|---|---|
| 1. Advanced GeoInformtics | 3 |
| 2. Photogrammetry | 3 |
| 3. Advanced Digital Image Processing | 3 |
| 4. GIS Customization | 3 |
| 5. GeoInformatics Applications | 3 |
| 6. Selected Topics In Geomatics/GeoInformatics | 3 |

| **Module 2: (Specialization in Astrodynamics)** | |
|---|---|
| 1. Orbital Mechanics | 3 |
| 2. Flight Dynamics and Control | 3 |
| 3. Flight structure | 3 |
| 4. Space Materials | 3 |
| 5. Guidance Navigation and Control | 3 |
| 6. Selected Topics In Astrodynamics | 3 |

| **Module 3: (Space and Satellite Communications)** | |
|---|---|
| 1. Space Mission Analysis | 3 |
| 2. Spacecraft Operations | 3 |
| 3. System Engineering in Aerospace Applications | 3 |
| 4. Space Instrumentation and Applications | 3 |
| 5. Space Data Systems and Processing | 3 |
| 6. Rocket and Spacecraft Propulsion | 3 |
| 7. Selected Topics In Space and Satellite Communications | 3 |

| **Module 4: (Astrophysics)** | |
|---|---|
| 1. Relativistic Quantum Mechanics | 3 |
| 2. Advanced Cosmology | 3 |
| 3. Group Theoretical Techniques | 3 |
| 4. Gravitational Physics | 3 |
| 5. Galactic Simulation | 3 |
| 6. Stellar and Galactic Astrophysics | 3 |
| 7. Selected Topics In Astrophysics | 3 |

| **Module 5: (Atmospheric & Environmental Sciences)** | |
|---|---|
| 1. Weather analysis and forecasting | 3 |
| 2. Numerical Weather Modeling and Predictions | 3 |
| 3. Climate Change Modeling | 3 |
| 4. Environmental Sciences | 3 |
| 5. Atmospheric Chemistry | 3 |
| 6. Hydrology | 3 |
| 7. Selected Topics in Atmospheric Sciences | 3 |

| ***Thesis:*** | 6 |
|---|---|

**Annex "A"**

# COMPULSORY COURSES IN ENGLISH FOR BE/BS IN ENGINEERING DISCIPLINE

## Semester-I

## Functional English

**Objectives:** To enhance language skills and develop critical thinking

### Course Contents

- Basics of Grammar
- Parts of speech and use of articles
- Sentence structure, Active and passive voice
- Practice in unified sentence
- Analysis of phrase, clause and sentence structure
- Transitive and intransitive verbs
- Punctuation and spelling

### Comprehension

Answers to questions on a given text

### Discussion

General topics and every day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

### Listening

To be improved by showing documentaries/films carefully selected by subject teachers)

### Translation skills

Urdu to English

### Paragraph writing

Topics to be chosen at the discretion of the teacher

## Presentation skills

Introduction

**Note: Extensive reading is required for vocabulary building**

## Recommended Books:

### 1. Functional English

a) Grammar

1. A. J. Thomson and A. V. Martinet. (1997), Practical English Grammar Exercises, Third edition. Oxford University Press.

b) Writing

1. Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet, (1993), Writing. Intermediate by Oxford Supplementary Skills. Fourth Impression.

c) Reading/Comprehension

1. Brain Tomlinson and Rod Ellis, (1992), Reading. Upper Intermediate. Oxford Supplementary Skills. Third Impression.

d) Speaking

## SEMESTER II

## Communication Skills

### Objectives:

To enable the students to meet their real life communication needs

### Course Contents:

**Paragraph writing**
Practice in writing a good, unified and coherent paragraph

**Essay writing**
Introduction

**CV and job application**

**Translation skills**
Urdu to English

**Study skills**
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

**Academic skills**
Letter/memo writing and minutes of the meeting, use of library and internet recourses

**Presentation skills**
Personality development (emphasis on content, style and pronunciation)

**Note:** documentaries to be shown for discussion and review

## Recommended Books:
## Communication Skills

### a) Grammar

1. A. J. Thomson and A. V. Martinet. (1986), Practical English Grammar Exercises, Third edition. Oxford University Press.

### b) Writing

1. Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet, (1993), Writing. Intermediate, Oxford Supplementary Skills. Fourth Impression.
2. Rob Nolasco, (1992), Writing, Upper-Intermediate, Oxford Supplementary Skills. Fourth Impression.

### c) Reading

1. Brian Tomlinson and Rod Ellis, (1991), Reading. Advanced. Oxford Supplementary Skills. Third Impression
2. John Langan, (Latest Edition), Reading and Study Skills
3. Riachard Yorky, (Latest Edition), Study Skills.

# Semester III

## Technical Writing and Presentation Skills

## Objectives:

To enable the students to write a research paper/technical report in a succinct manner according to a specified format.

## Course Contents:

## Presentation skills

## Essay writing

Descriptive, narrative, discursive, argumentative

## Academic writing

How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

## Technical Report writing

**Note: Extensive reading is required for vocabulary building**

## Recommended Books:

## Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Ron White. (1992), Writing. Advanced, Oxford Supplementary Skills. Third Impression.
2. John Langan. Mc-Graw-Hill College (2004), Writing Skills, Higher Education.
3. Laurie G. Kirszner and Stephen R. Mandell. (4th Edition), Patterns of College Writing, St. Martin's Press.

## Presentation Skills

## Reading

1. Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton, (Latest Edition), The Mercury Reader. A Custom Publication. Compiled by northern Illinois University.

| NAM OF COURSE | **ISLAMIC STUDIES** |
|---|---|
| CREDIT HOURS | 2 |
| TOTAL TEACHING PERIOD OF COURSE | 16 WEEKS |
| COURE OBJECTIVES: | This course is aimed at:<br><br>1. providing Basic information about Islamic Studies<br>2. enhancing understanding of the students regarding Islamic Civilization<br>3. improving Students skill to perform prayers and other worships<br>4. enhancing the skill of the students for understanding of issues related to faith and religious life. |

## UNIT NO.1: INTRODUCTION TO QURANIC STUDIES

Basic Concepts of the Holy Quran
History of the Quran
Uloom-ul -Quran

## UNIT No.2:STUDY OF SELLECTED TEXT OF HOLLY QURAN

Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
Verses of Surah Al-Hujrat Related to Adab Al-Nabi
(Verse No-1-18)
Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
Verses of Surah al-Furqan Related to Social Ethics
(Verse No.63-77)
Verses of Surah Al-Inam Related to Ihkam
(Verse No-152-154)

## UNIT No.3:STUDY OF SELLECTED TEXT OF THE HOLLY QURAN

Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

## UNIT NO.4: SEERAT OF HOLY PROPHET (S.A.W) I

Life of Muhammad Bin Abdullah ( Before Prophet Hood)
Life of the Holy Prophet (S.A.W) in Makkah
Important Lessons Derived from the life of Holy Prophet in Makkah

## UNIT NO. 5: SEERAT OF HOLY PROPHET (S.A.W) II

Life of Holy Prophet (S.A.W) in Madina

Important Events of Life Holy Prophet in Madina
Important Lessons Derived from the life of Holy Prophet in Madina

## UNIT NO. 6: INTRODUCTION TO SUNNAH

Basic Concepts of Hadith
History of Hadith
Kinds of Hadith
Uloom-ul-Hadith
Sunnah and Hadith
Legal Position of Sunnah

## UNIT NO. 7 SELLECTED STUDY FROM TEXT OF HADITH

## UNIT NO. 8 INTRODUCTION TO ISLAMIC LAW AND JURISPRUDENCE

Basic Concepts of Islamic Law and Jurisprudence
History and Importance of Islamic Law and Jurisprudence
Sources of Islamic Law and Jurisprudence
Nature of Differences in Islamic Law
Islam and Sectarianism

## UNIT NO. 9: ISLAMIC CULTURE AND CIVILIZATION

Basic Concepts of Islamic Culture and Civilization
Historical Development of Islamic Culture and Civilization
Characteristics of Islamic Culture and Civilization
Islamic Culture and Civilization and Contemporary Issues

## UNIT NO.10: ISLAM AND SCIENCE

Basic Concepts of Islam and Science
Contributions of Muslims in the Development of Science
Quranic and Science

## UNIT NO.11:ISLAMIC ECONOMIC SYSTEM

Basic Concepts of Islamic Economic System
Means of Distribution of wealth in Islamic Economics
Islamic Concept of Riba
Islamic Ways of Trade and Commerce

## UNIT NO.12: POLITICAL SYSTEM OF ISLAM

Basic Concepts of Islamic Political System
Islamic Concept of Sovereignty
Basic Institutions of Govt. in Islam

## UNIT NO.13: ISLAMIC HISTORY

PERIOD OF KHLAFT-E-RASHIDA
PERIOD OF UMMAYYADS
PERIOD OF ABBASIDS

## UNITNO.14: SOCIAL SYSTEM OF ISLAM

BASIC CONCEPTS OF SOCIAL SYSTEM OF ISLAM
ELEMENTS OF FAMILY
ETHICAL VALUES OF ISLAM

## Recommended Books:


1. Hameed Ullah Muhammad, “Emergence of Islam” , IRI, islamabad
2. Hameed Ullah Muhammad, “Muslim Conduct of State”
3. Hameed Ullah Muhammad, ‘Introduction to Islam
4. Mulana Muhammad Yousaf Islahi,” Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.
5. Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, international Islamic University, Islamabad (1993)
6. Mir Waliullah, “Muslim Jrisprudence and the Quranic Law of Crimes” Islamic Book Service (1982)
7. H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep and Deep Publications New Delhi (1989)
8. Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001).

**Annex "C"**

# Pakistan Studies (Compulsory)

(As Compulsory Subject for Degree Students)

## Introduction/Objectives

The course has been designed as a compulsory subject for the students studying for Bachelor's degree, general or professional. The course is of 2 credit hours carrying 100 marks (recommended). The teaching work is comprised of three dimensions: Historical Perspective (20%); Government and Politics (40%); and Contemporary Pakistan (40%). The course framework is issue-oriented. It has many dimensions, the historical and ideological background of Pakistan, the process of governance and national development as well as the issues arising in the modern, age and posing challenges to Pakistan. The course has been designed with a vision that Pakistan Studies should open a window to future.

## Course Outline:

## Historical Perspective

Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah. Factors leading to Muslim separatism, People and Land, Indus Civilization, Muslim advent, Location and Geo-Physical features.

## Government and Politics in Pakistan

Political and constitutional phases:

- 1947-58
- 1958-71
- 1971-77
- 1977-88
- 1988-99
- 1999 onward

## Contemporary Pakistan

Economic institutions and issues, Society and social structure, Ethnicity, Foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan.

## *Recommended Books:*


- Burki, Shahid Javed, (1980), *State and Society in Pakistan,* The Macmillan Press Ltd.
- Akbar, S. Zaidi. (2000) *Issue in Pakistan's Economy.* Karachi: Oxford University Press.

- S. M. Burke and Lawrence Ziring. (1993), Pakistan's Foreign Policy: An Historical analysis. Karachi: Oxford University Press.
- Mehmood, Safdar. (1994), *Pakistan Political Roots and Development.*Lahore.
- Wilcox, Wayne. (1972), *The Emergence of Bangladesh,* Washington: American Enterprise, Institute of Public Policy Research.
- Mehmood, Safdar. (Latest Edition), *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road.
- Amin, Tahir. (Latest Edition), *Ethno - National Movement in Pakistan,* Islamabad: Institute of Policy Studies, Islamabad.
- Ziring, Lawrence. (1980), *Enigma of Political Development.* Kent England: WmDawson and Sons Ltd.
- Zahid, Ansar. (1980), *History and Culture of Sindh.* Karachi: Royal Book Company.
- Afzal, M. Rafique. (1998), *Political Parties in Pakistan,* Vol. I, II and III. Islamabad: National Institute of Historical and cultural Research.
- Syed, Khalid Bin. (1967), *The Political System of Pakistan.* Boston: Houghton Mifflin.
- Aziz, K. K. *Party, (*1976), *Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research.
- Muhammad Waseem, (1987), Pakistan Under Martial Law, Lahore: Vanguard.
- Haq, Noor ul. (1993), *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research.

# RECOMMENDATIONS/SUGGESTIONS

To cater the current/ future needs of the academic and research institutions for the socio-economic uplift of the country, the National Curriculum Revision Committee (NCRC) of the Higher Education Commission in Space Science put forward the following recommendations:

1. It is recommended that in under-graduate courses of natural / applied sciences, basic knowledge of Space Science may be incorporated to broaden the field of specialization.

1. Students should be encouraged to take basic courses in Space Science for their special applications in robotics and related micro-processor control applications.

2. Institutions should be equipped with Astronomical, Space & Earth observations and other related Space Science lab facilities for fulfilling the teaching and research requirements.

3. The information on current trends of research in Space Sciences should be disseminated to the public/private sector universities.

4. Public awareness/outreach programmes like Sky-watch/Star-gazing shows, World Space Week should be organized by utilizing existing facilities/planetaria and by arranging space days/weeks, seminars, quizzes etc.

5. University and school teachers should be trained on various software tools that are in-use in different fields of Space Sciences via providing them hands-on trainings.

6. The revised curricula would offer flexibility to universities/institutions. The committee recommended that universities should offer such courses from the list of electives to prepare graduates in such a way that they are accepted by other institutions for further studies and placement.

7. Fundamental topics in Space Sciences may be introduced at Matric and Intermediate levels (including Mada'ris).

8. Interaction / collaboration among universities and the relevant research & development (R&D) organizations like, SUPARCO, NESCOM, NESPAK, NCP, PTA, CAA, PIA, WAPDA, IWASRI, IIMI, EPA, SSOP, OGDCL, GSP, SOP, PAEC, Urban Unit, PCRWR etc. for workshops / seminars / lectures on current topics of Space Science.

9. National and international institutions / R&D organizations should be approached to share their technical resources (labs, data, instruments,

human expertise, etc), collaborative studies / projects / theses, as well as split study programs.

10. The committee recommends extending the existing MS Space Sciences program to “MS Leading to PhD”.

11. Committee also recommends the use of Space Science & Technology to address and resolve indigenous / regional, social and environmental issues.

12. The committee strongly recommends renaming the discipline from “Space Sciences” to “Space Science and Technology”. This has been proposed in the wake of the meaning and scope of technology which would open new avenues of applications for the students and enhance the scope of the subject in Pakistan and abroad.

13. To bring at par the knowledge-base in the field of Space Science and allied disciplines with the space faring nations, the committee strongly proposed to establish a **National Centre of Excellence in Space Science**.

15. The committee proposed to establish a society namely “**Pakistan Space Science Society (PASSS)**” to make associations among space scientists.