Syllabus of

Bachelor of Science in Physics (BS in Physics)/ ADS in Physics (Only first four semesters)

Undergraduate Policy 2023

Effective from the Session Fall 2024 Onward

Member Board of Studies, Department of Physics

Subject Expert

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   Quetta

BS-Physics Scheme of Studies

S.No	Domain	Number of Courses	Number of Credit Hours	Number of Credit Hours till 4th semester (for ADS in Physics)
1	General Education Courses (G)	13	32	32
2	Major Courses	27	81	24
3	Interdisciplinary Courses	05	15	15
4	Capstone Project	-----	03	--------
Total		**45**	**131**	**71**

List of General Courses offered in Semester

S.No	Course Title	Credit Hours
1	Quantitative Reasoning-I	3(3-0)
2	Quantitative Reasoning-II	3(3-0)
3	Arts and Humanities (Introduction to History, Introduction to Philosophy, Introduction to Mass Communication, Introduction to Psychology)	2(2-0)
4	Natural Sciences (Chemistry)	3(2-1)
5	Functional English	3(3-0)
6	Expository writing	3(3-0)
7	Islamic Studies	2(2-0)
8	Ideology and Constitution of Pakistan	2(2-0)
9	Application of Information and Communication technologies (ICT)	3(2-1)
10	Entrepreneurship	2(2-0)
11	Social Sciences (Introduction to Geography, Fundamental of Disaster Management, Introduction to International Relations, Introduction to Sociology, Introduction to Political Science, Fundamentals of Economics)	2(2-0)
12	Civics and Community Engagement	2(2-0)
13	Pakistan Studies	2(2-0)
	Total	**32**

List of Major Courses Offered in semester

Note: Minimum requirement 72 credit hours (78 offered)

S.No	Course Code	Course Title	Credit Hours
1.	PHY-501	Mechanics	3(2-1)
2.	PHY-502	Waves and Oscillations	3(2-1)
3.	PHY-503	Heat and thermodynamics	3(2-1)
4.	PHY-504	Electricity and magnetism	3(2-1)
5.	PHY-505	Modern Physics-I	3(3-0)
6.	PHY-506	Optics	3(3-0)
7.	PHY-507	Modern Physics-II	3(2-1)
8.	PHY-508	Electronics –I	3(2-1)
9.	PHY-601	Classical Mechanics	3(3-0)

10.	PHY-602	Electronics- II	3(2-1)
11.	PHY-603	Solid State Physics-I	3(3-0)
12.	PHY-604	Electromagnetic Theory-I	3(3-0)
13.	PHY-605	Methods of Mathematical Physics-I	3(3-0)
14.	PHY-606	Thermal and Statistical Physics	3(2-1)
15.	PHY-607	Digital Electronics	3(2-1)
16.	PHY-608	Solid state Physics-II	3(3-0)
17.	PHY-609	Electromagnetic theory-II	3(3-0)
18.	PHY-610	Mathematical Methods of Physics-II	3(3-0)
19.	PHY-611	Atomic and molecular Physics	3(3-0)
20.	PHY-612	Quantum Mechanics-I	3(3-0)
21.	PHY-613	Field Experience / Internship	3(0-3)
22.	PHY-614	Quantum Mechanics- II	3(3-0)
23.	PHY-615	Nuclear Physics	3(2-1)
24.	PHY-616	Capstone Project	3(3-0)
25.	PHY-6xx	Elective-I, Elective-II, Elective-III , Elective-IV	12(12-0)

List of Interdisciplinary Courses in semester
Note: Minimum 12 Credit Hours (15 offered)

S.No	Course Code	Course title	Credit Hours
1	MATH-501	Calculus-I	3 (3-0)
2	MATH-502	Calculus-II	3 (3-0)
3	EP- 500	Environmental Physics	3 (3-0)
4	MATH-504	Linear Algebra	3 (3-0)
5	MATH-509	Ordinary Differential Equation	3 (3-0)

Field experiences /internship (PHY-613): 03 credit hours.
Capstone Project (PHY-616): 03 credit hours.

Bachelor of Science in Physics Syllabus

Programme: Bachelor of Science in Physics (BS in Physics)
Duration: 4 years
Number of semesters: 8
Number of weeks per semester: 16-18 (2 weeks for examinations)
Total number of credit hours: 131
Quit Option: After 4 semesters if any student wants to quit he/she will be awarded ADS (in Physics)
Number of credit hours per semester: 15-18
Eligibility Criteria for Admission:
FSc /A-Level Cambridge (with Physics) / Three-year polytechnic degree

Semester 1

Course Code	Course Title	Course Type	Credit Hours
PHY-501	Mechanics	Major	3(2 – 1)
MATH-501	Calculus-I	Interdisciplinary	3 (3 – 0)
CS-501	Application of Information and Communication technologies (ICT)	General course	3 (2 – 1)
ENG-501	Functional English	General course	3 (3 – 0)
QR-501	Quantitative Reasoning-I	General course	3 (3 – 0)
ISL-501	Islamic Studies / Ethics	General course	2 (2 – 0)
Total			**17**

Semester 2

Course Code	Course Title	Course Type	Credit Hours
PHY-502	Waves and Oscillation	Major	3 (2 – 1)
PHY-503	Heat and Thermodynamics	Major	3 (2 – 1)
MATH-502	Calculus-II	Interdisciplinary	3 (3 – 0)
EP- 500	Environmental Physics	Interdisciplinary	3 (3 – 0)
QR-502	Quantitative Reasoning-II	General course	3 (3 – 0)
ENG-502	Expository writing	General course	3 (3 – 0)
Total			**18**

Semester 3

Course Code	Course Title	Course Type	Credit Hours
PHY-504	Electricity & Magnetism	Major	3 (2 – 1)
PHY-505	Modern Physics-I	Major	3 (3 – 0)
PHY-506	Optics	Major	3 (3 – 0)
MATH-504	Linear Algebra	Interdisciplinary	3 (3 – 0)
GC-5XX	Arts and Humanities Arts and Humanities (Introduction to History, Introduction to Philosophy, Introduction to Mass Communication, Introduction to Psychology)	General Course	2 (2 – 0)
GC-5XX	Civics and Community Engagement	General course	2 (2 - 0)
PS-526	Ideology and Constitution of Pakistan	General course	2 (2 – 0)
Total			**18**

Semester 4

Course Code	Course Title	Course Type	Credit Hours
PHY-507	Modern Physic-II	Major	3 (2 – 1)
PHY-508	Electronics-I	Major	3 (2 – 1)
MATH-509	Ordinary Differential Equations	Interdisciplinary	3 (3 – 0)
CHEM-500	Chemistry (Natural Sciences)	General course	3 (2 – 1)
ENT-508	Entrepreneurship	General course	2 (2 – 0)
PST-501	Pakistan Studies	General course	2 (2 – 0)
GC-5XX	Social Sciences ((Introduction to Geography, Fundamental of Disaster Management, Introduction to International Relations, Introduction to Sociology, Introduction to Political Science, Fundamentals of Economics)	General course	2 (2 - 0)
Total			**18**

Semester 5

Course Code	Course Title	Course Type	Credit Hours
PHY-601	Classical Mechanics	Major	3 (3 – 0)
PHY-602	Electronics-II	Major	3 (2 – 1)
PHY-603	Solid State Physics-I	Major	3 (3 – 0)
PHY-604	Electromagnetic Theory-I	Major	3 (3 – 0)
PHY-605	Mathematical Methods of Physics-I	Major	3 (3 – 0)
Total			**15**

Semester 6

Course Code	Course Title	Course Type	Credit Hours
PHY-606	Thermal and Statistical Physics	Major	3 (3 – 0)
PHY-607	Digital Electronics	Major	3 (2 – 1)
PHY-608	Solid State Physics-II	Major	3 (2 – 1)
PHY-609	Electromagnetic Theory-II	Major	3 (3 – 0)
PHY-610	Mathematical Methods of Physics-II	Major	3 (3 – 0)
Total			**15**

Semester 7

Course Code	Course Title	Course Type	Credit Hours
PHY-611	Atomic and Molecular Physics	Major	3 (3 – 0)
PHY-612	Quantum Mechanics-I	Major	3 (3 – 0)
PHY-6XX	Elective Course- I	Major	3 (3 – 0)
PHY-6XX	Elective Course- II	Major	3 (3 - 0)
PHY-613	Field Experience / Internship	Major	3 (0 - 3)
Total			**15**

Semester 8

Course Code	Course Title	Course Type	Credit Hours
PHY-614	Quantum Mechanics-II	Major	3 (3 – 0)
PHY- 615	Nuclear Physics	Major	3 (2 – 1)
PHY-6XX	Elective Course-III	Major	3 (3 – 0)
PHY-6XX	Elective Course-IV	Major	3 (3 – 0)
PHY-616	**Capstone Project:** The research work will be conducted in 8th semester. In the final defense of project, a prototype will be shown to the external examiner and a project report will be submitted.	Major	3 (0 - 3)
Total			**15**

Optional Subjects (Elective Courses) in 7th and 8th Semesters

PHY-617	Computational Physics-I	3 (3 – 0)
PHY-618	Computational Physics-II	3 (3 – 0)
PHY-619	Mechatronics	3 (3 – 0)
PHY-620	Nanoscience and Nanotechnology	3 (3 – 0)
PHY-621	Communication System	3 (3 – 0)
PHY-622	Applied Solid State Physics	3 (3 – 0)
PHY-623	Radiation Safety and Nuclear Reactor Design	3 (3 – 0)
PHY-624	Introduction to Renewable Energy	3 (3 – 0)
PHY-625	Microprocessors and microcontrollers	3 (3 – 0)
PHY-626	Plasma Physics	3 (3 – 0)
PHY-627	Methods of Experimental Physics	3 (3 – 0)
PHY-628	Introduction to Quantum Computing	3 (3 – 0)
PHY-629	Quantum Information Theory	3 (3 – 0)

PHY-630	Quantum Field Theory	3 (3 – 0)
PHY-631	Lasers	3 (3 – 0)
PHY-632	Laser Engineering	3 (3 – 0)
PHY-633	Experimental Techniques in Particle and Nuclear Physics	3 (3 – 0)
PHY-634	Electronic Materials and Devices	3 (3 – 0)
PHY-635	Fluid Dynamics	3 (3 – 0)
PHY-636	Introduction to Photonics	3 (3 – 0)
PHY-637	Introduction to Materials Science	3 (3 – 0)
PHY-638	Particle Physics	3 (3 – 0)
PHY-639	Computer Simulations in Physics	3 (3 – 0)
PHY-640	Surface Sciences	3 (3 – 0)

Total Credit Hours: 131

Two-Two optional/Elective subjects of 03 credit hours each will be offered in 7th and 8th semesters. Internship will be offered to students during 7th semester or in sessional break. Capstone Project will be allocated in the 8th semester and the final defense will be held at the end of 8th semester.

PHY-501 **MECHANICS** **Credit Hours: 3(2-1)**

Major Course

Objectives:

The main objective of this course is to understand the different motions of objects on a macroscopic scale and to develop simple mathematical formalisms to analyze such motions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Basic Concepts: Scalars and Vectors, Multiplication of Vectors: Dot and Cross Products. Vector triple product, scalar triple product, Del Operator, Divergence theorem, stokes theorem, Coordinate systems: Cartesian system, spherical, cylindrical system of coordinates.

Motion in One, Two and Three Dimensions: Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames.

Newton's Laws: Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Gravitational Potential Energy, Escape Velocity, Kepler's Laws, Satellite Orbits & Energy.

Work and Kinetic Energy: Work done by Constant and Variable Forces: Gravitational and Spring Forces, Power, Conservative and Non-conservative Forces, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy.

System of Particles: Motion of a System of Particles and Extended Rigid Bodies, Center of Mass and Newton's Laws for a System of Particles, Linear Momentum, Impulse, Momentum & Kinetic Energy in One- and Two-Dimensional Elastic and Inelastic Collisions.

Rotational Motion: Rotation about a Fixed Axis, Angular Position, Angular Displacement, Angular Velocity and Angular Acceleration, Rotation under Constant Angular Acceleration, relationship between Linear and Angular Variables, Rotational Inertia, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Work and Rotational Kinetic Energy, Power, Rolling Motion, Angular Momentum for a single Particle and a System of Particles, Conservation of Angular Momentum, Precession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes i.e. for disc, bar and solid sphere.

Angular Momentum: Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum.

Simple Harmonic Motion (SHM): Amplitude, Phase, Angular Frequency,
Velocity and Acceleration in SHM, Linear and Angular Simple Harmonic Oscillators, Energy in SHM, Simple Pendulum, Physical Pendulum, SHM and Uniform Circular Motion, Damped Harmonic Oscillator.

Experiments:

1. To determine the value of "g" by simple pendulum.
2. To determine the value of "g" by compound pendulum/ Kater's Pendulum.
3. To study the damping features of an oscillating system using simple pendulum of variable mass.
4. To study the dependence of Centripetal force on mass, radius, and angular velocity of a body in circular motion.
5. Determination of moment of inertia of a solid/hollow cylinder and a sphere etc
6. Determination of the Modulus of rigidity of a wire by Static Method.
7. Determination of the modulus of rigidity of a wire by Maxwell's needle (dynamic method).
8. Determination of the modulus of rigidity of a wire by oscillating rod (Dynamic method).
9. Determination of the surface tension of water by capillary tube method.

10. Determination of Co-efficient of Viscosity of water by flow method.
11. Determination of the Co-efficient of viscosity of a liquid by Stoke's Law.
12. To study the dependence of centripetal force on mass, radius, and angular velocity of a body in circular motion.
13. Study of the Damping features of an oscillating system using Simple Pendulum of variable mass.
14. Determination of the moment of inertia of a solid/hollow cylinder and sphere.
15. To study the Conservation of Energy (Hooke's Law Apparatus)
16. Determination of the vertical distance between two points using a sextant.

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

MATH-501 CALCULUS- I Credit Hours: 3 (3-0)

Interdisciplinary Course

Prerequisites: Knowledge of Intermediate Calculus

Specific Objectives of course: Calculus serves as the foundation of advanced subjects in all areas of mathematics. This is the first course of Calculus. The objective of this course is to introduce students to the fundamental concepts of limit, continuity, differential and integral calculus of functions of one variable.

Contents:

Equations and inequalities: Solving linear and quadratic equations, linear inequalities. Division of polynomials, synthetic division. Roots of a polynomial, rational root; Viete Relations. Descartes rule of signs. Solutions of equations with absolute value sign. Solution of linear and non-linear inequalities with absolute value sign.

Functions and graphs: Domain and range of a function. Examples: polynomial, rational, piecewise defined functions, absolute value functions, and evaluation of such functions. **Operations with functions**: sum, product, quotient and composition.

Graphs of functions: linear, quadratic, piecewise defined functions.

Lines and systems of equations: Equation of a straight line, slope and intercept of a line, parallel and perpendicular lines. Systems of linear equations, solution of system of linear equations.

Nonlinear systems: at least one quadratic equation.

Limits and continuity: Functions, limit of a function. Graphical approach. Properties of limits. Theorems of limits. Limits of polynomials, rational and transcendental functions. Limits at infinity, infinite limits, one-sided limits. Continuity.

Derivatives: Definition, techniques of differentiation. Derivatives of polynomials and rational, exponential, logarithmic and trigonometric functions. The chain rule. Implicit differentiation. Rates of change in natural and social sciences. Related rates. Linear approximations and differentials. Higher derivatives, Leibnitz's theorem.

Applications of derivatives: Increasing and decreasing functions. Relative extrema and optimization. First derivative test for relative extrema. Convexity and point of inflection. The second derivative test for extrema. Curve sketching. Mean value theorems. Indeterminate forms and L'Hopitals rule. Inverse functions and their derivatives.

Integration: Anti derivatives and integrals. Riemann sums and the definite integral. Properties of Integral. The fundamental theorem of calculus. The substitution rule.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley Publishing Company, 2005
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition, JohnWiley & Sons, Inc. 2005
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's outlines series, 4th Edition, 1999
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry, Prentice Hall, Inc. 1988
6. E. W. Swokowski, Calculus with Analytic Geometry, PWS Publishers, Boston, Massachusetts, 1983.
7. M. Liebeck, A Concise introduction to pure Mathematics, CRC Press, 2011.
8. A. Kaseberg, Intermediate Algebra, Thomson Brooks/cole, 2004.

CS-501 APPLICATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) **General Education Course** **Credit Hours: 3 (2 – 1)**

Objective:

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

Contents

1. Introduction to Information and Communication Technologies:

- Components of Information and Communication Technologies (basics of hardware, software, ICT platforms, networks, local and cloud data storage etc.)
- Scope of Information and Communication Technologies (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.).
- Emerging technologies and future trends.

2. Basic ICT Productivity Tools:

- Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web.
- Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.).
- Microsoft Office Suites (Word, Excel, PowerPoint).
- Google Workspace (Google Docs, Sheets, Slides).
- Dropbox (Cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft Office integration).
- Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas).
- Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.).

- Social media applications (LinkedIn, Facebook, Instagram, etc.).

3. ICT in Education:

- Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.).
- Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.).
- Interactive multimedia and virtual classrooms.

4. ICT in Health and Well-being:

- Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkoopor, etc.).
- Telemedicine and online health consultations (OLADOC, Sehat Kahani, Marham, etc.).

5. ICT in Personal Finance and Shopping:

- Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax,
- ILINK and MNET, Keenu Wallet, etc.).
- E-commerce platforms (Daraz.pk, Telemart, Shophive, etc.)

6. Digital Citizenship and Online Etiquette:

- Digital identity and online reputation.
- Netiquette and respectful online communication.
- Cyberbullying and online harassment.

7. Ethical Considerations in Use of ICT Platforms and Tools:

- Intellectual property and copyright issues.
- Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources.
- Content accuracy and integrity (ensuring that the content shared through ICT platforms is free from misinformation, fake news, and manipulation).

Practical Requirements

As part of the overall learning requirements, the course will include:

1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools. Students may be assigned practical tasks that require them to create documents, presentations, and spreadsheets etc.
2. Assigning of tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems. Students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive).
3. The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.

Recommended Books:

1. "Discovering Computers" by Vermaat, Shaffer, and Freund.
2. "GO! with Microsoft Office" Series by Gaskin, Vargas, and McLellan.
3. "Exploring Microsoft Office" Series by Grauer and Poatsy.
4. "Computing Essentials" by Morley and Parker.
5. "Technology in Action" by Evans, Martin, and Poatsy

ENG-501 English I- FUNCTIONAL ENGLISH Credit Hours: 3(3-0)

General Education Course

Objectives: This course is designed to equip to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure.

Contents

1. Foundations of Functional English:

- Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions)
- Communicative grammar (subject-verb-agreement, verb tenses, fragments, run-ons, modifiers, articles, word classes, etc.)
- Word formation (affixation, compounding, clipping, back formation, etc.)
- Sentence structure (simple, compound, complex and compound-complex)
- Sound production and pronunciation

2. Comprehension and Analysis:

- Understanding purpose, audience and context
- Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.)
- Reading strategies (skimming, scanning, SQ4R, critical reading, etc.)
- Active listening (overcoming listening barriers, focused listening, etc.)

3. Effective Communication:

- Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.)
- Structuring documents (introduction, body, conclusion and formatting)
- Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.)
- Public speaking (overcoming stage fright, voice modulation and body language)
- Presentation skills (organization content, visual aids and engaging the audience)
- Informal communication (small talk, networking and conversational skills)
- Professional writing (business e-mails, memos, reports, formal letters, etc.)

Suggested Practical Activities (Optional)

As part of the overall learning requirements, students will also be exposed to relevant simulations, role- plays and real-life scenarios and will be required to apply skills acquired throughout the course in the form of a final project.

Recommended Books:

1. "Understanding and Using English Grammar" by Betty Schrampfer Azar.
2. "English Grammar in Use" by Raymond Murphy.
3. "The Blue Book of Grammar and Punctuation" by Jane Straus.
4. "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters.
5. "Cambridge English for Job-hunting" by Colm Downes.

QR-501 QUANTITATIVE REASONING-I Credit Hours: 3 (3 – 0)

General Course

Objective:

Quantitative Reasoning (1) is an introductory-level undergraduate course that focuses on the fundamentals related to the quantitative concepts and analysis. The course is designed to familiarize students with the basic concepts of mathematics and statistics and to develop students' abilities to analyze and interpret quantitative information. Through a combination of theoretical concepts and practical exercises, this course will also enable students cultivate their quantitative literacy and problem-solving skills while effectively expanding their academic horizon and breadth of knowledge of their specific major/field of study.

Contents:

1. Numerical Literacy

- Number system and basic arithmetic operations,
- Units and their conversions, dimensions, area, perimeter and volume;
- Rates, ratios, proportions and percentages,
- Types and sources of data;
- Measurement scales,
- Tabular and graphical presentation of data;
- Quantitative reasoning exercises using number knowledge.

2. Fundamental Mathematical Concepts

- Basics of geometry (lines, angles, circles, polygons etc.);
- Sets and their operations;
- Relations, functions, and their graphs,
- Exponents, factoring and simplifying algebraic expressions;
- Algebraic and graphical solutions of linear and quadratic equations and inequalities Quantitative reasoning exercises using fundamental mathematical concepts.

3. Fundamental Statistical Concepts

- Population and sample;
- Measures of central tendency, dispersion and data interpretation;
- Rules of counting (multiplicative, permutation and combination);
- Basic probability theory;
- Introduction to random variables and their probability distributions,
- Quantitative reasoning exercises using fundamental statistical concepts.

Recommended Books:

1. "Quantitative Reasoning: Tools for Today's Informed Citizen" by Bernard L., Madison, Lynn and Arthur Steen.
2. "Quantitative Reasoning for the Information Age" by Bernard L. Madison and David M. Bressoud.
3. "Fundamentals of Mathematics" by Wade Ellis.
4. "Quantitative Reasoning: Thinking in Numbers" by Eric Zaslow.
5. "Thinking Clearly with Data: A Guide to Quantitative Reasoning and Analysis" by Ethan Bueno de Mesquita and Anthony Fowler.
6. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
7. "Discrete Mathematics and its Applications" by Kenneth H. Rosen.
8. "Statistics for Technology: A Course in Applied Statistics" by Chatfield, C.
9. "Statistics: Unlocking the Power of Data" by Robin H. Lock, Patti Frazer Lock, Kari Lock Morgan, and Eric F. Lock.

ISL-501 ISLAMIC STUDIES Credit Hours: 2(2-0)

General Education Course

Pre-Requisite: Nil

Objective

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

Contents

1. Introduction to Islam:

- Definition of Islam and its core beliefs.
- The Holy Quran (introduction, revelation and compilation).
- Hadith and Sunnah (compilation, classification, and significance)
- Key theological concepts and themes (Tawhid, Prophethood, Akhirah etc.)

2. Sirah of the Holy Prophet (Peace Be Upon Him) as Uswa-i-Hasana:

- Life and legacy of the Holy Prophet PBUH.
- Diverse roles of the Holy Prophet PBUH (as an individual, educator, peace maker, leader etc.).

3. Islamic History and Civilization:

- World before Islam.
- The Rashidun Caliphate and expansion of Islamic rule.
- Contribution of Muslim scientists and philosophers in shaping world civilization.

4. Islamic Jurisprudence (Fiqh):

- Fundamental sources of Islamic jurisprudence.
- Pillars of Islam and their significance.
- Major schools of Islamic jurisprudence.
- Significance and principles of Ijtihad.

5. Family and Society in Islam:

- Status and rights of women in Islamic teachings.
- Marriage, family, and gender roles in Muslim society.
- Family structure and values in Muslim society.

6. Islam and the Modern World:

- Relevance of Islam in the modern world (globalization, challenges and prospects).
- Islamophobia, interfaith dialogue, and multiculturalism.
- Islamic viewpoint towards socio-cultural and technological changes.

Recommended Books:

1. "The Five Pillars of Islam: A Journey Through the Divine Acts of Worship" by Muhammad Mustafa Al-Azami.
2. "The Five Pillars of Islam: A Framework for Islamic Values and Character Building" by Musharraf Hussain.
3. "Towards Understanding Islam" by Abul A'la Mawdudi.
4. "Islami Nazria e Hayat" by Khurshid Ahmad.
5. "An Introduction to Islamic Theology" by John Renard.
6. "Islamic Civilization Foundations Belief & Principles" by Abul A' la Mawdudi.
7. "Women and Social Justice: An Islamic Paradigm" by Dr. Anis Ahmad.
8. "Islam: Its Meaning and Message" by Khurshid Ahmad.

Note: This course is compulsory for Muslim and optional for non-Muslim undergraduate students. Non-Muslim students can opt for any course of at least the same or more credits in subjects such as religious studies, ethics, theology, comparative religion, Christian ethics, etc.

ISL-501 ETHICS for NON-MUSLIMS Credit Hours: 2(2-0)

نصاب بی اے اخلاقیات (غیر مسلم طلباء کے لیے)

Syllabus of B.A.Ethics (for Non Muslim)

۱۔ تعریف اخلاق، علم الاخلاق کا دیگر علوم سے تعلق (علم الاخلاق اور نفسیات، علم الاخلاق اور عمرانیات، علم الاخلاق اور سیاسیات، علم الاخلاق اور قانون)

۲۔ اسلام کا فلسفہ اخلاق، اسلام میں اخلاق کی اہمیت، فضائل اخلاق (صدق، سخاوت، عفت و پاکیزگی، دیانتداری، عدل وانصاف، عہد کی پابندی، احسان، عفو و درگذر) اخلاق ذمیمہ (جھوٹ، خیانت، غداری، چوری، رشوت، ظلم)

۳۔ عیسائیت کی اخلاقی تعلیمات، عقیدہ تثلیث، عقیدہ کفارہ، عقیدہ مصلوبیت، بپتسمہ، عشائے ربانی، اناجیل اربعہ۔

۴۔ ہندومت کی اخلاقی تعلیمات، عقیدہ تری مورتی، آواگون، ذات پات، مذہبی کتب۔

۵۔ گرونانک کی حیات وخدمات، تصور معبود، تصور عبادت، خالصہ اور ان کے پانچ کاف۔

۶۔ گوتم بدھ کے حالات زندگی اور اخلاقی تعلیمات، بھکشو بننے کے لیے شرائط، ہشت پہلو۔

مطالعاتی کتب:

(۱) سید سلیمان ندوی	سیرت النبی (جلد ششم)	(۲) حفظ الرحمٰن سیوہاروی	اخلاق وفلسفہ اخلاق
(۳) سی اے قادر	اخلاقیات	(۴) خورشید احمد	اسلامی نظریہ حیات
(۵) مولنا مودودی	اسلام کا اخلاقی نقطہ نظر	(۶) امام غزالی	اسلامی آداب واخلاق
(۷) عبدالعلی اچکزئی	روضۃ الاسلام	(۸) عبدالعلی اچکزئی	روضہ علوم اسلامیہ (۲)
(۹) عبدالرشید	ادیان ومذاہب کا تقابلی مطالعہ	(۱۰) غلام رسول چیمہ	مذاہب عالم کا تقابلی مطالعہ

PHY-502 WAVES AND OSCILLATIONS Credit Hours: 3(2-1)

Major course

Pre-requisites: Mechanics, Calculus II

Objectives: To develop a unified mathematical theory of oscillations and waves in physical systems.

Contents:

Simple and Damped Simple Harmonic Oscillation: Mass-Spring System, Simple Harmonic Oscillator Equation, Complex Number Notation, LC Circuit, Simple Pendulum, Quality Factor, LCR Circuit.

Forced Damped Harmonic Oscillation: Steady-State Behavior, Driven LCR Circuit, Transient Oscillator Response, Resonance.

Coupled Oscillations: Two Spring-Coupled Masses, Two Coupled LC Circuits, Three Spring Coupled Masses, Normal Modes, Atomic and Lattice Vibrations.

Transverse Waves: Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity, Pulse wave form.

Longitudinal Waves: Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas.

Traveling Waves: Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Reflection and Transmission at Boundaries, Electromagnetic Waves. Standing Waves in a Finite Continuous Medium

Multi-Dimensional Waves: Plane Waves, Three-Dimensional Wave Equation, Laws of Geometric Optics, Waveguides, Cylindrical Waves.

Interference and Diffraction of Waves: Double-Slit Interference, Single-Slit Diffraction.

Experiments:

1. Measurement of the wavelength of the sodium D lines by Newton's Rings.
2. Investigation of the Phase change with position in a Travelling wave and measurement of Velocity of Sound by C.R.O.
3. To Study of the laws of vibrations of a Stretched string using Sonometer.
4. Determination of the wavelength of sodium light using diffraction grating and Fresnel's biprism.
5. Determination of the resolving power of a diffraction grating.
6. Determination of the specific rotation of sugar solution using Laurent's half-shade polarimeter.
7. Determination of the radius of lycopodium particles.
8. Oscillations of a spring pendulum, and determination of oscillation period as a function of the oscillating mass
9. The frequency of the oscillators to be determined with the electronic counter of the light barrier and the stopwatch for a particular frequency of excitation.
10. By means of a path-time measurement the phase velocity of a transverse wave is to be determined.
11. For three different frequencies the corresponding wavelengths are to be measured and it is to be shown that the product of frequency and wavelength is a constant.
12. The four lowest natural frequencies with two ends of the oscillator system fixed are to be detected.
13. Use the comb to generate two circular waves and observe the resulting interference. Increase the number of interfering circular waves up to ten by using all teeth of the comb to demonstrate Huygens' Principle.
14. Generate plane water waves and use a barrier to demonstrate diffraction at an edge. Then, form a slit and observe diffraction behind the slit. Repeat this experiment for a double-slit.
15. By using the integrated wave generator as well as the external wave generator, generate two circular waves and observe the interference. Vary the phase of the external wave generator and observe the resulting interference pattern to understand the principle of "phased array antennas".

Recommended Books:

1. J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed. 2005.
2. P. French, "Vibrations and Waves", CBS Publishers (2003).
3. F. S. Crawford, Jr., "Waves and Oscillations", Berkeley Physics Course, vol. 3, McGraw-Hill, 1968.

PHY-503 HEAT AND THERMODYNAMICS Credit Hours: 3 (2-1)

Major course

Pre-requisites: Mechanics

Objectives: To understand the fundamentals of heat and thermodynamics.

Basic Concepts and Definitions in Thermodynamics: Thermodynamic system, Surrounding and Boundaries. Type of systems. Macroscopic and microscopic description of system. Properties and state of the substance: Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium. Processes and Cycles: Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium.

Heat and Temperature: Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts.

Internal energy of an ideal gas: Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state.

Thermodynamics: First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible processes. Second law of thermodynamics, Carnot theorem and Carnot engine. Heat engine, Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamics, Entropy and Probability.

Thermodynamic Functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule-Thomson effect and its equations. Thermoelectricity: Thermocouple, Seabeck's effect, Peltier's effect.

Experiments:

1. Measurement of the Thermal E.M.F. of a thermocouple as a function of temperature between its Hot and Cold junctions.
2. Determination of the temperature co-efficient of resistance of a wire.
3. Determination of the Mechanical Equivalent of Heat by J Callendar and Barne's constant flow apparatus with heat loss compensation.
4. Determination of Stefan's constant.
5. Calibration of a thermocouple by potentiometer.

Recommended Books:

1. D. Halliday, R. Resnick and K. Krane, "Physics", John Wiley, 5th ed.2002.
2. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010.
3. M. W. Zemansky, "Heat and Thermodynamics", Mc Graw Hill, 7th ed.1997.
4. M. Sprackling, "Thermal Physics" McMillan 1991.
5. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics,London 1995.

MATH- 502 CALCULUS –II Credit Hours: 3(3-0)

Interdisciplinary course

Prerequisites: Calculus I

Objectives: This is second course of Calculus. As continuation of Calculus I, it focuses on techniques of integration and applications of integrals. The course also aims at introducing the students to infinite series, parametric curves and polar coordinates.

Contents:

Techniques of integration: Integrals of elementary, hyperbolic, trigonometric, logarithmic and exponential functions. Integration by parts, substitution and partial fractions. Approximate integration. Improper integrals.

Applications of integrals: Area under and between curves, Area between lines, area between the line and curve, average value. Volumes. Arc length. Area of a surface of revolution. Applications to Economics, Physics, Engineering and Biology.

Power series. Convergence of power series. Representation of functions as power series. Differentiation and integration of power series. Taylor and McLaurin series. Approximations by Taylor polynomials.

Conic section: parameterized curves and polar coordinates: Curves defined by parametric equations. Calculus with parametric curves: tangents, areas, arc length. Polar coordinates. Polar curves, tangents to polar curves. Areas and arc length in polar coordinates.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison WesleyPublishing Company, 2005
2. H. Anton, I. Bevens, S. Davis, Calculus, 8th Edition, John Wiley & Sons, Inc. 2005
3. Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002.
4. Frank A. Jr, Elliott Mendelson, Calculus, Schaum's outlines series, 4th Edition, 1999
5. C.H. Edward and E.D Penney, Calculus and Analytics Geometry, Prentice Hall, Inc. 1988
6. E. W. Swokowski, Calculus with Analytic Geometry, PWS Publishers, Boston, Massachusetts, 1983.
7. M. Liebeck, A Concise introduction to pure Mathematics, CRC Press, 2011.
8. A. Kaseberg, Intermediate Algebra, Thomson Brooks/COLE, 2004.
9. J. Stewart, Calculus early transcendentals, 7th Edition, Brooks/COLE, 2008.

EP-500 ENVIROMENTAL PHYSICS Credit Hours: 3 (2-1)

Interdisciplinary Course

Objectives: To become familiar with the essentials of environment and Global climate. To learn to use spectroscopy for environments.

Contents:

Introduction to the Essentials of Environmental Physics: The economic system, living in green house, enjoying the sun, Transport of matter, Energy and momentum, the social and political context.

Basic Environmental Spectroscopy: Black body radiation, The emission spectrum of sun, The transition electric dipole moment, The Einstein Coefficients, Lambert – Beer‟s law, The spectroscopy of bi-molecules, Solar UV and life, The ozone filter.

The Global Climate: The energy Balance, (Zero-dimensional Greenhouse Model), elements of weather and climate, climate variations and modeling.

Transport of Pollutants: Diffusion, flow in reverse, ground water. Flow equations of fluid Dynamics, Turbulence, Turbulence Diffusion, Gaussian plumes in air, Turbulent jets and planes.

Noise: Basic Acoustics, Human Perceptions and noise criteria, reducing the transmission of sound, active control of sound.

Radiation: General laws of Radiation, Natural radiation, interaction of electromagnetic radiation and plants, utilization of photo synthetically active radiation.

Atmosphere and Climate: Structure of the atmosphere, vertical profiles in the lower layers of the atmosphere, Lateral movement in the atmosphere, Atmospheric Circulation, cloud and Precipitation, The atmospheric greenhouse effect.

Topo Climates and Micro Climates: Effects of surface elements in flat and widely unduling areas, Dynamic action of seliq. Thermal action of selief.

Climatology and Measurements of Climate Factor: Data collection and organization, statistical analysis of climatic data, climatic indices, General characteristics of measuring equipment. Measurement of temperature, air humidity, surface wind velocity, Radiation balance, precipitation, Atmospheric Pressure, automatic weather stations.

Experiments:

1. Measurement of Electrical conductivity of Extract from Soil Saturated paste by use of digital conductivity Meter.
2. Measurmrnt of Viscosity of water.
3. Measurement of intensity of Noise by sound level meter.
4. Measurement of Air pollution by stochastic modeling techniques.
5. Measurement of conductivity of water.
6. Measurement of Relative humidity by using Dry and Wet bulb thermometers.
7. Measurement of total dissolved solids in water sample.
8. Preparation of EIA reports for Environmental protection.
9. Measurement of Different Atmospheric parameters. .

Recommended Books:

1. E.t Booker and R. Van Grondelle, "Environmental Physics", John Wiley, 3rd ed. 2011.
2. G. Guyot, "Physics of Environment and Climate", John Wiley, 1998.

QR-502 QUANTITATIVE REASONING-II Credit Hours: 3 (3 – 0)

General course

Objectives:

Quantitative Reasoning (II) is a sequential undergraduate course that focuses on logical reasoning supported with mathematical and statistical concepts and modeling / analysis techniques to equip students with analytical skills and critical thinking abilities necessary to navigate the complexities of the modern world. The course is designed to familiarize students with the quantitative concepts and techniques required to interpret and analyze numerical data and to inculcate an ability in students the logical reasoning to construct and evaluate arguments, identify fallacies, and think systematically. Keeping the pre-requisite course of Quantitative Reasoning (1) as its base, this course will enable students further their quantitative, logical and critical reasoning abilities to complement their specific major/field of study.

Contents

1. Logic, Logical and Critical Reasoning

- Introduction and importance of logic,
- Inductive, deductive and abductive approaches of reasoning;
- Propositions, arguments (valid, invalid), logical connectives, truth tables and propositional
- equivalences;
- Logical fallacies,
- Venn Diagrams;
- Predicates and quantifiers,

- Quantitative reasoning exercises using logical reasoning concepts and techniques.

2. Mathematical Modeling and Analyses

- Introduction to deterministic models,
- Use of linear functions for modeling in real-world situations.
- Modeling with the system of linear equations and their solutions;
- Elementary introduction to derivatives in mathematical modeling
- Linear and exponential growth and decay models,
- Quantitative reasoning exercises using mathematical modeling

3. Statistical Modeling and Analyses

- Introduction to probabilistic models:
- Bivariate analysis, scatter plots,
- Simple linear regression model and correlation analysis;
- Basics of estimation and confidence interval;
- Testing of hypothesis (z-test; t-test);
- Statistical inference in decision making;
- Quantitative reasoning exercises using statistical modeling.

Recommended Books:

1. "Using and Understanding Mathematics: A Quantitative Reasoning Approach" by Bennett, J. O., Briggs, W. L., & Badalamenti, A.
2. "Discrete Mathematics and its Applications" by Kenneth H. Rosen. 3. "Discrete Mathematics with Applications" by Susanna S. Epp.
3. "Applied Mathematics for Business, Economics and Social Sciences" by Frank S Budnick.
4. "Elementary Statistics: A Step by Step Approach" by Allan Bluman.
5. "Introductory Statistics" by Prem S. Mann.
6. "Applied Statistical Modeling" by Salvatore Babones.
7. "Barrons SAT" by Sharvon Weiner Green, M.A and Ira K. Wolf.

ENG-502 EXPOSITORY WRITING Credit Hours: 3 (3 – 0)

General course

Pre-Requisite: Functional English

Objectives: Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation of the pre-requisite course, Functional English, this course will enhance students' abilities of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays.

Contents:

1. Introduction to Expository Writing:

- Understanding expository writing (definition, types, purpose and applications)
- Characteristics of effective expository writing (clarity, coherence and organization)
- Introduction to paragraph writing

2. The Writing Process:

- Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.)
- Drafting (three stage process of drafting techniques)
- Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.)
- Proof reading (fine-tuning of the draft)
- Peer review and feedback (providing and receiving critique)

3. Essay Organization and Structure:

- Introduction and hook (engaging readers and introducing the topic) Thesis statement (crafting a clear and focused central idea)
- Body Paragraphs (topic sentences, supporting evidence and transitional devices)
- Conclusion (types of concluding paragraphs and leaving an impact)
- Ensuring cohesion and coherence (creating seamless connections between paragraphs)

4. Different Types of Expository Writing:

- Description
- Illustration
- Classification
- Cause and effect (exploring causal relationships and outcomes)
- Process analysis (explaining step-by-step procedures)
- Comparative analysis (analyzing similarities and differences)

5. Writing for Specific Purposes and Audiences:

- Different types of purposes (to inform, to analyze, to persuade, to entertain etc.) Writing for academic audiences (formality, objectivity, and academic conventions)
- Writing for public audiences (engaging, informative and persuasive language)
- Different tones and styles for specific purposes and audiences

6. Ethical Considerations:

- Ensuring original writing (finding credible sources, evaluating information etc.)
- Proper citation and referencing (APA, MLA, or other citation styles)
- Integrating quotes and evidences (quoting, paraphrasing, and summarizing)
- Avoiding plagiarism (ethical considerations and best practices)

Suggested Practical Activities (Optional)

As part of the overall learning requirements, students will be required to build a writing portfolio having a variety of expository texts and present the same at the end of the course showcasing proficiency in expository writing.

Recommended Books:

1. "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper.
2. "They Say/1Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein.
3. "Writing Analytically" by David Rosenwasser and Jill Stephen.
4. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup.
5. "The Elements of Style" by William Strunk Jr. and E.B. White.
6. "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer.

PHY-504 ELECTRICITY AND MAGNETISM Credit Hours: 3(2-1)

Major course

Pre-requisite: Mechanics, Calculus I

Objectives: The main objective of this course is to understand the Physics of Electromagnetism and to develop simple mathematical formalisms to analyze the electromagnetic fields and interactions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Contents:

Electrostatics: Electric Charge, , Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to different Charge Distribution (line, disc, ring), Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry.

Electric Potential: Electric potential, Electric potential energy**,** Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and Electric Potential.

Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot- Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole,

Electro Magnetic Induction: Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self-Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.

Alternating Fields and Currents: LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents, Forced Oscillations, Resistive, Capacitive, and Inductive Loads, RLC series Circuit, Power in AC Circuits, Transformers, Gauss' Law for Magnetism, Induced Magnetic Fields, Displacement Current, Spin & Orbital Magnetic Dipole Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis.

Experiments:

1. To determine the frequency of AC supply.
2. Measurement of high resistance using a neon flash bulb and a capacitor.
3. Measurement of low resistance coil by a Cary Foster Bridge.
4. Conversion of a moving-coil galvanometer into voltmeter and ammeter.
5. Calibration of an ammeter using a potentiometer.
6. Calibration of a voltmeter using a potentiometer.
7. To determine (i) current sensitivity and (ii) charge sensitivity of a ballistic galvanometer
8. Comparison of capacities of two capacitors by a ballistic galvanometer.
9. To determine the self-inductance of a coil by Rayleigh's Method.
10. To determine the self-inductance of a coil by Anderson's Method.
11. To determine the coefficient of mutual inductance of a pair of a coils.
12. Measurement of resistance using neon flash bulb and condenser
13. To convert a Weston type galvanometer into an ammeter of a given range
14. To study the BH curve and measuring the magnetic properties
15. Determination of the resonance frequency, band width and quality factor of a series RLC (acceptor) circuit and parallel RLC (rejecter) circuit.
16. Measurement of DC and AC voltages by Cathode ray oscilloscope.

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 2010.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

PHY-505 MODERN PHYSICS-I Credit Hours: 3(3-0)

Major course

Pre-requisites: Mechanics, Electricity and Magnetism

Objective(s):

To understand the non-classical aspects of Physics, the emphasis is on the applications of Quantum Physics in microscopic-scale Physics, atomic and molecular structure and processes.

Contents:

Motivation for Non--Classical Physics: Blackbody radiation and ultraviolet catastrophe, Planck's quantization.

Wace-Particle Duality: Photoelectric effect, Compton effect, production and properties of X-rays, diffraction of X-rays, concept of matter waves, de Broglie relationship, Quantum interference electrons are waves, electron diffraction, particulate nature of matter, contributions of Faraday (atoms exist), Thomson (electron exists), Rutherford (nucleus exists) and Bohr (quantization of energies inside

an atom), wave packets and wave groups, dispersion, Heisenberg uncertainty principle, direct confirmation of quantization through Franck-Hertz experiment and spectroscopy, working of electron microscopes.

Quantum Mechanics in One Dimension: The concept of a wavefunction, time independent Schrodinger equation and interpretation of the equation, solving the Schrodinger equation for a free particle, for a particle inside an infinite box, relationship between confinement and quantization, working of a CCD camera.

Quantum Mechanical Tunneling: Concept of tunneling, reflection and transmission of wave functions from barriers, applications: radioactivity, scanning tunneling microscope, decay of black holes.

Recommended Books:

1. R.A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", Brooks Cole, 3rd ed. 2004.
2. Paul A. Tipler and Ralph A. Llewellyn, "Modern Physics", W H Freeman and Company 6th ed. 2012.
3. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th ed. 2002.
4. R. M. Eisberg and R. Resnick, "Quantum Physics of Atoms, molecules, Solids, Nuclei and Particles", John Wiley, 2nd ed. 2002.

PHY-506 OPTICS Credit Hours: 3(3-0)

Major Course

Pre-Requisites: Waves and Oscillations

Objective(s): To understand the optical phenomena and their uses in physical systems.

Contents:

Propagation of Light & Image Formation: Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface, Thin Lenses, Newtonian Equation for a Thin Lens.

Matrix Methods in Paraxial Optics: Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points of an Optical System with examples, Optical Instruments including Simple Magnifiers, Telescopes and Microscopes, Chromatic and Monochromatic Aberrations, Spherical Aberrations, Coma, Distortion, Stops, Pupils, Windows.

Superposition & Interference: Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple-Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range.

Polarization: Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction.

Fraunhofer Diffraction: from a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings.
Fresnel Diffraction: Zone Plates, Rectangular Apertures, Cornu's Spiral
Coherence & Holography: Temporal Coherence, Spatial Coherence, Holography of a Point object and an Extended Object
Laser Basics: Stimulated Emission, Population Inversion, Resonators, Threshold and Gain, Multi-layered Dielectric Films.

Recommended Books:

1. F.Pedrotti, L.S. Pedrotti and L.M. Pedrotti,"Introduction to Optics", Pearson Prentice Hall, 3rd ed. 2007.
2. E. Hecht and A. Ganesan, "Optics", Dorling Kindersley, 4th ed. 2008.
3. M. V. Klein and T. E. Furtak, "Optics", John Wiley, 2nd ed. 1986.
4. K. K Sharam, "Optics: Principles and Applications", Academic Press, 2006.
5. C. A. Bennett, "Principles of Physical Optics", John Wiley, 2008.

MATH- 504 LINEAR ALGEBRA Credit Hours: 3(3-0)

Interdisciplinary course

Prerequisites: Calculus I
Objectives: Linear algebra is the study of vector spaces and linear transformations. The main objective of this course is to help students learn in rigorous manner, the tools and methods essential for studying the solution spaces of problems in mathematics, engineering, the natural sciences, and social sciences and develop mathematical skills needed to apply these to the problems arising within their field of study; and to various real-world problems.

Contents:

System of Linear Equations: Representation in matrix form. Matrices. Operations on matrices. Echelon and reduced echelon form. Inverse of a matrix (by elementary row operations). Solution of linear system. Gauss-Jordan method. Gaussian elimination.
Determinants: Permutations of order two and three and definitions of determinants of the same order. Computing of determinants. Definition of higher order determinants. Properties. Expansion of determinants.
Vector Spaces: Definition and examples, subspaces. Linear combination and spanning set. Linearly Independent sets. Finitely generated vector spaces. Bases and dimension of a vector space. Operations on subspaces, Intersections, sums and direct sums of subspaces. Quotient Spaces.
Linear mappings: Definition and examples. Kernel and image of a linear mapping. Rank and nullity. Reflections, projections, and homotheties. Change of basis. Eigen-values and eigenvectors. Theorem of Hamilton-Cayley.
Inner product Spaces: Definition and examples. Cauchy inequality. Orthogonal and orthonormal basis. Gram Schmidt Process. Diagonalization.

Recommended Books:

1. Ch. W. Curtis, Linear Algebra, Springer 2004.
2. T. Apostol, Multi Variable Calculus and Linear Algebra, 2nd ed., John Wiley and sons, 1997.
3. H. Anton, C. Rorres , Elementary Linear Algebra: Applications Version, 10th Edition, John Wiley and sons, 2010.
4. S. Friedberg, A. Insel, Linear Algebra, 4th Edition, Pearson Education Canada, 2003.
5. S. I. Grossman, Elementary Linear Algebra, 5th Edition, Cengage Learning, 2004.

GC-5XX ARTS AND HUMANITIES ((INTRODUCTION TO HISTORY, INTRODUCTION TO PHILOSOPHY, INTRODUCTION TO MASS COMMUNICATION, INTRODUCTION TO PSYCHOLOGY) General Education Course Credit hours: 2 (2 – 0)

Course Content may be taken from the selected discipline (See on Page no. 65)

SOC-502 CIVICS AND COMMUNITY ENGAGEMENT Credit Hours: 2 (2 - 0)
General Education Course

Pre-Requisite: Nil

Objectives:

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

Contents:

1. Civics and Citizenship:
- Concepts of civics, citizenship, and civic engagement.
- Foundations of modern society and citizenship.
- Types of citizenship: active, participatory, digital, etc.

2. State, Government and Civil Society:
- Structure and functions of government in Pakistan.
- The relationship between democracy and civil society.
- Right to vote and importance of political participation and representation.

3. Rights and Responsibilities:
- Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973.
- Civic responsibilities and duties.
- Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)

4. Community Engagement:
- Concept, nature and characteristics of community.
- Community development and social cohesion.
- Approaches to effective community engagement.
- Case studies of successful community driven initiatives.

5. Advocacy and Activism:
- Public discourse and public opinion.
- Role of advocacy in addressing social issues.
- Social action movements.

6. Digital Citizenship and Technology:
- The use of digital platforms for civic engagement.
- Cyber ethics and responsible use of social media.
- Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship.

7. Diversity, Inclusion and Social Justice:
- Understanding diversity in society (ethnic, cultural, economic, political etc.).
- Youth, women and minorities' engagement in social development.
- Addressing social inequalities and injustices in Pakistan.

- Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

Suggested Practical Activities (Optional)

As part of the overall learning requirements, the course may have one or a combination of the following practical activities:

1. Community Storytelling: Students can collect and share stories from community members. This could be done through oral histories, interviews, or multimedia presentations that capture the lived experiences and perspectives of diverse individuals.

2. Community Event Planning: Students can organize a community event or workshop that addresses a specific issue or fosters community interaction. This could be a health fair, environmental cleanup, cultural festival, or educational workshop.

3. Service-Learning: Students can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time and skills to address a particular community need, such as tutoring, mentoring, or supporting vulnerable populations.

4. Cultural Exchange Activities: Students can organize a cultural exchange event that celebrates the diversity within the community. This could include food tastings, performances, and presentations that promote cross-cultural understanding.

Recommended Books:

1. "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education.
2. "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman.
3. "Engaging Youth in Civic Life" by James Youniss and Peter Levine.
4. "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson.
5. "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
6. "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and Susan M. Omilian.

PS-526 IDEOLOGY AND CONSTITUTION OF PAKISTAN Credit Hours: 2 (2–0)

General Course

Objectives:

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

Contents:

1. **Introduction to the Ideology of Pakistan:**
   - Definition and significance of ideology.
   - Historical context of the creation of Pakistan (with emphasis on socio-political, religious, and cultural dynamics of British Indin between 1857 till 1947).
   - Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah,, etc.
   - Contributions of women and students in the freedom movement for separate homeland for Muslims of British India.

2. **Two-Nation Theory:**
   - Evolution of the Two-Nation Theory (Urdu-Hindi c ontroversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937
   - Lahore Resolution 1940)
   - Role of communalism and religious differences.
3. **Introduction to the Constitution of Pakistan:**
   - Definition and importance of a constitution.
   - Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949)
   - Overview of constitutional developments in Pakistan.
4. **Constitution and State Structure:**
   - Structure of Government (executive, legislature, and judiciary).
   - Distribution of powers between federal and provincial governments.
   - 18th Amendment and its impact on federalism.
5. **Fundamental Rights, Principles of Policy and Responsibilities:**
   - Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
   - Overview of Principles of Policy (Articles 29-40).
   - Responsibilities of the Pakistani citizens (Article 5).
6. **Constitutional Amendments:**
   - Procedures for amending the Constitution.
   - Notable constitutional amendments and their implications.

Recommended Books:

1. "The Idea of Pakistan" by Stephen P. Cohen.
2. "Ideology of Pakistan" by Javed Iqbal.
3. "The Struggle for Pakistan" by 1.H. Qureshi.
4. "Pakistan the Formative Phase" by Khalid Bin Sayeed.
5. "Pakistan: Political Roots and Development" by Safdar Mahmood.
6. "Ideology of Pakistan" by Sharif-ul-Mujahid.
7. "The Struggle for Pakistan: A Muslim Homeland and Global Politics" by Ayesha Jalal.
8. "Jinnah, Pakistan and Islamic Identity: The Search for Saladin" by Akbar S. Ahmed.

PHY-507 MODERN PHYSICS-II Credit Hours: 3(2-1)
Major course

Pre-requisites: Modern Physics-I

Objective(s): To understand the non-classical aspects of Physics, the emphasis is on the applications of Quantum Physics in microscopic-scale Physics, atomic and molecular structure and processes.

Contents:

Special Theory of Relativity: Inertial and non-inertial frame, Postulates of Relativity, The Lorentz Transformation, Derivation, Assumptions on which inverse transformation is derived, Consequences of Lorentz transformation, Relativity of time, Relativity of length, Relativity of mass, Transformation of velocity, variation of mass with velocity, mass energy relation and its importance, relativistic momentum and Relativistic energy, (Lorentz invariants)

Quantum Mechanics in Three Dimensions: The Hydrogen atom, orbitals, angular momentum and its quantization, orbital magnetism, concept of spin, Building of the periodic table, magnetic resonance and MRI, why is iron magnetic? White dwarfs, and neutron stars.

Nuclear Structure: Size and structure of nucleus, nuclear forces, radioactivity and nuclear reactions, radiocarbon dating.

Recommended Books:

1. R.A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", Brooks Cole, 3rd ed. 2004.
2. Paul A. Tipler and Ralph A. Llewellyn, "Modern Physics", W H Freeman and Company 6th ed. 2012.
3. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th ed. 2002.
4. R. M. Eisberg and R. Resnick, "Quantum Physics of Atoms, molecules,
5. Solids, Nuclei and Particles", John Wiley, 2nd ed. 2002.

Experiments:

1. To study the characteristics of photoelectron emission and determination of Planck's constant using a photocell.
2. Determination of ionization potential of mercury.
3. Variation of Photoelectric current with intensity of light.
4. Measurement of the Thermal E.M.F. of a thermocouple as a function of temperature between its Hot and Cold junctions.
5. Determination of the temperature co-efficient of resistance of a wire.
6. Determination of the Mechanical Equivalent of Heat J by Callendar and Barne's constant flow apparatus with heat loss compensation.
7. Determination of Stefan's constant.
8. Calibration of a thermocouple by potentiometer.

PHY-508 ELECTRONICS-I Credit Hours: 3(2-1)

Major course

Pre-requisites: Modern Physics-I

Contents:

Diodes and their applications: Semiconductors, Conductors and Insulators; N-Type Semiconductors; The PN-Junction and it's Basing; Current-Voltage Characteristic of a PN-Junctions; The Diode and its Models. Half-wave Rectifier; Full-wave Rectifier (Simple and Bridge); Smoothing Circuits (Series Inductor, Shunt Capacitor, LC and CLC filter); Clipper and Clamper Circuits; Voltage Multiplier circuits; Zener Diodes; Voltage Regulation; Varactor Diode; Optical Diodes (LED and Photodiode); LED Applications; Current Regulator Diode; The Schottky Diode; The PIN Diode; The Tunnel Diode; The laser Diode.

Circuit Theory and Analysis: Superposition theorem, Thevenin's Theorem, Norton's Theorem, Model for circuit, one port and two-port network, Hybrid parameter equivalent circuit, Power in decibels.

Bipolar junction transistor.

Basic Transistor Operation; Transistor Characteristics and Parameters (Alpha and Beta Parameters, Current and Voltage Analysis, Characteristic Curves, DC Load Line, Variation of Beta with Temperature); Transistor as an Amplifier: Transistor as a Switch; Photo transistor, The DC Operating Point; Voltage Divider Bias; Base Bias; Emitter Bias, Emitter feedback bias, Collector Feedback Bias

Bipolar junction transistor amplifiers.

Amplifier Operation; Transistor AC Equivalent Circuits (r-Parameters, h – parameters); Common Emitter Amplifier DC and AC Analysis, Voltage Gain, Current Gain, Power Gain); Common Collector Amplifier (Voltage Gain; Input Resistance; Current Gain; Power Gain); Darlington Pair; Common Base Amplifier (Voltage Gain, Input Resistance, Current Gain, Power Gain); Multistage Amplifiers, Differential amplifier.

Experiments:

1. IV characteristics of forwarded and reversed biased PN junction diode
2. To perform half- Wave Rectification and to calculate its
   i. Ripple factor
   ii. Form factor
   iii. Efficiency
3. To perform full-Wave Rectification and to calculate its
   i. Ripple factor
   ii. Form factor
   iii. Efficiency
4. To design and assemble a common-emitter voltage amplifier and study its frequency response.
5. To design and assemble a common-collector amplifier (emitter follower) and study its frequency response.
6. To design and assemble a two –stage RC coupled amplifier and study its frequency response.
7. To design and assemble a class' A' power amplifier and study its frequency response.
8. To design & assemble a class 'B' (complementary symmetry) power amplifier and study its frequency response.
9. To design and assemble a Push-Pull class' B' amplifiers study its frequency repose.
10. To design and assemble a transistorized split load phase inverter.

Recommended Books:

1. T.L.Floyd' Electronic Devices 9/e Prentice Hall (2012) Main Text Book.
2. Robert L. Boylestad. Introductory Circuit Analysis, 12th /e,
3. Hayt & Kimberly Circuit Analysis - Electrical and Computer Engineering, McGraw-Hill Book Company 8th /e
4. A.P. Malvino' Electronic Principles' 7/e with CD-ROM Glencoe/ McGraw-Hill (2007).
5. D.A. Bell' Electronic Devices and Circuits'4/e Prentice Hall (1999).
6. C.J. Savant Jr. M.S. Roden and G.L Carpenter' Electronic Design Circuit and System' The Benjamin Publishing Co., California (1994).
7. B. Grob, "Basic Electronics", McGraw-Hill, Tch ed. 1997.
8. B. Streetman and S. Banerjee "Solid State Electronics Devices", Prentice
9. Hall, 6th ed. 2005.
10. R. T. Paynter, "Introductory Electric Circuits", Prentice Hall, 1998.

MATH-509 ORDINARY DIFFERENTIAL EQUATIONS Credit Hours: 3(3-0)

Interdisciplinary Course

Prerequisites: Calculus I

Specific Objectives of course: To introduce students to the formulation, classification of differential equations and existence and uniqueness of solutions. To provide skill in solving initial value and boundary value problems. To develop understanding and skill in solving first and second order linear homogeneous and nonhomogeneous differential equations and solving differential equations using power series methods. To understand the skill used in solving partial differential equations and their applications.

Course Outline:

Introduction to differential equations: Definitions and terminology, Initial-value problems, Linear and nonlinear equations, general solution, Particular solution, explicit solution, implicit solution, Differential equations as mathematical models.

First order differential equation: Basic concepts, formation and solution of differential equations. Separable variables, Exact Equations, Homogeneous Equations, Linear equations, integrating factors. Some nonlinear first order equations with known solution, differential equations of Bernoulli and Ricaati type, Clairaut equation. Applications of first order differential equations.

linear differential equations of higher order: Initial value and boundary value problems, linear dependence and independence, solutions of linear equations, constructing a second solution from a known solution, homogeneous linear equations with constant coefficients, undetermined coefficients, variation of parameters, applications of second order ODEs (simple harmonic motion, damped and forced oscillators, electrical circuits and springs)

Differential equations with variable coefficients: Cauchy-Euler equation, power series solution of differential equations – solutions about ordinary and singular points-Legendre's and Bessel's equations as examples,

Partial Differential Equation: Introduction to important PDEs in Physics (wave equation, diffusion equation, Poisson's equation, Schrodinger‟s equation), general form of solution, general and particular solutions (first order, inhomogeneous, second order), characteristics and existence of solutions, uniqueness of solutions, separation of variables in Cartesian coordinates, superposition of separated solutions, separation of variables in curvilinear coordinates,

Recommended Books:

1. Dennis G. Zill and Michael R., Differential equations with boundary-value problems by Cullin 5th Edition Brooks/Cole, 1997.
2. William E. Boyce and Richard C. Diprima, Elementary differential equations and
3. boundary value problems, Seventh Edition John Wiley & Sons, Inc
4. Apostol, Multi Variable Calculus and Linear Algebra, 2nd ed., John Wiley sons, 1997.

CHEM- 500 CHEMISTRY Credit Hours: 3 (2-1)

General Course (Natural Science)

Objective:

To study the basic concepts of chemistry including periodic table, hydrogen and hydrides, electrochemical cells, hydrocarbons, organic polymers, Chromatography and spectroscopy.

Contents:

Atomic Structure: Structure of atom, Quantum Numbers, Heisenberg's Uncertainty Principle, Ionization Potential, Electronegativity and Electron affinity.

Periodic Table and Periodicity: Development of Modern Periodic Table, Periodicity of Properties electronic configuration and classification of elements.

Chemical Bonding: Nature and types of chemical bond, Ionic, Covalent, Coordinate Covalent, Sigma, Pi, Polar and Non-polar bonds.

Basic Concepts of Organic Chemistry: Introduction, Functional groups, resonance effect, inductive effect, hydrogen bonding, Tautomerism.

Recommended Books:

1. M. Younas, Organic Spectroscopy and Chromatography, Lahore Ilmi Kitab Khana, 1998
2. M. Younas, A Textbook of Organic Chemistry, Publication: Lahore Ilmi Kitab Khana, 2011
3. M. Zafar Iqbal, Text Book of Inorganic Chemistry, Ilmi Kitab Khana, 1990.
4. JohnE. Mcmurry, Organic Chemistry, Mary Finch, 8th Edi., 2012.
5. Rehman, A., Text book of Organic Chemistry. Karwan book house.
6. March, J., Advanced Organic Chemistry. John Wiley and sons.
7. Pine., S.H., Organic Chemistry, McGraw Hill, Inc.
8. Sykes, F., Organic reaction Mechanism.
9. *Younas, M., Organic spectroscopy, A.H. Publisher.*
10. Vogel, A.I, Organic analysis, Longman Green & Co.
11. Solomon, T.W.G., Organic Chemistry, John Wiley and sons.

ENT-508 ENTREPRENEURSHIP Credit hours: 2 (2 – 0)

General Education Course

Objectives:

This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge, skills, abilities, enabling them to seize the identified opportunities for initiating ventures and successful navigating the challenges that come with starting a business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business, market research, opportunity identification, business planning. Financial literacy for managing finances and securing funding, marketing and sales, team building and innovation.

Contents:

1. Introduction to Entrepreneurship:

- Definition and concept of entrepreneurship.
- Why to become an entrepreneur?
- Entrepreneurial process.
- Role of entrepreneurship in economic development.

2. Entrepreneurial Skills:

- Characteristics and qualities of successful entrepreneurs (including stories of successes and failures).
- Areas of essential entrepreneurial skill and ability such as creative and critical thinking.
- Innovation and risk taking abilities etc.

3. Opportunity Recognition and Idea Generation:

- Opportunity identification, evaluation and exploitation;
- Innovative idea generation techniques for entrepreneurial ventures.

4. Marketing and Sales

- Target market identification and segmentation;
- Four P's of Marketing.
- Developing a marketing strategy.
- Branding.

5. Financial Literacy:

- Basic concepts of income, savings and investments.

- Basic concepts of assets, liabilities and equity.
- Basic concepts of revenue and expenses.
- Overview of cash-flows.
- Overview of banking products including Islamic modes of financing.
- Sources of funding for startups (angel financing, debt financing, equity financing etc.).

6. Team Building for Startups:

- Characteristics and features of effective teams.
- Building and effective leadership for startups.

7. Regulatory Requirements to Establish Enterprises in Pakistan:

- Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.).
- Intellectual property rights and protection.
- Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms.
- Taxation and financial reporting obligation.

Suggested Practical Activities (Optional)

As part of the overall learning requirements, students shall be tasked with creating and presenting a comprehensive business plan at the end of the course for a hypothetical or real business idea. This practical exercise shall allow them to apply the knowledge, skills and competencies acquires in the course to develop a feasible business plan.

Recommended Books:

1. "Entrepreneurship: Successfully Launching New Ventures" by Bruce R. Barringer and R. Duane Ireland.
2. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko.
3. "New Venture Creation: Entrepreneurship for the 21st Century" by Jeffry A. Timmons, Stephen Spinelli Jr., and Rob Adams.
4. "Entrepreneurship: A Real-World Approach" by Rhonda Abrams.
5. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.
6. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valérie Ohlsson.

PST - 501 PAKISTAN STUDIES Credit hours: 2 (2 – 0)

General Education Course

Objectives:

This course is designed to provide students with a comprehensive exploration of Pakistan's identity, spanning geographical, historical, and cultural dimensions. It delves into the diverse landscapes, ancient civilizations, and rich cultural heritage that define Pakistan. Moreover, it examines the socio-cultural and political transformations in Pakistan over time including democratic transitions and military interventions. The aim of this course is to inculcate in students a nuanced understanding of Pakistan's past, present, and potential future trajectories, enabling them to critically evaluate the complex dynamics shaping the nation's development.

Course Learning Outcomes:

By the end of this course, students will be able to:

1. Have enhanced knowledge of the geographical, historical, and political aspects of Pakistan.
2. Understand the society and culture of Pakistan.
3. Understand and explain the socio-economic developments in Pakistan.

4. Explore contemporary issues and challenges faced by Pakistan and their implications for the future.

Contents:

1. Introduction to Pakistan:

- Geographical location and significance.
- Historical background: Ancient civilizations in the region.
- Factors leading to the creation of Pakistan.

2. Political History of Pakistan:

- Formative phase.
- Military interventions and democratic transitions.

3. Geography of Pakistan:

- Physiography: Mountains, plains, plateaus, deserts, valleys and coastal areas.
- River systems: Indus River and its tributaries
- Climatic regions of Pakistan.

4. Society and Culture of Pakistan:

- Socio-cultural diversity.
- Languages and literature of Pakistan.

5. Economic Development of Pakistan:

- Agriculture and industrial sectors of Pakistan.
- Economic challenges of Pakistan.

6. Contemporary Issues:

- Foreign relations of Pakistan.
- Security challenges: terrorism, extremism, and regional conflicts.
- Environmental problems and sustainable development (SDGs).
- Media and social change.

Recommended Books:

1. "Jinnah of Pakistan" by Stanley Wolpert
2. "The Sole Spokesman: Jinnah, the Muslim League, and the Dermand for Pakistan" by Ayesha Jalal
3. "The struggle for Pakistan" by Ishtiaq Husain Qureshi 4. "Pakistan, the Formative Phase, 1857-1948" by Khalid B. Sayeed
4. "Pakistan Studies: A Book of Readings" by Sikandar Hayat
5. "Constitutional and Political History of Pakistan" by Hamid Khan
6. "Trek to Pakistan" by Ahmad Saeed and Kh. Mansur Sarwar
7. "Pakistan: A Modern History" by lan Talbot
8. "Politics in Pakistan: The Nature and Direction of Change" by Khalid B. Sayeed
9. "Physical Geography of Pakistan" by Umar Jahangir
10. "A Geography of Pakistan: Environment, People, and Economy" by Fazle Karim Khan 12. "Pakistan's Foreign Policy: An Historical Analysis" by S. M. Burke
11. "Separatism in East Pakistan" by Rizwan Ullah Kokab 14. "Being Pakistani: Socicty, Culture and the Arts" by Raza Rumi
12. "Pakistan's Cultural Heritage: Socio-Economic and Technological Aspects" edited by Abdul Jabbar Khan
13. "Language and Politics in Pakistan" by Tariq Rahman
14. "Sociology" by Horton and Hunt
15. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring
16. "Economic Development of Pakistan" by Ishrat Husain

GC-5XX SOCIAL SCIENCES (FUNDAMENTAL OF GEOGRAPHY, FUNDAMENTAL OF DISASTER MANAGEMENT, INTRODUCTION TO INTERNATIONAL RELATIONS, INTRODUCTION TO SOCIOLOGY, INTRODUCTION TO POLITICAL SCIENCE, FUNDAMENTALS OF ECONOMICS)

General Education Course **Credit hours: 2 (2 – 0)**

Select only one course, course contents may be taken from the selected discipline (See on page no. 68)

PHY-601 CLASSICAL MECHANICS Credit Hours: 3(3-0)

Major course

Pre-requisites: Mechanics

Central Force Motion: Review of Newtonian Mechanics, Central Force, the two-body problem and reduce mass, General properties of Central force motion, effective potential and classification of orbits, Kepler's laws, stability of circular orbits, Scattering in a Central Force Field, hyperbolic orbits and Rutherford scattering, scattering cross-sections. Center of mass co-ordinate system

The Lagrange Formulation of Mechanics: Degree of freedom and Constraints, Generalized co-ordinates, Virtual work, D'Alembert's principle, Lagrange's Equations and applications, Equivalence of Lagrange 's and Newton's Equation

Hamiltonian Dynamics, Hamilton's principle, Lagrange's equation from Hamilton's principle, integrals of motion, non-conservative system and generalized potential, the Hamiltonian of a dynamical system(Legender transformation), Hamilton's canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem.

Motion in Non-Inertial Systems: Accelerated translational co-ordinate system, dynamics in rotating co-ordinate system, Coriolis Force, motion of a particle near the surface of the earth

The Motion of Rigid Bodies: The Euler Theorem, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, Euler's Angles, motion of a torque-free symmetrical top, stability of rotational motion.

Recommended Books:

1. T. L. Chow, "Classical Mechanics", John Wiley, 1995.
2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed.2004.

PHY-602 ELECTRONICS II Credit Hours: 3(2-1)

Major Course

Field Effect Transistors: Junction FET; MOSFET; Operation and Construction; Biasing (Self Bias and Voltage Divider Bias); Insulated Gate Bipolar Junction Transistor (IGBT), Common Source and Common Drain Amplifiers (DC and AC Analysis, Input Resistance, Voltage and Current Gain, Frequency Response etc), Common Gate Amplifier, Class-D Amplifier, Multistage Amplifier (RC Coupled); Tuned RF Voltage Amplifiers.

Thyristors: Four layer diode, Shockley Diode, The Silicon controlled rectifier, SCR Equivalent Circuit, SCR Applications, The Light-Activated SCR (LASCR), Half-Wave Power Control, Backup Lighting for Power Interruptions, Sawtooth Generator, Diac, Triac, Diac and Traic Applications, Silicon controlled switch, Uni-junction transistor

Oscillators: Introduction; Barkhausen Criterion; Feedback Oscillators; positive feedback condition for oscillation, startup conditions, RC Oscillators (Wien Bridge Phase, Shift Oscillator and T-twin oscillator); LC Oscillators (Colpitts, Crystal and Hartley Oscillators); Crystal controlled oscillators, Square-wave Oscillators; 555 Timer Oscillators.

Operational Amplifiers: Introduction to Operational Amplifiers; The Differential Amplifier; Operational Amplifier and its Parameters; The Inverting and Non-inverting Circuits; Frequency Response; Feedback in Operational amplifier Circuits; Voltage follower Circuit; Operational

amplifier Amplifier Applications (Comparator, Differentiator, Summing and Active Filter Circuits); Instrumentation Amplifiers.

Experiments:

1. To study the characteristics of a field Effect Transistor.
2. To design and assemble astable multivibartor and to study the variation of time period and wave shape.
3. To design and assemble a monostable multivibrator and to study the variation of time period and wave shape.
4. To design and assemble a bistable multivbrator to study the variation of time period and wave shape.
5. To design and assemble Hartley oscillator.
6. To design and assemble Colpitts oscillator.
7. To design and assemble a RC phase shift oscillator for a given operating frequency.
8. To study the basic parameters of an operational amplifier.
9. To study the adder circuit using the operational amplifier.
10. To study the integrator circuit using an operational amplifier.
11. To study the differentiator circuit using an operational amplifier.
12. To study the comparator circuit using an operational amplifier.
13. To study the Schmidt Trigger Circuit using an operational amplifier.
14. To study the frequency response of low pass filter.
15. To study the frequency response of high pass filter.
16. To study the frequency response of band pass filter.

Recommended Books:

1. T.L.Floyd' Electronic Devices 9/e Prentice Hall (2012) Main Text Book.
2. A.P. Malvino' Electronic Principles' 7/e with CD-Rom Glencoe/ McGraw-Hill (2007).
3. D.A. Bell' Electronic Devices and Circuits'4/e Prentice Hall (1999).
4. C.J. Savant Jr. M.S. Roden and G.L Carpenter' Electronic Design Circuit and System' The Benjamin Publishing Co., California (1994).

PHY-603 SOLID STATE PHYSICS-I Credit Hours: 3(3-0)

Major course

Pre-requisites: Mechanics

Crystal Structure and Interatomic Forces

Crystal Structure*:* Introduction, Crystal Translation Vectors, Symmetry Operations, Types of Lattices, Lattice Planes and Miller Indices, Simple Crystal Structures (Sodium Chloride, Cesium Chloride, Hexagonal closed Packed, Diamond Cubic and Zinc Sulphide Structures), Reciprocal Lattice and its Properties.

Crystal Diffraction*:* Introduction , Bragg's Law and X-ray Spectrometer, Experimental Methods in X-ray diffraction (Laue , Rotating crystal and Powder Method), Analysis of Cubic Structure by Powder Method.

Crystal Binding*:* Binding Energy of a crystals, Ionic, Covalent, Metallic, Van der Waal Hydrogen Bonded Crystals.

Lattice Dynamics: Introduction, One dimensional Mono and Diatomic Lattices, Dispersion Curves, Three Dimensional Lattice.

Thermal Properties of Solids: Introduction, Classical theory of Specific Heat, Mean energy of Quantized linear Harmonic Oscillator, Einstein's and Debye's Theory of Specific Heatand comparison with Experimental results, Thermal Conductivity, Phonon-Phonon Interaction (Normal and Umklapp Processes).

Recommended Books:

1. C Kittle 'Introduction to Solid State Physics' 8/e John Wiley & Sons, New York 2004.
2. J.R. Christman'Fundamentals of Solid State Physics' John Wiley & Sons, New York (1988)
3. M A Wahab 'Solid State Physics: Structure and Properties of Materials' 2/e Narosa Publications House, New Delhi, 2005.
4. C M Kachhava 'Solid State Physics' Tata McGraw Hill, Hew Delhi, 1990.
5. M A Omar 'Elementary Solid State Physics' Adison Wesley, 1975.
6. S.O. Pilai'Solid State Physics' 6/e New Age International (P) Ltd, New Delhi (2005).
7. J P Mckelvey 'Solid State and Semiconductor Physics' Robert E. Krieger Publishing Company Malabar, Florida.

PHY-604 ELECTROMAGNETIC THEORY-I Credit Hours: 3(3-0)

Major course

Pre-requisites: Electricity and Magnetism, Calculus-II

Fundamental Concepts: Recapitulation of the Fundamental Concepts; Electric Field Intensity **E**, Electric Displacement Vector **D**, Magnetic Induction **B**, Magnetic intensity **H**, Maxwell's equations (differential and integral form), Pointing Theorem and Energy Conservation, Equation of Continuity.

Time Dependent Electromagnetic Fields: Potential Function and Electromagnetic Fields; Retarded Potential; Lienard-Wiechart Potentials; Field of a Uniformly Moving Potential Charge; Radiation by Accelerated Charges.

Solution of Electrostatics Problems: Poisson and Laplace Equations; Uniqueness Theorem; Solution of Laplace Equation in Cartesian, Spherical and Cylindrical Polar Coordinates; Electrostatic Images and Simple Application (Point Charge and Conducting Infinite Plane, Point Charge and a Conducting Sphere, Line Charges and Line images); Solution of Poisson's Equation.

Reflection And Refraction of Electromagnetic Waves: Laws of Reflection and Refraction; Fresnel's Equations; Reflection and Refraction at the boundary of two Ideal Dielectrics (Normal and Oblique Incidence); Reflection and Refraction at the surface of a Perfect conductor (Normal and Oblique Incidence); Total Internal Reflection; Surface Impedance; Surface Impedance.

Recommended Books:

1. H.C Ohanion 'Classical Electrodynamics' Allyn and Bacon Ine, Massachusetts (1988).
2. Roatd K Wangsness' Electromagnetic fields and waves'W H freeman and Co., New York. (1978).
3. P.C. Lorrain and D.R. Corson' Electromagnetic fields and Waves' W.H. Freeman, New York (1978).
4. C.R. Paul, K. W. Whites and S.A. Nasar' Introduction to Electromagnetic Fields' 3/e McGraw-Hill (1998).
5. D.J. Griffiths' Introduction to Electrodynamics' 3/e Pearson Education (2009).

PHY-605 MATHEMATICAL METHODS OF PHYSICS-I Credit Hours: 3(3-0)

Major course

Pre-requisite: Mechanics, Differential Equations, Linear Algebra

Objective(s): The course aims at developing understanding about fundamental concepts of PDEs theory, identification and classification of their different types, how they arise in applications, and analytical methods for solving them.

Contents:

Vector. Vector Integration; Line, Surface and Volume Integrals; Green's Theorem in the plane: Gauss's Divergence Theorem; Stokes's Theorem; Curvilinear Coordinates; Orthogonal Curvilinear Coordinates; Representation of Gradient.

Fourier Analysis. Definition and Examples of Fourier Series; Half-range Expansions; Complex form of Fourier Series; Physical Applications (i.e., Analysis of Periodic Wave forms); Fourier Integral Theorem; Sine and Cosine Transforms; Complex Fourier Transform; Properties of Fourier

Transform (Linearity, Time Shift, Frequency Shift, Scaling and Symmetry Properties) Convolution integral theorem.

The Laplace Transform. Definition; Laplace Transform of Elementary Functions; Properties of Laplace Transform; Inverse Laplace Transform and its Properties; The Convolution Theorem; Application to the Solution of Differential Equations with Constant Coefficients.

Recommended Books:

1. G.B. Arfken and H.J. Weber "Mathematical Methods for Physicists" 6/e Academic Press (2005).
2. M.L. Boas "Mathematical Methods in the Physical Science" 3/e John Wiley (2005).
3. S.H. Hassani " Mathematical Physics: A Modern Introduction to its Foundation" Springer (1999).
4. H.Jefreys and B. Jeffreys " Methods of Mathematical Physics" 3/e Cambridge University Press (1999).
5. E. Kreyszig" Advanced Engineering Mathematics" 9/e John Wiley (2006).

PHY-606 THERMAL AND STATISTICAL MECHANICS Credit Hours: 3(3-0)

Major Course

Introduction to Statistical Mechanics: Statistical Basis, Probability, Permutation and combination, Macrostate and Microstate, Thermodynamic Probability, Most Probable state, Concept of cell in a compartment, Position space, Momentum space, Phase Space.

Kinetic theory of gasses: Velocity space, Maxwell's law of Distribution of Molecular velocities, Mean velocity, Root mean square velocity and most probable velocity of molecules, Kinetic Interpretation of Temperature, Degree of freedom and principle of Equipartition of energy.

Partition Function: Relations of Partition Function with Thermodynamic Variables; Examples (An assembly of Simple Harmonic Oscillators, Pauil and Van Vleek Paramagnetism); Theorem of Equipartition of Energy.

Statistical systems: Maxwill-Boltzmann, Bose-Einstein and Fremi-Dirac Statistical Systems; Examples of Thermodynamics of these Systems; Black Body Radiation; Gas of electrons in solids.

Statistical mechanics of interacting systems: Lattice Vibrations in Solids; Van der Waal Gas; Mean Field Calculation; Ferromagnets in Mean Free Approximation.

Recommended Books:

1. E. Mandl' Statistical Physics 2/e John Wiley, London (1988).
2. F. Reif' Fundamentals of Statistical and Thermal Physics' McGraw-Hill (1965).
3. B.N. Roy' Fundamentals of Classical and Statistical thermodynamics' John Wiley (2002).
4. S.K. Sinha' Introduction to Statistical Mechanics' Narosa Publishing House, Delhi (2005).
5. Brij Lal, N. Subrahmanyam, P.S hemne "heat thermodynamics and statistical physics", s.chand series (2011).

PHY-607 DIGITAL ELECTRONICS Credit Hours: 3(2-1)

Elective Course

Pre-requisites: Electronics-II

Objective(s):

To learn the basics of digital electronics such as Boolean Algebra. To develop logic circuit using the Boolean algebra. To understand the computer interface and micro-controller along with the embedded systems.

Contents:

Review of Number Systems: Binary, Octal and Hexadecimal number system, their inter-conversion, concepts of logic, truth table, basic logic gates. Boolean Algebra: De Morgan's theorem, simplification of Boolean expression by Boolean Postulates and theorem, K-maps and their uses. Don't care condition, Different codes. (BCD, ASCII, Gray etc.). Parity in Codes.

IC Logic Families: Basic characteristics of a logic family. (Fan in/out, Propagation delay time, dissipation, noise margins etc. Different logic based IC families (DTL, RTL, ECL, TTL, CMOS).

Combinational Logic Circuit: Logic circuits based on AND – OR, OR-AND, NAND, NOR Logic, gate design, addition, subtraction (2's compliments, half adder, full adder, half subtractor, full subtractor encoder, decoder, PLA. Exclusive OR gate.

Sequential Logic Circuit: Flip-flops clocked RS-FF, D-FF, T-FF, JK-FF, Shift Register, Counters (Ring, Ripple, up-down, Synchronous) A/D and D/A Converters.

Memory Devices: ROM, PROM, EAPROM, EE PROM, RAM, (Static and dynamic) Memory mapping techniques Micro Computers: Computers and its types, all generation of computers, basic architecture of computer, microprocessor (ALU, UP Registers, Control and Time Section). Addressing modes, Instruction set and their types, Discussion on 8085/8088, 8086 processor family, Intel Microprocessor Hierarchy

Micro-controller/ Embedded System: Introduction to Embedded and microcontroller based systems, The Microprocessor and microcontroller applications and environment, microcontroller characteristics, features of a general purpose microcontroller, Microchip Inc and PIC microcontroller, Typical Microcontroller examples:, Philips 80C51 & 80C552 and Motorola 68Hc05/08, Interfacing with peripherals.

Experiments:

1. To demonstrate the operation and characteristics of TTL Logic Gate and to show how. It can be used to perform any three basic logic functions.
2. To demonstrate the operation and characteristics of CMOS Logic Gate and to show how it can be used to perform any three basic logic functions.
3. To demonstrate the operation of XOR Logic Gate and XNOR Logic To demonstrate the operation and characteristics of a set and rest (Latch) Flip Flop.
4. To demonstrate the operation and characteristics of a D-type Flip Flop and storage register.
5. To demonstrate the operation and characteristics of a binary counter.
6. To demonstrate the operation of a BCD counter.
7. To demonstrate the operation of Decoder gate.
8. To demonstrate the operation of Decoder.
9. To demonstrate the operation of Multiplexer.

Recommended Books:

1. T.C Bartec' **Digital System Design and Micro processor'** (NBF) Latest Edition
2. Brey, "The Intel Microprocessors: Architecture, Programming and Interfacing", Merril, 2nd ed. 1991.
3. M. .Morris Mano **'Digital Logic and Computer Design** 'Prentice Hall Latest Edition
4. M. M. Mono, "Digital Logic and Computer Design", Prentice Hall, 1995.
5. R. Tokheim, "Digital Electronics", McGraw Hill, 7th ed. 2007.
6. R.L Tokheim **'Digital Electronics: Principles and Applications'** 6/e, McGraw-Hill (2003)
7. T. Wilmshurst, "The Design of Small-Scale Embedded Systems", Palgrave, 2001.
8. T.L Floyd '**Digital Fundamental'** 10th /e Prentice Hall (2013)

PHY-608 SOLID STATE PHYSICS-II Credit Hours: 3(2-1)

Major Course

Free Electron Theory of Metals: Drude Model; D.C. Electrical Conductivity; Hall Effect in Metals; A.C. Electrical Conductivity; Thermal Conductivity in Metals; Wiedemann-Franz Law, Summerfield Model: Motion of Electrons in one-dimensional infinite Potential well and Three-dimensional Potential Well: Fermi-Dirac Statistics: Density of Energy States; Fermi Energy; Effect of Temperature on Fermi Energy; Applications of Free Electron Theory (Electronic Specific Heat and Thermionic Emission).

Band theory of solids: Introduction; The Bloch Theorem; The Kronig-Penny Model; Analysis and existence of Energy Bands; The Distinction among Metals, Insulators and Semiconductors; Brillouin Zones and Reduced Zone Schemes; Effective Mass of Electron; Nearly Free Electron Model; Tight Binding Approximation.

Elementry semiconductor physics: Brief Review; Intrinsic and Extrinsic Semiconductors; Electron and Hole Concentration in Intrinsic Semiconductors; Product of Electron and Hole Concentration and its Analysis; Position of Fermi Level; Carrier Concentration in Extrinsic Semiconductors; Temperature Dependence of Carrier Concentration; Motion of Charge Carriers; Hall Effect in Semiconductors; Cyclotron Resonance.

Dielectric Solids: The Macroscopic Concept of Polarization; The Microscopic Concept of Polarization; Electronic, Ionic, Orientational, Space Charge Polarization etc.; The Local Field; Clausius-Mossotti Equation; Dielectric in an Alternating Field (The Complex Dielectric Constant and Dielectric Loss).

Experiments:

1. To determine the charge on an electron by Millikan's oil drop experiment.
2. To determine of (e/m) of an electron by magnetron method.
3. To determine specific charge (e/m) of an electron using fine Beam Tube.
4. To determine the speed of light using Foucault-Michelson method.
5. To determine the value of Planck's constant by spectrometers method.
7. To determine the value of Cauchy's constants for glass.
8. To determine the wavelength of sodium light using a Michelson interferometer.
9. Franck-Hertz experiment.
10. Zeeman Effect for a line in the spectrum of helium.
11. Stern-Gerlach Experiment.
12. Compton Effect.
13. X-Ray Diffraction

Recommended Books:

1. C Kittle 'Introduction to Solid State Physics' 8/e John Wiley & Sons, New York 2004
2. N W Ashcroft & N D Mermin 'Solid State Physics' Holt Rinehart and Winston, NY 1976.
3. J.R. Hook and H.E. Hall'Solid State Physics' 2/e John Wiley & Sons, Chichester (1991).
4. D A Neamen 'Semiconductor Physics and Devices' 2/e Irwin McGraw Hill, Boston, 2003.
5. B G Streetman and S Banerjee 'Solid State Electronic Devices' Pearson Education, 2000.
6. A J Dekker 'Solid State Physics' Prentice Hall publication Inc. Englewood Cliffs NJ, 1958.
7. H.M. Rosenberg'The Solid State: An Introduction to the Physics, Material Science and Engineering' 3/e , Oxford (1988).
8. A AZaky and Hawley 'Dielectric Solids' Dover Publications Inc. New York, 1970.

PHY-609 ELECTROMAGNETIC THEORY II Credit Hours: 3(3-0)

Major Course

Wave guides and Guided Waves: Waves Guided by Perfectly Conducting Parallel Plates (Transverse Electric Waves, Transverse Magnetic Waves and Transverse Electromagnetic Wave); Cylindrical Wave Guide, Rectangular and Circular Wave Guides (TE and TM mode analysis), Attenuation in Wave Guides, Elementary Concepts of Cavity Resonator, (Rectangular Circular and Spherical Cavity Resonators); Quality Factor of Rectangular Cavity Resonator, Wave Equations for the Grounded Dielectric Slab (TE and TM modes

Electromagnetism and special relativity: Einstein Postulates; The Geometry of Space-Time; The Lorentz transformations and its Consequences; Addition of Velocities; Relativistic Momentum and Energy; Relativistic Kinetics; Relativistic Dynamics; Magnetism as a Relativistic Phenomenon; Lorentz Transformations of Electric and Magnetic fields.

Covariant formulation of vacuum electrodynamics: Four-Vectors, Four-current density of and Four-potential; The Electromagnetic Field Tensor; Electrodynamics in tensor Notation; Relativistic Potentials Covariant form of Maxwell's Equations; Equation of motion of a charged particle in an Electromagnetic field; Maxwell's equation from the principle of least action; The Energy-Momentum Tensor of Electromagnetic field.

Recommended Books:

1. H.C Ohanion 'Classical Electrodynamics' Allyn and Bacon Ine, Massachusetts (1988).
2. Roatd K Wangsness' Electromagnetic fields and waves'W H freeman and Co., New York. (1978).
3. P.C. Lorrain and D.R. Corson' Electromagnetic fields and Waves' W.H. Freeman, New York (1978).
4. C.R. Paul, K. W. Whites and S.A. Nasar' Introduction to Electromagnetic Fields' 3/e (1998).
5. A.M. Portis' Electromagnetic fields' John Wiley & Sons, New York (1978).
6. D.J. Griffiths' Introduction to Electrodynamics' 3/e Pearson Education (2009).

PHY-610 MATHEMATICAL METHODS OF PHYSICS-II Credit Hours: 3 (3-0)

Major course

Pre-requisite: Mathematical Methods of Physics-I

Objective(s): Introduction to special functions and complex analysis

(1) Special Functions.

(a)The Gamma and Beta Functions.

(b) Bessel Functions; Bessel Differential Equation and its Solution; Bessel Functions of First and Second Kind; Generating Function; Recursion Relations; Orthogonality and Normalization Properties of Bessel Functions of First Kind.

(c) Legendre Functions of First Kind: Legendre Differential Equation and its solution; Legendre Functions; Rodrigues's Formula; Generating Function; Recursion Relations; Orthogonality and Normalization Properties.

(d) Associated Legendre Functions: Introduction; Associated Legendre Functions;

(e) Hermite Functions: Hermite Differential Equation and its Solution; Rodrigues's Formula; Generating Function; Recursion Relations; Orthogonality and Normalization Properties.

(f) Laguerre Functions: Laguerre Differential Equation and its Solution; Rodrigues's Formula; Generating Function;Recursion relations; Orthogonality and Normalization Properties.

(2) Complex Analysis.

(a) Complex differentiation: Derivative; Analytic function; Cauchy-Riemann Equations; Harmonic Function; Derivative of Elementary Functions.

(b) Complex Integration: Definite Integrals; Contours; Line Integration; Cauchy-Goursat Theorem; Cauchy's Integral Formula.

(c) Residues and Poles: The Residue theorem; Methods of Finding Residues and Poles; Evaluation of Definite Integrals.

Recommended Books:

1. C.W Wong 'Introduction to Mathematical Physics: Methods & Concepts' Oxford University Press. (1995).
2. E. Saff and A, Snider 'Fundamentals of Complex Analysis with Applications to Engineering Science and Mathematics' 3/e Pearson Education (2003).
3. E.Butkov' Mathematical Physics' Addison-Wesley (1968).
4. A. Jeffrey' Advanced Engineering Mathematics' 3/e Academic Press (2002).
5. B.D. Gupta' Mathematical Physics' 3/e Vikas Publishing, New Delhi (2004).

PHY-611 ATOMIC AND MOLECULAR PHYSICS Credit Hours: 3 (3-0)

Major course

Objective(s):

To provide an introduction to the structure and spectra of atoms and molecules. To prepare students for more advanced courses on Physics of Atoms, Molecules and Photons.

Contents:

Atomic Spectra: Review of Bohr's Theory of Hydrogen and Hydrogen-Like Atoms; Franck-Hertz Experiment: Correspondence Principle; finite Mass Correction; Wilson-Summerfield Quantization Rules: Summerfield's Elliptic Orbits Relativistic correction.

Vector Atom Model: The Geomagnetic Ratio; The Bohr Magnetron; Quantum Numbers and their Physical Significance; Magnetic Moment of an Atom and Lande's Splitting Factor; Larmor's theorem, Stern-Gerlach Experiment.

Atom in External Magnetic and Electric Field: Introduction; Normal and Anomalous Zeeman Effect; classical Theory of the Normal Zeeman Effect; Physics Significance; Quantum Theory of Normal and Anomalous Zeeman Effect; LS and JJ Coupling Paul's Exclusion Principle and the Periodic Table; Paschen-Back Effect; The Stark Effect, Fine Structure of Hydrogen Atom.

Molecular Spectra: Introduction; Molecular Bonding; Diatomic Molecule as a Rigid Rotator; Rotational Energy Levels; Spectral Transition Probabilities and Selection Rules; Vibrational Spectra; Determination of Bond Length, Vibrational-Rotational Spectra; Electronic Spectra; Electronic Spectra.

LASERS: Introduction; Absorption, Spontaneous Emission, Stimulated Emission; Significance of Einstein Continents: Pumping and Pumping Schemes (electrical and Optical), Laser Beam Characteristics; Resonators; Type of Lasers (He, Ne Laser, Ruby laser, CO_2 laser); Applications.

Recommended Books:

1. Anne, P. Thorn" Spectrophysics' 2/e Chapman and Hall (1988).
2. B.H. Bransden and C.j.joachain Physics of Atoms and Molecules' 2/e Pearson Education (2003).
3. R Eisberg & R Resnick „ Quantum Physics of Atoms, Molecules, Solids, Nuclei& Particles J. Willey (1985).
4. B.B. Land 'Lasers and Nonlinear Opties' 2/e New Age International Publishers, New Delhi (2001).
5. Robert L BrooksThe Fundamentals of Atomic and Molecular Physics (Latest Edi)

PHY-612 QUANTUM MECHANICS-I Credit Hours: 3(3-0)

Major course

Pre-requisites: Modern Physics I & II

Inadequacies of Classical Physics (Review of Modern Physics): Optical spectra (Ritz combination principle), Black body radiation with emphasis on ultraviolet catastrophe (Planck's radiation oscillators), The photoelectric effect, Einstein matter oscillators, The Compton effect, Review of physical optics (interference diffraction and polarization), Young's double slit experiment with emphasis on duality of matter wave, The Franck Hertz experiment, The Rutherford atom, Stationary states of atom, The correspondence principle and Bohr's atom, Spectroscopic series, Wilson Sommerfeld quantization rule, Shortcoming of old quantum theory, Pauli exclusion principle, Stern Gerlach experiment, Zeeman effect, De-Broglie hypothesis and Quantum mechanical atom, Analogies between optics and mechanics (Fermat's principle of least time, principle of least action)

Mathematical Tools of Quantum Mechanics: Introduction, The Hilbert space and Wave Function, Dirac Notation, Operators, Representation in Discrete Bases, Representation of Continuous Bases, Matrix and Wave Mechanics.

Quantum Mechanics of One-Dimensional Potential Problems: The Time Independent Schrödinger Equation;The Time-dependent Schrödinger Equation interpretation of the Wave function; Expectation Values and Differential operators: Solution of Schrödinger Equation for (a) Free Particle (b)Step Potential (c)Potential Barrier (Refection and Transmission Coefficients) (d) Square Well Potential (e)Infinite Potential Well and (f) Linear Harmonic Oscillator.

The postulates of quantum mechanics: The State of System: Dynamic Variables and Operators: Expansion in Eigen functions; commuting and Non commuting Operators ; the Heisenberg Uncertainty Relations; Time Evolution of a System the Schrödinger and Heisenberg Pictures; Symmetry Principles and Conservation Laws.

Angular Momentum: Orbital Angular Momentum; The Eigenvalues and Eigen functions of L^2 and L_Z ; Matrix Representation of Angular Momentum Operators; Spin Angular Momentums; Total Angular momentum; The Addition of Angular momentums.

Recommended Books:

1. B.H Bransden and C.I Joachain‟ Quantum Mechanics‟ 2/e Pearson Education.
2. J.S Townsend‟ A Modern Approach to Quantum Mechanics‟ University Science Books, Sausaabto, California.
3. W.Greiner‟ Quantum Mechanics: An Introduction „Springer-Verlarg (1989)
4. R.L Liboff'Introduction Quantum Mechanics' 4/e Pearson Education (2003)
5. I. Bialynicki-Birula.M.Cieplak and J. Kaminski‟ Theory of Quanta' Oxford University Press (1992)
6. D.J Griffiths' Introductory Quantum Mechanies'2/e Pearson Education (2005)
7. S. Gasiorowiez‟ Quantum Physics'3/e John Wiley, New York (2003)
8. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

PHY-614 FIELD EXPERIENCE /INTERNSHIP Credit Hours: 3(0-3)

Major course

Field experience is a professional learning experience that offers meaningful and practical work experience related to a student's field of study or career interest. It is an opportunity to apply knowledge gained in the classroom with practice in the field.

PHY-614 QUANTUM MECHANICS -II Credit Hours: 3(3-0)

Major course

The Schrodinger Equation in Three Dimensions

Separation of Schrödinger Equation in Cartesian Coordinates (The Free Particle, The Three- Dimensional Box) Central Potential and Separation of the Schrödinger Equation in Spherical Polar Coordinates; the Free Particle the Three-dimensional Square Well Potential: Analysis of Hydrogen-like Atoms; The Three Dimensional Isotropic Oscillator.

Approximate Methods

Time Independent Perturbation Theory for Non-degenerate and Degenerate Energy Levels; the Variational Method; the WKB Approximation; Time Dependent Perturbation Theory.

Identical Particles and Second Quantization

Many particle system, System of identical particles, Pauli Exclusion Principle, The Exclusion principle and periodic table

Theory of Scattering

Scattering Experiments and Cross-sections; Potential Scattering, the Method of Partial Waves and its Application; the Born Approximation.

Recommended Books:

1. A.P.Frech and E.F Taylor‟ An Introduction to Quantum Physics' Thomas Nelson (1978)
2. J.L. Powel and B. Crasemann‟ Quantum Mechanics' Addison-Wesley. Reading(1978)
3. R.H. Dicke‟ Introduction to Quantum Mechanics' Addison-WealeyReading(1966)
4. P.M. Mathews and K. Venkatcsan‟ A Textbook of Quantum Mechanics' Tata Mic GrawHill(1976)
5. N. Zettili‟ Quantum Mechanics: Concepts and Application 2/e John Wiley (2009)

PHY-615 NUCLEAR PHYSICS Credit Hours: 3(2-1)

Objectives: **Major course**

To understand the nuclear structure using different nuclear models. To understand the nature of nuclear forces. To give understanding of radioactivity and nuclear reactions.

Contents:

History: starting from bacqurel's discovery of radioactivity to chedwick's neutron.

Basic properties of nucleus: Nuclear size; mass; binding energy; nuclear spin; magnetic dipole and electric quadruple moment parity and statistics.

Nuclear forces: Yukawa's theory of nuclear forces, charge independence and spin dependence of nuclear force.

Nuclear models: Introduction, liquid drop model, shell model, collective model,

Theories of radioactive decay:

(a) alpha decay: - energy, range, ionization power and stopping power of alpha particles: quantum mechanical theory of alpha decay; alpha particle spectra, nuclear energy levels.

(b) beta decay:-energy velocity and range of beta particles; fermi theory of beta decay; neutrino hypothesis, non-conservation of parity.

(c) gamma decay: - energy range and nature of gamma rays; theory of gamma decay; classification of gamma decays; internal conversion.

Nuclear reactions: Conservation laws of nuclear reactions; q-value and threshold energy of nuclear reaction; energy level and level width; cross section for nuclear reactions; bohr‟s theory of compound nucleus and its limitation; direct reaction; resonance reactions; breit-wigner one level formula.

Experiments:

1. To study the characteristics of Geiger-Muller tube and calculation of its dead time.
2. To investigate the characteristics of an ionization chamber.
3. To study the nature of radioactive decay i.e. Poisson distribution.
4. To determine the half-life a radioisotope (Radon-220)

5. Range of alpha particles in air using a solid- state detector.
6. Absorption coefficient of aluminum for beta particles.
7. Measurement of linear absorption coefficient of lead for gamma rays.
8. Verification of inverse square law for gamma rays.
9. Measurement of the gamma ray spectrum of a radioisotope.
10. Use of a multi – channel analyzer

Recommended Books:

1. E.Segre‟ Nuclei and Particles‟ Addison-Wesley (1977)
2. I. Kaplan‟ Nuclear Physics' Addison-Wesley (1962)
3. A.E.S. Green‟ Nuclear Physics' McGraw Hill (1955)
4. Kenneth S. Krane‟ Introductory to Nuclear Physics „john Willy (1987)
5. S.B. Patel „Nuclear Physics: An Introduction „New Age International (P) Ltd, New Delhi (1991)
6. S.N Ghoshal „Nuclear Physics' S. Chand and Co; New Delhi (1994)
7. W.E Burcham‟ Elements of Nuclear Physics' Longman (1979)

PHY-616 CAPSTONE PROJECT Credit Hours: 3(0-3)

A capstone project allows students to bring together the concepts, principles and methods that they have learned in their course of study and to apply their knowledge and acquired competencies to address the real world problems.

The research work will be conducted in 8th semester. In the final defense of project, a prototype will be shown to the external examiner and a project report will be submitted.

PHY-617 COMPUTATIONAL PHYSICS -I Credit Hours: 3(3-0)

Elective Course

Objective(s):

Introduction of computer languages. To know the use of computer in numerical analysis. Computer simulation and modeling.

Contents:

Computer Languages: A brief introduction of the computer languages Matlab and known software packages of computation

The solution of nonlinear equations: Introduction; the bisection method; the method of false position (regula false method); newton- Raphson method; convergence of newton-raphson method; the secant method. The iteration method (x = g(x) form).

System of linear equations: Introduction; gauss-jordan method; inversion of co-efficient matrix, cramer's rule, lu decomposition Crout's, cholesky & doolittle methods; iterative methods (jacobi and gauss-seidal methods).

Ordinary differential equation (ode): Introduction, different methods to solve odes, picard's method, taylor series method, euler's Method, euler's modified method, huen's method, runge-kutta method (fourth order)

Recommended Books:

1. C.F Gerald & P.O Wheatley „ Applied Numerical Analysis' 7/e Pearson Education 2004.
2. S.C Chapra and R.P Canate‟ Numerical Methods for Engineers with Software and Programming. Applications „ 4/e mcgraw-Hill (2002).
3. M. Iqbal‟ An Introduction to Numerical Analysis‟ llmi Kitab Khanna, Lahore (1991).
4. S.A Bhatti & N.A Bhatti‟ A First Course in Numerical Analysis with C++', Shaharyar Publishers,Lahore (2002).

PHY-618 COMPUTATIONAL PHYSICS -II Credit Hours: 3(3-0)

Elective Course

Contents:

Interpolation: Introduction; Linear operators and Interrelationship between operators, Newton-Gregory's forward and backward difference interpolating polynomials; Gauss forward and backward interpolation (central difference formula); Newton's divided difference interpolation for Un-equally spaced arguments.Lagrange's formula

Numerical Differentiation and Numerical Integration: Introduction; Differentiation based on Newtown's forward and backward difference formula; Derivatives based on Lagrange's interpolating polynomial and Newton divided difference interpolation. Integration based on Rectangular rule and Trapezoidal rule, The Newton-Cotes integration formula (Simpson's $1/3^{rd}$rules, Simpson's $3/8^{th}$relation); Estimation of errors.

Statistical Techniques: Different types of mean, median and mod, Mean deviation; standard deviation; Curve fitting (Straight Line, parabola, and Exponential).Binomial and Poisson probability distribution.

Recommended Books:

1. J.H Mathews „ Numerical Methods for Mathematics, Science and Engineering '2/e Prentice Hall (1992)
2. Sher Muhammad Chaudhry, Introduction to Statistical Theory 'Part I lllmi Kitab Khana Lahore (2010).
3. J Mehdi" Statistical Methods' 6/e New International Publishers, New Delhi (2006).
4. G Shankar Rao 'Numerical Analysis' 3/e New Age International Publishers, New Delhi (2010).
5. B.S. Grewal' Numerical Methods in Engineering and Science' 7/e Khanna Publishers, Delhi (2005)

PHY-619 MECHATRONICS Credit Hours: 3(2-1)

Contents:

Introduction: Introduction, DC motor speed controller, stepper motor speed and position controller, DC motor position and speed controller.

Sensors: Position and speed measurement (Proximity Sensors and Switches, Potentiometer, Linear Variable Differential Transformer, Digital Optical Encoder), stress and strain measurement (Electrical Resistance Strain Gage, Measuring Resistance Changes with a Wheatstone Bridge, Measuring Different States of Stress with Strain Gages, Force Measurement with Load Cells), temperature measurement (Liquid-in-Glass Thermometer, Bimetallic Strip, Electrical Resistance Thermometer, Thermocouple), vibration and acceleration measurement (Piezoelectric Accelerometer), pressure and flow measurement, semiconductor sensors and microelectromechanical devices.

Actuators: Electromagnetic principles, solenoids and relays, electric motors, dc motors, electronic control of a permanent magnet dc motor, stepper motors, stepper motor drive circuits, hydraulics (hydraulic valves, hydraulic actuators), pneumatics (pneumatics cylinder, pneumatics muscle and their control)

Digital Control: Arduino Uno, Arduino nano, Arduino mega, ESP32, Bluetooth module (HC-05/06), Introduction to scratch programing, introduction to mBlock, mBlock for programing Arduino (Uno, Nano, Mega, and ESP32). Programing for sensors, Programing for motors (Stepper, Servo and DC).

Experiments:

1. Experiments on different types of Temperature sensors and signal conditioner.
2. Experiments on linear position sensor and conditioner
3. Experiments on angular position and speed measurement sensor
4. Experiments on Pressure sensors
5. Experiments on weight sensors
6. Experiments on water level and pressure
7. Experiments on stepper and DC motors
8. Experiments on vacuum level sensors and actuators
9. Experiments on industrial interface card using visual designer
10. Experiments on programmable logic controller (PLC)
11. Experiments of Robotic Arm
12. Experiments on accelerometer and velocity transducer

Recommended Books:

1. David G. Alciatore and Michael B. Histand. "**Introduction to Mechatronics and Measurement Systems**", Fourth Edition, (Mc Graw Hill 2012)
2. Robert H. Bishop **"Mechatronics an introduction**" , First Edition, (Taylor & Francis 2006)

PHY-620 NANO SCIENCE AND NANOTECHNOLOGIES Credit Hours: 3(2-1)

Pre-requisite: Solid State Physics-II, Quantum Mechanics-II

Objective(s):

Introduce the concept and applications of nano sciences and nanotechnologies. Nano structures and nano technologies.

Contents:

Introduction: Feynman talks on small structures, Nano scale dimension, Course goals and objectives.

Quantum Effects: Wave particle duality, Energy quanta, Uncertainty principle, De Broglie relation, Quantum Dots, Moore's law, tunneling.

Surfaces and Interfaces: Interfaces, Surface chemistry and physics, Surface modification and characterization, Thin Films, Sputtering, Selfassembled films.

Material Properties: Subatomic physics to chemical systems, types of chemical bonds, solid state physics / Material properties.

Tools and Instrumentation: STM, AFM, Electron Microscopy, Fluorescence methods, Synchrotron Radiation.

Fabricating Nano Structures: Lithography (photo and electron beam), MBE, Self-assembled masked, FIB, Stamp technology, Nano junctions.

Electrons in Nano Structures: Variation in electronic properties, free electron model, Bloch's theorem, Band structure, Single electron transistor, Resonant tunneling.

Molecular Electronics: Lewis structures, Approach to calculate Molecular orbitals, Donor Acceptor properties, Electron transfer between molecules, Charge transport in weakly interacting molecular solids, Single molecule electronics.

Nano Materials: Quantum dots, nano wires, nano photonics, magnetic nano structures, nano thermal devices, Nano fluidic devices, biomimetic materials.

Nano Biotechnology: DNA micro-arrays, Protein and DNA Assembly, Digital cells, genetic circuits, DNA computing.

Nanotechnology the Road Ahead: Nanostructure innovation, Quantum Informatics, Energy solutions.

Experiments:

1. Experiments on Natural nanomaterials

2. Experiments on Liquid crystals
3. Experiments on Colorimetric gold nanosensor
4. Experiments on Superhydrophobic materials
5. Experiments on Electropolishing, Electroplating, Anodizing and Etching.

Recommended Books:

1. S. Lindsay, "Introduction to Nanoscience", Oxford University Press, 2009.
2. C. Binns, "Introduction to Nanoscience and Nanotechnology (Wiley Survival Guides in Engineering and Science)", Wiley, 2010.

PHY-621 CUMMUNICATION SYSTEM Credit Hours: 3(2-1)

Elective Course

Pre-requisites: Electronics-I and II

Objective(s):

Signals and Systems: Introduction to signals and systems; Types of signals; Types of systems; Signal representation; Review of Fourier series and transform. Fourier analysis of signals and systems

Modulation and Noise in Communication Systems: Modulation process and Modulation schemes; Analog and Digital types of Communication, baseband modulation and pass band modulation Noise in Communication Systems: Thermal noise; Calculation of Thermal Noise; Shot Noise; Signal to Noise Ratio; Noise Figure and Noise Temperature; Ideal Filter; Real Filter; Low-Pass, Band Pass, and High-Pass filters

Analogue Communications: Communication Model. Linear Modulation in Time Domain and Frequency Domain; Amplitude Modulation and its Mathematical Form; Demodulation of AM Wave; Carrier Suppression: DSBSC and SSBSC Generation and Demodulation of DSBSC and SSBSC Signals; VSB, Angle Modulation Frequency and Pulse Modulation; Generation of FM and PM Waves; Demodulation of FM and PM; Pre-Emphasis

Pulse and Digital Communications: Pulse Modulation (PAM,PTM,PWM And PPM); Digital Modulation Techniques (ASK, PSK, DPSK QPSK); Sampling Process; Shannon's Theorem; Analogue to Digital Conversion: Pulse Code Modulation ; Delta Modulation ; Adaptive Delta modulation; Signal detection; Inter Symbol Interference, Nyquist theorem, Error Detection and Error Correction (Hamming codes, Convolution codes);

Introduction to Cellular Communications: Introduction to Mobile communication; Evaluation of Mobile communications System cellular concept: Hand off Strategies; Interference and Channel Capacity; Cellular Phone Systems and Standards: Technical Features of AMPS and GSM;GSM System Architecture; GPRS; Multiple Access techniques; Frequency division Multiple Access(FDMA); Time Division Multiple Access (TDMA); Code Division Multiple Access (CDMA) ; Space Division Multiple Access (SDMA).

Experiments:

1. To design Amplitude Modulated circuit and calculate its modulation index.
2. To observe the demodulation of AM wave.
3. To construct a Frequency Modulated Circuit and to calculate the modulating index.
4. To observe the demodulation of FM wave.
5. Demodulation of FM using PLL circuit.

6. To construct a Balance Modulator circuit.
7. To construct a Pulse Amplitude Modulation and Demodulation circuit.
8. To study and implement PWM modulation using IC 555.
9. To construct a Pulse Position Modulation circuit.
10. To Study and implement ASK modulation and demodulation circuit.
11. To construct a FSK modulation and demodulation circuit.
12. To Study Pre Emphasis and De Emphasis circuit.
13. Experiment on Fourier analysis of Signals.
14. Experiments on Passive and Active Filters.

Recommended Books:

1. H. Taube and D.L. Schilling 'Principles of Communication Systems' 2/e McGraw-Hill (1986)
2. B.P Lathi' Modern Digital and Analog Communication Systems '3/e Oxford University (1998)
3. A.B Carlson' Communication Systems '4/e McGraw-Hill (2001)
4. S. Hay kin' Communication Systems '4/e John Wiley (2001)
5. W. Tomasi' Electronic Communication Systems: Fundamentals through Advanced '6/e Pearson Education (2005)
6. L.E Frenzel 'Principles of Electronic Communication Systems' 3/e, McGraw-Hill (2007)
7. G.Kennedy and B. Davis 'Electronic Communication Systems '4/e Glencoe (1993)
8. R. Stele and L. Hanzo (Eds.)' Mobile Radio Communications' 2/e John Wiley (1999)

PHY-622 APPLIED SOLID STATE PHYSICS Credit Hours: 3(2-1)

Elective Course

Pre-requisites: Solid State Physics-I and II

Contents:

Magnetism in solids: Introduction and Terminologies. Magnetic non-Magnetic materials, magnetic dipole, atomic magnetic moment, Types of Magnetic materials, Diamagnetism, (classical and quantum explanation), Paramagnetism (Langevine's classical theory, Quantum theory), adiabatic demagnetization, Ferromagnetism, Antiferromagnetism, Weiss theory of Ferromagnetism, concept of domains and Hysteresis, Paramagnetic resonance, Nuclear magnetic resonance, Ferromagnetic resonance, Spin Waves (Basic concepts).

Superconductivity: Introduction and historical background, electrical resistivity, Meissner effect Perfect Diamagnetism, Supercurrents and penetration depth, Critical temperature, Type-I and Type-II superconductors, London Equation, Branden- Cooper- Schrieffer theory (Qualitative Approach). Josephson's effect, High temperature superconductors.

Experiments:

1. To study the electrical conductivity in solids.
2. To study the Ferromagnetic Hysteresis.
3. To study the Hall effect in P-type germanium.
4. To study the Band gap of Germanium.

Recommended Books:

1. Introduction to Solid State Physics, Charles Kittle, 8th Edition, Wiley
2. Solid State Physics, Neil W Ashcroft and David M, Saunders College Publishing
3. Elementary Solid State Physics, M A Omar, 2nd edition, Pearson educations
4. Physics of solids, Wert and Thomson, 2nd edition. McGraw-Hill.

PHY-623 RADIATION SAFETY AND NUCLEAR REACTOR DESIGN Credit Hours: 3(2-1)
Elective Course

Pre-requisites: Nil
Objective(s):
Basic of radiation, radiation doses, effects of radiation and radiation protection principles, dose assessment and dose constraints, dose guidance and interventional levels, applications of radiation in medical, industry, agriculture and research purposes, Detailed description of various basic and advance radiation applications in medical, industrial, agriculture, and research.
Nuclear reactions, chain reaction, controlled chain reaction, neutron flux and neutron absorption, radiation dosimerty, exposure and contamination and their control, emergency preparedness and response mechanism, radioactive waste management processes, environmental monitoring, radiation detection techniques and measurement process, inspection and authorization for radiation safety, case studies, gamma spectroscopy, categorization of radioactive sources. National and International legal and Regulatory Framework for the nuclear and radiation safety and security including convention, resolutions, treaties, guidance document, national ordinance and regulations. Basic of Reactor design, operational principle of nuclear power plant, safety of nuclear power plant operation, safe use of nuclear energy, relevant international codes and standards for the safe use of nuclear energy, safety and security culture.

Experiments:
1. TI based NaI gamma Spectroscopy,
2. HPGe spectrometer and associated analytical softwares,
3. Spectrum analysis and categorization of nuclear and other radioactive materials, Environmental sampling and analysis techniques

Recommended Books:
1. E.Segre‟ Nuclei and Particles‟ Addison-Wesley (1977)
2. Kaplan‟ Nuclear Physics' Addison-Wesley (1962)
3. A.E.S. Green‟ Nuclear Physics' McGraw Hill (1955)
4. Kenneth S. Krane‟ Introductory to Nuclear Physics „john Willy (1987)
5. S.B. Patel „Nuclear Physics: An Introduction „New Age International (P) Ltd, New Delhi (1991)
6. S.N Ghoshal „Nuclear Physics' S. Chand and Co; New Delhi (1994)
7. W.E Burcham‟ Elements of Nuclear Physics' Longman (1979)

PHY-624 INTRODUCTION TO RENEWABLE ENERGY Credit Hours: 3(3-0)
Elective Course

Pre-requisites: Nil
Objective(s):
Students are introduced to different types of renewable energy resources by engaging in various activities to help them understand the transformation of energy (solar, water, nuclear, biomass and wind) into electricity. Students explore the different roles engineers who work in renewable energy fields have in creating a sustainable environment – an environment that contributes to greater health, happiness and safety.
Content:
Introduction: Promising renewable energy sources, their potential availability and present status, existing technologies and availability,

Solar energy: Sun-Earth relationship, solar geometry, sun path and solar irradiance, solar spectrum. Solar constant, atmospheric effects, global distribution, effects of tilt angle, daily and seasonal variations, resource estimation. Extraterrestrial, global, direct, diffused radiation, Flat plate collectors, their designs, heat transfer, transmission through glass, absorption transmission of sun energy, selective surfaces, performance, and efficiency,

Photovoltaic: PV effect, materials, solar cell working, efficiencies, different types of solar cells, characteristics, (dark, under illumination), efficiency limiting factors, power spectral response, fill factor, temperature effect; PV systems, components, modules, arrays, controllers, inverters, storage, PV system sizing, performance and applications,

Wind Energy: Global distribution, resource assessment, wind speed, height and topographic effects, power extraction for wind energy conversion, wind mills, their types, capacity, properties, wind mills for water lifting and power generation, environmental effect.,

Hydropower: Global resources, and their assessment, classification, micro, mini, small and large sources principles of energy conversion; turbines, their working and efficiency for micro to small power systems, environmental impact,

Biogas: Biomass sources; residue, farms, forest. Solid wastes; agricultural, industrial and municipal wastes etc.; applications, traditional and nontraditional uses: utilization, process, gasification, digester, types, energy forming, Environment issues,

Geothermal Energy: Temperature variation in the earth, sites, potentials, availability, extraction techniques, applications; water and space heating, power generations, problems, environmental effects,

Nuclear Energy: Global generations of reserves through reprocessing and breeder reactors, growth rate prospect of nuclear fusion, safety and hazards issue.

Experiments:

1. Measurement of power of Solar cell
2. Measurement of Color effect on absorption of solar radiation
3. Study the plate flat collectors
4. Study of different parameter of solar cooker.
5. Wind speed and direction measurement.

Recommended Books:

1. Manfred Grathwhol. World Energy Supply: Resources, Technologies and Prospective, Walter deGruyter-Berlin, Latest edition
2. J.W Twidell and A.D. Weir. Resources, E & F.N. Spon Ltd, London, Latest edition
3. M Iqbal. An Introduction to Solar Radiation, Academic Press, Canada, Latest edition
4. Simon Roberts. A Practical Guide to Solar Electricity, Prentice Hall, Latest edition
5. Martin A G. Solar cells: Operating Principles, Technology, & System Application, Prentice Hall, Latest edition
6. T.J. Jansen. Solar Engineering Technology, Prentice Hall, Latest edition
7. Daniel H' Wind Power. A Book on Wind Energy Conversion System, Litton Educational Press, Latest edition

PHY-625 MICROPROCESSORS AND MICROCONTROLLERS Credit Hours: 3(3-0)

Elective Course

Pre-requisites: Digital Electronics

Contents:

Microprocessors: Basic computer (central processing unit, memories and storage, input output ports, busses, computer software, the computer system), introduction to microprocessor, the 8086 microprocessor internal Architecture (bus interface unit, execution unit, instruction queue, internal busses), 8088 microprocessor Architecture, overview of intel microprocessors family.

Microprocessor Programing: Addressing modes, Data transfer instructions, Arithmetic instruction, Bit manipulation instructions, loops and jumps, String instructions, subroutine and Interrupts, process control instructions.

Digital Signal Processing: Introduction to digital signal processing (DSP), applications of DSP, converting analog signal to digital (sampling and filtering, Holding the Sampled Value, conversion, quantization), Analog to digital converter (Flash analog to digital converter, Dual -Slope Analog to digital converter, Successive- Approximation analog to digital converter), Digital to analog conversion (Weighted input digital to analog converter, R/2R ladder digital to analog converter).

Memory and Storage: Introduction to memory system (memory units, memory array, memory address and capacity, write and read operation), The RAM Family, Static RAM unit cell, Asynchronous Static RAM organization, synchronous Burst SRAM organization, Cache Memory, DRAMs storage cell, Basic organization of DRAM, types of DRAM, ROM, internal ROM organization, PROMs and EPROMs, Flash memories (Flash memory cell, Flash memory operation, Basic flash memory array), Memory expansion (Word length Expansion, word capacity Expansion), SIMMs and DIMMs, Special types of memories (FIFO memories, LIFO memorie), Magnetic and optical Storage (Magnetic Hard Disks, Floppy Disks, CD-ROM)

Introduction to Microcontrollers: Arduino Uno, Arduino nano, Arduino mega, ESP32, Bluetooth module (HC-05/06), Introduction to scratch programing, introduction to mBlock, mBlock for programing Arduino (Uno, Nano, Mega, and ESP32). Programing for sensors (ultrasonic), Programing for motors (Stepper, Servo and DC).

Recommended Books:

1. T.L Floyd ‘ Digital Fundamental ‘ 9/e Prentice Hall (2006)
2. Barrey B. Brey ‘ The Intel Microprocessors 8086/8088, 80186/81088, 80286, 80386, 80486, Pentium and Pentium Pro Processor , Pentium 2, Pentium 3, Pentium 4: Architecture, Programming and Interfacing ‘ 7/e Prentice Hall (2005)
3. Douglas V. Hall ‘ Microprocessors and interfacing: Programming and Hardware’ 2/e Glance(1992)
4. M. Rafiquzaman’ Microprocessors: Theory & Applications with 68000/68020 & Pentium ‘J Wlley, 2008.

PHY-626 PLASMA PHYSICS Credit hours: 3(3-0)

Elective course

Pre-requisite: Electromagnetic Theory-II, Waves and Oscillations

Objective(s):

To learn about the importance of the plasma along with the basic concept of plasma. To know fluid description of the plasma.

Introduction: Occurrence of plasma, Concept of temperature, Debye shielding, the plasma parameter, Criteria for plasma.

Applications of Plasma Physics: Single-particle motion in electromagnetic field, Uniform and non-uniform E and B fields, Time-variant E and B fields, Fluid description of plasma, Wave propagation in plasma, Derivation of dispersion relations for simple electrostatic and electromagnetic modes, Introduction to Controlled Fusion, Basic nuclear fusion reactions, Reaction rates and power density, radiation losses from plasma, operational conditions.

Recommended Books:

1. F. F. Chen, “Introduction to Plasma Physics”, 2nd ed. Plenum, 1995.
2. D. A. Gurnett and A. Bhattacharjee, “Introduction to Plasma Physics: with space and laboratory application”, Cambridge University Press, 2005.
3. T. J. M. Boyd and J. J. Sanderson, “The Physics of Plasmas”, Cambridge University Press, 2003.

PHY-627 METHODS OF EXPERIMENTAL PHYSICS Credit hours: 3(3-0)

Elective course

Objective(s): To learn about the vacuum techniques. To learn the detection techniques about radiation, temperature. To learn about the measuring techniques along with data analysis.

Contents:

Vacuum Techniques: Gas Transport: Throughout, Pumping Speed, Pump down Time Ultimate pressure.

Fore-Vacuum Pumps: Rotary Oil pumps, sorption pumps. Diffusion pumps, sorption pumps (High Vacuum). Production of ultrahigh vacuum, Fundamental concepts, guttering pumps, Ion pumps, Cryogenic pumps, Turbo molecular pumps. Measurement of total pressure in Vacuums Systems, Units pressure ranges, Manometers, Perini gauges, The McLoad gauges, Mass spectrometer for partial measurement of pressure. Design of high Vacuum system, Surface to Volume ratio, Pump Choice, pumping system design. Vacuum Components, Vacuum valves, vacuum Flanges, Liquid Nitrogen trap, Mechanical feed throughs & Electrical feed throughs

Leak detection: Basic consideration, leak detection equipment, Special Techniques and problems, Repair Techniques.

Radiation Detection and Measurement: GM tubes, scintillation detector, channeltron, photo multipliers, neutron detectors, alpha/beta detectors, x-rays/gamma detectors, cosmic rays detectors, Spectrographs and Interferometers.

Sensor Technology: Sensors for temperature, pressure displacement, rotation, flow, level, speed, rotation position, phase, current voltage, power magnetic field, tilt, metal, explosive and heat. Electronics and Electronic Instruments: Operational amplifiers, summing amplifiers, difference amplifiers, Differentiators, Integrators, Logarithmic amplifiers, current to voltage converter, Spectroscopy amplifiers, charge sensitive pre-amplifiers, Coincidence circuits, Isolators, Ramp Generators, and single channel analyzer. Power supplies, Signal Generators, Counters, Multichannel analyzer, Lock in Amplifiers, Boxcar averages.

Computer Introduction: Introduction to computers, GPIB Interface, RS 232. Interfacing, DA/AD conversion, Visual c/visual Basic.

Data Analysis: Evaluation of measurement: Systematic Errors, Accuracy, Accidental Errors, Precision, Statistical Methods, Mean Value and Variance, Statistical Control of Measurements, Errors of Direct measurements, Rejection of data, Significance of results, Propagation of errors, preliminary Estimation, Errors of Computation. Least squares fit to a polynomial. Nonlinear functions. Data manipulation, smoothing, interpolation and extrapolation, linear and parabolic interpolation.

Recommended Books:

1. F. James, "Statistical Methods in Experimental Physics", World Scientific Company, 2nd ed. 2006.
2. M. H. Hablanian, "High-Vacuum Technology", Marcel Dekker, 2nd ed.1997.
3. P. Bevington and D. K. Robinson, "Data Reduction and Error Analysis for Physical Science", McGraw-Hill, 3rd ed. 2002
4. S. Tavernier, "Experimental Techniques in Nuclear and Particle Physics", Springer, 2010.

PHY-628 INTRODUCTION TO QUANTUM COMPUTING Credit hours: 3(3-0)

Elective course

Pre-requisite: Quantum Mechanics-I, Computational Physics

Objective(s):

To be familiar with the quantum computing. To learn about the Quantum circuits, and cryptography. Computer technology and historical background, Basic principles and postulates of quantum mechanics: Quantum states, evolution, quantum measurement, superposition, quantization from bits

to qubits, operator function, density matrix, Schrodinger equation, Schmidt decomposition, EPR and Bell's inequality, Quantum Computation: Quantum Circuits, Single qubit operation, Controlled operations, Measurement, Universal quantum gates, Single qubit and CNOT gates, Breaking unbreakable codes: Code making, Trapdoor function, One time pad, RSA cryptography, Code breaking on classical and quantum computers, Schor's algorithm, Quantum Cryptography: Uncertainty principle, Polarization and Spin basis, BB84, BB90, and Ekert protocols, Quantum cryptography with and without eavesdropping, Experimental realization, Quantum Search Algorithm.

Recommended Books:

1. M. A. Nielson and I. L. Chuang, "Quantum Computation and Quantum Information", Foundation Books, 2007.
2. P. Williams and S. H. Clearwater, "Exploration in Quantum Computation" Springer, 2011.
3. P. Bouwmester, A. Ekert, and A. Zeilinger, "The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation", Springer, 2010.
4. R. K. Brylinsky and G. Chen, "Mathematics of Quantum Computation" by Chapman & Hall/CRC, 2002.

PHY-629 QUANTUM INFORMATION THEORY Credit hours: 3(3-0)

Elective course

Pre-requisites: Quantum Mechanics I

Objective(s): To understand the fundamental concepts of quantum information, communication, computation, and physical protocols for quantum computation.

Review of Quantum Mechanics and overview of Quantum information: Postulates of quantum mechanics, quantum states and observables, Dirac notation, projective measurements, density operator, pure and mixed states, entanglement, tensor products, no-cloning theorem, mixed states from pure states in a larger Hilbert space, Schmidt decomposition, generalized measurements, (CP maps, POVMs), qualitative overview of Quantum Information.

Quantum Communication: Dense coding, teleportation, entanglement swapping, instantaneous transfer of information, quantum key distribution.

Entanglement and its Quantification: Inseparability of EPR pairs, Bell inequality for pure and mixed states, entanglement witnesses, Peres- Horodecki criterion, properties of entanglement measures, pure and mixed state entanglement, relative entropy as entanglement measure, entanglement and thermodynamics, measuring entanglement.

Quantum Information: Classical information theory (data compression, Shannon entropy, von Neumann entropy), fidelity, Helstrom's measurement and discrimination, quantum data compression, entropy and information, relative entropy and its statistical interpretation, conditional entropy, Holevo bound, capacity of a quantum channel, relative entropy and thermodynamics, entropy and erasure, Landauer's erasure.

Quantum Computation: Classical computation (Turing machines, circuits, complexity theory), quantum algorithms (Deutsch's algorithm, Oracles, Grover's algorithm, factorization and quantum Fourier transform), role of entanglement in algorithms (search algorithm), modeling quantum measurements, Bekenstein bound, quantum error correction (general conditions, stabilizer codes, 3-qubit codes, relationship with Maxwell's demon), fault tolerant quantum computation (overview).

Physical Protocols for Quantum Information and Computation: Ion trap, optical lattices, NMR, quantum optics, cavity QED.

Recommended Books:

1. V. Vedral, "Introduction to Quantum Information Science", Oxford University Press, 2007.
2. M. Nielsen and I. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, 10th Anv. ed. 2010.

3. W. Steeb and Y. Hardy, "Problems and Solutions in Quantum Computing and Quantum Information", World Scientific Publishing, 3rd ed. 2011.
4. Book on general quantum mechanics: A. Peres, Quantum Theory: Concepts and Methods, Kluwer Academic Publishers (2002).
5. Seth Lloyd's notes on quantum information available online at: web.mit.edu/2.111/www/notes09/spring.pdf

PHY-630 QUANTUM FIELD THEORY Credit hours: 3(3-0)

Elective course

Pre-requisites: Quantum Mechanics-II

Lagrangian Field Theory: Classical Field Theory. Canonical Quantization. Noether's theorem. **Klein-Gordon Field:** Real Klein-Gordon field. Complex Klein-Gordon field. Covariant commutation relations. Meson propagator

Dirac Field: Number representation for fermions. Quantization of Dirac field. Spin-statistics theorem. Fermion propagator

Electromagnetic Field: Classical electromagnetic field. Covariant quantization. Photon propagator

Interacting Fields: Interaction Lagrangian and gauge invariance. Interaction picture. S-matrix expansion. Wick's theorem. Feynman Diagrams. Feynman rules for QED. Cross sections and decay rates.

Recommended Books:

1. F. Mandl and G. Shaw, "Quantum Field Theory", Wiley, 2nd ed. 2010.
2. M. E. Peskin and D. V. Schroeder, "An Introduction to Quantum Field Theory", Addison Wesley, 1995.
3. S. Weinberg, "The Quantum Theory of Fields", Vol. 1, Cambridge University Press, 1999.
4. N. N. Bogoliubov and D. V. Shirkov, "Introduction to the Theory of Quantized Fields", John Wiley, 1980.

PHY-631 LASERS Credit hours: 3(3-0)

Elective course

Pre-requisite: Quantum Mechanics-II, Atomic and Molecular Physics

Objective(s): Develop fundamental concepts about lasers. Learn the principles of spectroscopy of molecules and semi-conductors. Understand the optical resonators and laser system. Applications of lasers.

Introductory Concepts: Spontaneous Emission, Absorption, Stimulated Emission, Pumping Schemes, Absorption and Stimulated Emission Rates, Absorption and Gain Coefficients, Resonance Energy Transfers.

Properties of Laser Beam: Monochromaticity, Coherence, Directionality, Brightness

Spectroscopy of Molecule and Semiconductors: Electronic Energy Levels, Molecular Energy Levels, Level Occupation at Thermal Equilibrium, Stimulated Transition, Selection Rules, Radiative and Nonradiative Decay, Semiconductor

Optical Resonators: Plane Parallel (Fabry-Perot) Resonator, Concentric (Spherical) Resonator, Confocal, Resonator, Generalized Spherical Resonator, Ring Resonator, Stable Resonators, Unstable Resonators. , Matrix Formulation of Geometrical Optics, Wave Reflection and Transmission at a Dielectric Interface, Stability Condition Standing and Traveling Waves in a two Mirror Resonator, Longitudinal and Transverse Modes in a Cavity, Multilayer Dielectric Coatings, Fabry-Perot Interferometer. Small Signal Gain and Loop Gain

Pumping Processes: Optical pumping: Flash lamp and Laser, Threshold Pump Power, pumping efficiency, Electrical Pumping: Longitudinal Configuration and Transverse Configuration, Gas Dynamics Pumping, Chemical Pumping.

Continuous Wave (CW) and Pulsed Lasers: Rate Equations, Threshold Condition and Output Power, Optimum Output Coupling, Laser Tuning, Oscillation and Pulsations in Lasers, Q-Switching and Mode-Locking Methods, Phase Velocity, Group Velocity, and Group-Delay Dispersion, Line broadening.

Lasers Systems: Solid State Lasers: Ruby Laser, Nd: YAG & Nd: Glass Lasers and Semiconductor Lasers: Homojunction Lasers Double- Heterostructure lasers, Gas lasers: Helium Neon laser, CO2 laser, Nitrogen Laser and Excimer Lasers, Free-Electron and X-Ray Lasers.

Laser Applications: Material Processing: Surface Hardening, Cutting, Drilling, Welding etc. Holography, Laser Communication, Medicine, Defense Industry, Atmospheric Physics.

Recommended Books:

1. O. Svelto, "Principles of Lasers", Springer, 5th ed. 2009.
2. J. Eberly and P. Milonni, "Lasers Physics", John Wiley, 2nd ed. 2010.
3. M. O. Scully and M. S. Zubairy, "Quantum Optics", Cambridge University Press, 1997.
4. W. T. Silfvast, "Laser Fundamentals", Cambridge University Press, 2nd ed. 2008.
5. W. M. Steen, J. Mazumder and K. G. Watkins, "Laser Material Processing", Springer, 4th ed. 2010.

PHY-632 LASER ENGINEERING Credit hours: 3(3-0)

Elective course

Pre-requisites: Modern Physics, Optics, Waves and Oscillations, Electricity and Magnetism

Objective(s): Deep understanding of Laser and its components, Designing of Laser.

Introduction: What is laser, brief history of laser development, principle components of laser, types of lasers, properties of laser beam, an overview of laser technology, energy states in atom, transition between energy states (absorption, spontaneous and stimulated emission), principles of laser, power and energy, special features of laser beam (directionality, diffraction, intensity, monochromaticity, coherency, line-width).

General Principles of Laser Operation: Thermal equilibrium, Einsteincoefficients, condition for large stimulated emissions, condition for light amplification, population inversion, energy state, metastable state, three level laser, four level laser, line broadening, laser rate equations (two, three, and four level systems), generic laser, gain medium, pumping source, resonant cavity

Generic Laser: Amplification and gain, optical resonator, laser action, gain of active medium (mathematical treatment), threshold condition, gain calculation, conditions for steady state oscillation, cavity resonance frequencies, laser modes (longitudinal and transverse), single mode operation, examples

Optical Resonators: Resonator (cavity) configuration, fabry-perot resonator or plane parallel cavity, confocal resonator, hemispherical cavity or combination of plane and spherical resonator, long radius cavity, stability criterion, examples (stable and unstable resonator)

Pumping Source and Active Medium: What is pumping, pumping methods, optical pumping, electric pumping (direct discharge), electric pumping for semiconductor laser, chemical pumping, flash lamps, optical pumping configuration, optical pumping assembly, active mediums (atoms, molecules, liquids, dielectric solids, semiconductor material)

Gas Lasers (theory, working, design and construction), Metal Vapor Lasers: Gas lasers, atomic lasers, ionic lasers, molecular lasers, basic concepts of discharge tube, Brewster angle cut discharge tube, electrical circuits for gas lasers, high voltage power supplies for gas lasers, He-Ne laser, design problems related to He-Ne laser, Argon Ion laser, Krypton Ion laser, CO2 (carbon dioxide) laser, N2 (nitrogen) laser, Excimer laser, He-Cd laser, Copper vapor laser, Gold vapor laser.

Chemical and Dye Lasers: Introduction to chemical laser, HF (hydrogen and fluoride) laser, Chemical Oxygen-Iodine laser (COIL), military applications of COIL, dye lasers, Rhodamine dye laser.

Solid State Lasers (concepts, working, design and construction): Introduction to solid state laser, Ruby laser, Nd:YAG laser, Nd:Glass laser, electronics for solid state laser, cooling system for solid state laser, cavity design and pumping concepts for solid state laser, brief overview to commercial Nd:YAG lasers, Ti:Sapphire laser, tunable solid state laser (Alexandrite laser).

Semiconductor Laser, and Free-Electron Laser: Introduction to semiconductor laser, homojunction laser, heterojunction laser, semiconductor laser array, quantum well laser, vertical cavity surface emitting laser (VCSEL), brief introduction to free-electron laser.

Control of Laser Output (Q-switching and mode locking): Introduction to control of laser output beam, frequency selection, generation of high power pulses, Q-factor, Q-switching and giant pulses, methods of Q-switching, active Q-switching (mechanical Q-switching, acousto-optic Q-switching, electro-optic Q-switching), passive Q-switching (saturable absorber, cavity dumping), introduction to mode-locking, mode-locking techniques (active mode-locking, passive mode-locking), Q-switched Nd:YAG laser system.

Ultrafast Lasers: What is ultrafast laser, Ti: Sapphire laser, chirped pulse amplification (CPA) laser system, ultrafast laser systems, ultrafast diagnostics, mode-locked Ti: Sapphire laser system, basic concepts to Ti: Sapphire CPA laser system, ultrafast phenomenon, applications of ultrafast lasers.

Laser Applications: Industrial applications, material processing (laser drilling, laser cutting, laser welding), LIDAR (laser imaging detection and ranging), photolithography, medical applications (LASIK surgery, laser seizer), isotope separation using laser, Nuclear fusion, brief overview of major laser facility (NIF facility), laser holography, military applications.

Recommended Books:

1. K. J. Kuhn, "Laser Engineering", Prentice Hall, 1997.
2. O. Svelto, "Principles of Lasers", Springer, 5th ed. 2009.
3. W. T. Silfvast, "Laser Fundamentals", Cambridge, 2nd ed. 2008.
4. K. R. Nambiar, "LASERS: Principles, Types and Applications", New Age, 2009.
5. W. Koecher, "Solid-State Laser Engineering", Springer, 2009

PHY-633 EXPERIMENTAL TECHNIQUES IN PARTICLE AND NUCLEAR PHYSICS

Elective course **Credit hours: 3(3-0)**

Pre-requisites: Particle Physics, Nuclear Physics

Objective(s): To give students with the practical hand on the experimental techniques, Physically understand the nuclear phenomena. Review of Basic Concepts: Units used in particle physics, Definition used in particle physics, Types of particles to be detected, Cross section, Decay width, Lab Frame and CM frame, Pseudo rapidity, History of Accelerator. Linear accelerators, Circular accelerators, Introduction to RHIC, Tevatron, LEP, LHC.

Introduction to Accelerators: Lattice and geometry, The arcs, Periodicity, Aperture, Beam crossing angle, Luminosity, RF cavities, Power requirements, Longitudinal feedback system, Injection, Injection scheme, PS, SPS, Magnets, Cryogenics, Vacuum system.

Introduction to Detectors: Introduction to detectors, Need of detectors, Passage of radiation through matter, Cross-section, Interaction probability in a distance x, Mean free path, Energy loss of heavy charged particles by atomic collisions, Bohr's, calculation – classical case - The Bethe Bloch formula, Cherenkov radiation, Energy loss of electron and photon, Multiple coulomb scattering, Energy straggling, The interaction of photons, The interaction of neutrons.

General Characteristics of Detectors and Gas Detectors: Sensitivity, Detector response, Energy resolution The Fano-factor, The response function, Response time, Detector efficiency, Dead time-Ionization detectors, Gaseous ionization detectors, Ionization & transport phenomenon in gases, Transport of electrons and ions in gases, Avalanche multiplication, The cylindrical proportional

counter, The multi-wire proportional counter, The drift chambers, Time projection chambers, Liquid ionization detector.

Scintillators, Photomultipliers, Semi-conductor Detectors: Scintillation detectors, Organic scintillation, Inorganic crystals, Gaseous scintillators Glasses, Intrinsic detector efficiency for various radiations, Photomultipliers, Basic construction and operation, The photocathode, The electron-optical input system, Semiconductor detectors, Silicon diode detectors, Introduction to CMS and its detectors.

Detector Software and Physics Objects: Introduction to Linux operating system, Introduction to CMS software (CMSSW), Basic infrastructure of software, Introduction to PYTHIA, Introduction to GEN, SIM, DIGI, RECO, reconstruction of final state objects.

Recommended Books:

1. The Large Hadron Collider Conceptual Design CERN/AC/95-05 (LHC)
2. Detector performance and software, Physics Technical Design Report, Volume1
3. Techniques for Nuclear and Particle Physics Experiments by W.R. Leo
4. R. Fernow, "Introduction to experimental particle physics", Cambridge University Press, 1989.
5. D.H. Perkins, "Introduction to High Energy Physics",Cambridge University Press, 4th ed. 2000.

PHY-634 ELECTRONIC MATERIALS AND DEVICES Credit hours: 3(3-0)

Elective course

Pre-requisite: Electronics-I, Optics

Objective(s): To understand the relation between electrical, optical and magnetic devices.

Semiconductor Fundamentals: Composition, purity and structure of semiconductors, energy band model, band gap and materials classification, charge, effective mass and carrier numbers, density of states, the Fermi function and equilibrium distribution of carriers, doping, n and p-type semiconductors and calculations involving carrier concentrations, EF etc., temperature dependence of carrier concentrations, drift current, mobility, resistivity and band bending, diffusion and total currents, diffusion coefficients, recombination-generation, minority carrier life times and continuity equations with problem solving examples.

Device Fabrication Processes: Oxidation, diffusion, ion implantation, lithography, thin-film deposition techniques like evaporation, sputtering, chemical vapour deposition (CVD), epitaxy etc.

PN Junction and Bipolar Junction Transistor: Junction terminology, Poisson's equation, qualitative solution, the depletion approximation, quantitative electrostatic relationships, ideal diode equation, non-idealities, BJT fundamentals, Junction field effect transistor, MOS fundamentals, the essentials of MOSFETs.

Dielectric Materials: Polarization mechanisms, dielectric constant and dielectric loss, capacitor dielectric materials, piezoelectricity, ferroelectricity and pyroelectricity.

Optoelectronic Devices: Photoconductors, photovoltaics and photodetectors, photodiodes and photovoltaics, solar cell basics, LEDs, Lasers, displays, LCDs.

Magnetism and Magnetic Materials: Basics of magnetism, hysteresis loops, magnetic domains and anisotropy, hard and soft magnetic materials, transformers, DC motors and data storage.

Recommended Books:

1. R. F. Pierret, "Semiconductor Device Fundamentals", Addison Wesley, 2nd ed. 1996.
2. N. Braithwaite, and G. Weaver, "Electronic Materials", MA: Butterworth, 2 nd ed. 1990.
3. S. O. Kasap, "Electronic Materials and Devices", McGraw-Hill, 3rd ed. 2005.
4. R. C. O'Handley, "Modern Magnetic Materials: Principles and Applications", Wiley Inter-Science, 1999.
5. D. Jiles, "Introduction to Magnetism and Magnetic Materials", Chapman & Hall, 2nd ed. 1998.

PHY-635 FLUID DYNAMICS Credit hours: 3(3-0)

Elective course

Pre-requisites: Mechanics, Calculus-I, Differential Equations

Objective(s): Physical understanding of fluid dynamics.

Introduction: Phenomenological introduction to fluid dynamics, Kinematics and conservation laws, Ideal fluids, the Euler equations, irrational flow, The Navier-Stokes equations

Viscous flow: Stokes flow, drag, lubrication theory, thin film flow

Waves: surface waves, internal gravity waves, nonlinear waves.

solitons, shocks Instabilities: linear stability analysis, Kelvin-Helmholts instability, Rayleigh-Bénard convection, other instabilities

Other topics depending on interest and as time permits possibly: airfoil theory, granular flows, biophysical flows.

Recommended Books:

1. D. J. Acheson, "Elementary Fluid Dynamics", Oxford University Press, 1990.
2. P. K. Kundu and I.M. Cohen, "Fluid Mechanics", Academic Press, 4th ed. 2010.
3. D. J. Tritton, "Physical Fluid Dynamics", Clarendon, 2nd ed. 1988.
4. L. D. Landau and E. M. Lifschitz, "Fluid Mechanics", Butterworth- Heinemann, 2nd ed. 1

PHY-636 INTRODUCTION TO PHOTONICS Credit hours: 3(3-0)

Elective course

Pre-requisites: Waves and Oscillations, Optics, Linear Algebra, Electronics-I

Objective(s): To study the application of light, studying the photonic devices including detectors.

Guided Wave Optics: Planar slab waveguides, Rectangular channel waveguides, Single and multi-mode optical fibers, waveguide modes and field distributions, waveguide dispersion, pulse propagation

Gaussian Beam Propagation: ABCD matrices for transformation of Gaussian beams, applications to simple resonators

Electromagnetic Propagation in Anisotropic Media: Reflection and transmission at anisotropic interfaces, Jones Calculus, retardation plates, polarizers

Electro-optics and Acousto-optics: Linear electro-optic effect, Longitudinal and transverse modulators, amplitude and phase modulation, Mach-Zehnder modulators, Coupled mode theory, Optical coupling between waveguides, Directional couplers, Photoelastic effect, Acousto-optic interaction and Bragg diffraction, Acousto-optic modulators, deflectors and scanners

Optoelectronics: p-n junctions, semiconductor devices: laser amplifiers, injection lasers, photoconductors, photodiodes, photodetector noise.

Recommended Books:

1. B. E. A. Saleh and M. C. Teich, "Fundamentals of Photonics", John Wiley,2nd ed. 2007.
2. J-M. Liu, "Photonic Devices", Cambridge University Press, 2009.
3. A. Yariv and P. Yeh, "Photonics: Optical Electronics in Modern Communications", Oxford University Press, 2006.
4. E. Hecht, "Optics", Addison-Wesley, 4th ed. 2001.

PHY-637 INTRODUCTION TO MATERIALS SCIENCE Credit hours: 3(3-0)

Elective course

Pre-requisites: Solid State Physics-I

Objective(s): To understand the important aspects of materials. Moving towards microstructures.

Content:

Atomic Structure of Materials: The packing of atoms in 2-D and 3-D, unit cells of the hexagonal close packing (hcp) and cubic closed packing (ccp) structures, interstitial structures, density computation, lattices and symmetry elements, indexing lattice directions and lattice planes, interplanar spacing, lattices and crystal systems in 3-D, symmetry, crystallographic point groups and space groups, Bragg's law and the intensities of Bragg reflections.

Imperfections in Solids: Vacancies, impurities, dislocations, interfacial defects, bulk or volume defects, atomic vibrations.

Microstructure: Microstructure and microscopy, pressure vs. temperature phase diagrams, temperature vs. composition phase diagrams, equilibrium, thermodynamic functions, variation of Gibbs energy with temperature and composition, general features of equilibrium phase diagrams, solidification, diffusion mechanisms, nucleation of a new phase, phase diagrams of Fe-C system and other important alloys, materials fabrication.

Mechanical Behavior of Materials: Normal stress and normal strain, shear stress and shear strain, elastic deformation, plastic deformation, Young's modulus, shear modulus, Poisson's ratio, elastic strain energy, thermal expansion, estimate of the yield stress, dislocations and motion of dislocations, slip systems, dislocations and strengthening mechanisms, fracture mechanics, ductile fracture, brittle fracture, Griffith criterion, ductile fracture, toughness of engineering materials, the ductile-brittle transition temperature, cyclic stresses and fatigue, creep.

Polymers: Polymer basics, polymer identification, polymer molecules, additional polymerization, step growth polymerization, measurement of molecular weight, thermosetting polymers and gels, rubbers and rubber elasticity, configuration and conformation of polymers, the glassy state and glass transition, determination of Tg, effect of temperature and time, mechanical properties of polymers, case studies in polymer selection and processing.

Biomaterials: Introduction to biomaterials, materials selection, biopolymers, structural polysaccharides, hard materials, biomedical materials.

Recommended Books:

1. W. D. Callister, "Materials Science and Engineering: An Introduction", Wiley, 7th ed. 2006.
2. W. D. Callister and D. G. Rethwisch "Fundamentals of Materials Science and Engineering: An Integrated Approach", Wiley, 4th ed. 2012.
3. J. F. Shackelford, "Introduction to Materials Science for Engineers", Prentice Hall, 7th ed. 2008.

PHY-638 PARTICLE PHYSICS Credit hours: 3(3-0)

Elective course

Pre-requisites: Quantum Mechanics-II, Nuclear Physics

Contents:

Introduction to Elementary Particles: Fundamental building blocks and their interactions. Quantum Electrodynamics. Quantum Chromodynamics. Weak interactions. Decays and conservation laws.

Relativistic Kinematics: Lorentz transformations. Four-Vectors. Energy and momentum. Particle collisions.

Mandelstam variables. Symmetries: Symmetries and conservation laws, Spin and orbital angular momentum. Flavour symmetries. Parity. Charge conjugation. CP Violation. Time reversal and TCP Theorem.

Quantum Electrodynamics: Klein-Gordon equation. Dirac equation. Solution of Dirac equation. Bilinear covariants. Feynman rules for QED. Casimir's trick. Cross sections & lifetimes. Neutrino Oscillations: Solar neutrino problem. Oscillations, Neutrino masses. PMNS mixing matrix.
Gauge Field Theories: Lagrangian in Relativistic Field Theory. Gauge Invariance. Yang-Mills Theory. The mass term. Spontaneous symmetry breaking. Higgs mechanism. Higgs boson. Grand Unification. Supersymmetry. Extra dimensions. String theory. Dark energy. Dark Matter.

Recommended Books:

1. D. Griffiths, "Introduction to Elementary Particles", Wiley-VCH, 2nd ed. 2008.
2. F. Halzen and A.D. Martin, "Quarks and Leptons: An introductory course in modern Particle Physics", John Wiley, 1984.
3. D. H. Perkins, "Introduction to High-Energy Physics", Cambridge University Press, 4th ed. 2000.
4. V. D. Barger and R. J. N. Phillips, "Collider Physics", Addison-Wesley, 1996.

PHY-639 COMPUTER SIMULATIONS IN PHYSICS Credit hours: 3(3-0)
Elective course

Pre-requisites: Calculus-II, Linear Algebra, Probability and Statistics, Differential Equations, Introduction to Computing,
Objective(s): The aim is to develop the ability to turn theoretical ideas of mathematics and physics into computer simulations of real-world systems.
Contents:
Programming for Scientific Computation: unix/linux basics, the editing- coding-compiling-debugging-optimizing-visualizing-documenting production chain, Fortran95.
Numerical Programming: Functions: approximation and fitting, Numerical calculus. Ordinary differential equations, Matrices, Spectral analysis, Partial differential equations. Modeling and Simulation: Molecular dynamics simulations, modeling continuous media Monte Carlo simulations.
Project: A project will be chosen by the student in consultation with the instructor. Selection of the project should be done soon after the module on modelling and simulation starts and continue over the course of the rest of the semester. The final part of the course is reserved for presentation of preliminary and final results.
Recommended Books:

1. T. Pang, "An Introduction to Computational Physics", Cambridge University Press, 2008.
2. R. Landau, M. Paez, C. Bordeianu, "A Survey of Computational Physics", Princeton University Press, 2008.

PHY-640 SURFACE SCIENCES Credit hours: 3(3-0)
Elective course

Pre-requisite: Solid State Physics-II
Objective(s): To understand the basics of surface physics. Strengthen the previous knowledge of Solid State Physics and Quantum Mechanics.
Basics of Surface Science: Surface reactions, Heterogeneous catalysis, Semiconductor technology, Corrosion, Nanotechnology,
Surface Structure and Reconstruction: Classification of solids, Crystal structure, Unit cell, Bravais lattices,
Electronic Structure of Surfaces: Band structure of metals, insulators and semiconductors, Fermi level, Screening, Work Function, Surface States, Electron Affinity, Ionization Potential, Surface Chirality, Thermodynamics of Surfaces, Equilibrium Crystal Shape.

Quantum confinement of Electrons at Surfaces: Interference of Electron Waves, Quantum size effects, Quantum wells, Mechanical Quantum Wells, Quantum Wires, Chemist's Approach, Bonds to Bands.

Surface Dynamics: Nucleation and growth of nanostructures and films, Surface Magnetism and magnetic imaging, Diamagnetism, Paramagnetism, Anti-Ferromagnetism, Magnetism in thin films, Kerr microscopy (MOKE), Spin Polarized Photoemission (SP-PEEM), Magnetic Force Microscopy (MFM).

Surface Study Techniques: Surface Sensitivity and specificity, Explanation and comparison of Low-Energy Electron Diffraction (LEED) and Reflection High-Energy Electron Diffraction (RHEED), Explanation of Near-Edge X-ray Absorption Fine Structure (NEXAFS), High-Resolution Electron Energy Loss Spectroscopy (HREELS), Introduction to Desorption Techniques, Thermal Desorption Spectroscopy (TDS), Electron Stimulated Desorption (ESD), Electron Stimulated Desorption Ion Angular Distribution (ESDIAD), Photon Stimulated Desorption (PSD), Electron Spectroscopy, Theory: Mean free path, Koopman's Theorem, Spin orbit coupling effects, chemical shifts, binding energy, Auger Electron Spectroscopy (AES), X-Ray Photo-electron Spectroscopy, Electron Analyzer, Electron optics, Scanning Tunneling Microscopy (STM), History, Theory, Electronics and applications.

Case Studies: Silicon Surfaces: Geometric and Electronic Structure, Molecular Adsorption on Semiconductor Surfaces, Adsorption Properties of CO on Metal Single-Crystal Surfaces, Molecular or dissociative adsorption, Chemical bonding and Orientation, Adsorption Site as a function of coverage, Over layer long-range order, Ammonia Synthesis, Oxide Surfaces.

Photovoltaic and Organic Electronics: Different types of semiconductors (organic, inorganic, conjugated polymers), Prototypes (OLEDs etc), intra- molecular bonding, Van der Waals, electronic properties, polarization effects, Field effect Transistors, basics of excitonic solar cells.

Recommended Books:

1. A. Zangwill, "Physics at Surfaces", Cambridge University Press, 1988.
2. D. P. Woodruff and T. A. Delchar, "Modern Techniques of Surface Science", Cambridge University Press, 2nd ed. 1994.
3. D. Briggs and M. P. Seah, "Practical Surface Analysis", Vol-I, John Wiley,2nd ed. 1990.
4. J. B. Hudson, "Surface Science, an Introduction", Wiley-Interscience, 1998.
5. H. Luth, "Surfaces and Interfaces of Solids", Springer-Verlag, 2nd ed.1993.
6. M. Prutton, "Introduction to Surface Physics", Oxford University Press, 1994.

COURSES OF ARTS AND HUMANITIES

Only one course of Arts and Humanities from the below list will be taken depend upon the availability of faculty member.

S. No	Course Code	Course Title	Cr. Hrs.
1	HIS-501	Introduction to History	2 (2-0)
2	PHIL-501	Introduction to Philosophy	2 (2-0)
3	MS-501	Introduction to Mass Communication	2 (2-0)
4	PSY-501	Introduction to Psychology	2 (2-0)

HIS-501 **INTRODUCTION TO HISTORY** **Credit hours: 2(2-0)**

Arts and Humanities course

Content:

What is History? Nature and scope of History. Benefits of History: History as a corrective force; History as a repetitive force, Branches of History (political, cultural, social, economic), Relationship of History with other social sciences, Causation, Objectivity and subjectivity, Classification of History: Narrative History, Scientific History, Philosophy of History, Future History

Recommended Books:

1. Bernard Cohn. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988
2. Caroline Steedman. Dust: The Archive and Cultural History, Manchester University Press, 2002
3. Carlo, Ginzburg. Clues. Myths, and the Historical Method, John Hopkins: University Press, 1992
4. Carr, E. H., What is History? Harmondsworth: Penguin, 1961.
5. Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.
6. G. W. G. Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991
7. Gertrude Himmalfarb. The New History and the Old, Cambridge: Harvard University Press, 1987
8. Govranski. History Meaning and Methods, USA, 1969
9. John Struart Mill. On Liberty and Other Essay, Oxford University Press, 2008

PHIL-501 **INTRODUCTION TO PHILOSOPHY** **Credit hours: 2(2-0)**

Arts and Humanities course

Contents:

Introduction to Philosophy: Definition of Philosophy, Etymology of Philosophy, Scope of Philosophy, Nature of Philosophy.

Philosophical Questions *(Note: Learning Method: Question/Answer Method):* What Is Truth? What is Justice? What is Good? What is Beauty? What is Love? What Is the Meaning of Life? Is Knowledge Possible? What Does It Mean to Be Free? Are You Really You? How Does the Brain Produce the Mind? Does Happiness Define the Good? What Makes a Society Fair or Just?

Branches of Philosophy: Metaphysics, Epistemology, Logic, Ethics, Political Philosophy, Aesthetics.

Historical Background of Philosophy: Ancient Greek Philosophy, Medieval Western and Muslim Philosophy, Modern Western Philosophy.

Philosophy and Social Sciences: Philosophy and Psychology, Philosophy and Sociology, Philosophy and Political Science, Philosophy and Literature

Recommended books

1. Dr. Khalid Almas and KashifFaraz Ahmed "Advanced Philosophy "Advanced AP Pub. Lahore.
2. W. Russ Payne, "An Introduction to Philosophy" Bellevue College, 2015.
3. Edward Craig, "Philosophy A Very Short Introduction" by Oxford University Press, Inc., New York 2002.
4. Dallas M. Roark, Ph.D. "Introduction to Philosophy" Emporia State University Copyright 1982 edition, 2016.
5. Nigel Warburton "Philosophy: The Basic" published byRoutledge, fifth edition published 2013.
6. Oswald kulpe "Introduction to philosophy, translated from the German (1895), W. B. Pillsbury and E. B Titchener, London Swan Sonnenschein. & Co., Limited New York:

MS-501 INTRODUCTION TO MASS COMMUNICATION Credit hours: 2(2-0)
Arts and Humanities course

Contents:

Definition, types and significance of communication, Process of Communication: source; message; channel; noise; destination; encoding; decoding; and feedback. Barriers in communication.

- **Essentials of effective communication**
- Dimensions of mass communication: mass media, advertising, public relations, blogging, new media etc.
- **Nature and Functions of mass communication:** (Information, Education, opinion Formation, Entertainment and Development)
- Introduction to journalism, Definition, assignment, and pursuit of a "beat," key writing concepts, including the inverted pyramid, how to write a lead, and when and how to use quotes effectively.
- In addition to covering basic news stories, students will be exposed to various magazine styles, and encouraged to write a query letter and feature article for a magazine of his or her choice.
- The art and practice of good reporting skills, which includes brainstorming story ideas, rudimentary interviewing skills, and contacting sources in preparation for a series of news stories (crime/accident/fire/town meeting)

Recommended books

1. Dominick J.R. (2006). *Dynamics of MassCommunication.*(8th edition). New York McGrawHill
2. Merrill, J.C Le, Friedlander, E.J (1994). *Modern Mass Media*(2ndedition).New York. Harper Collin College Publishers
3. Straubhaar, La Rose. (2002). *Media Now: Communication Media in theInformation Age* (3rdEdition.) USA, Wadswort

PSY-501 INTRODUCTION TO PSYCHOLOGY Credit hours: 2(2-0)
Arts and Humanities course

Contents:

Understanding Psychology

Psychology: Scientific perspective, Historical perspective, Schools of psychology, Methods of psychology, Fields of psychology and their application

Biological Basis of Behavior

Neuron and its function, Nervous system: Central and Peripheral, Endocrine system

Sensation and Perception

Sensation and the Senses: Vision, audition, smell, taste and kinesthetic
Perception: Principles of perceptual organization
Depth Perception: Binocular and monocular cues
Illusions and extra sensory perception

Learning: Definition of learning, Types of learning: Classical and Operant conditioning; Social learning

Memory: Definition and types of memory, Processes and techniques of improving memory
Forgetting: Nature and causes

Cognition and Intelligence: Concept of cognition, Problem solving, Judgment and decision making, LanguageDevelopment, Concept and Theories of intelligence, Assessment of intelligence, Concept ofcreativity and its stages

Motivation and Emotion: Concept and types of motivation, Factors affecting motivation,

Introduction to emotions,Theories of emotions, Physiology and emotion
Personality: Defining personality, Theories of personality, Personality assessment
Social Influence and Socialization
Social facilitation, Crowd behavior, Conformity, Obedience, Helping behavior, Agents of Socialization

Recommended Books

1. Atkinson R. C., & Smith, E. E. (2000). Introduction to psychology (13th ed.). NY: Harcourt Brace College Publishers.
2. Coon, D., & Mutterer, J. (2008). Introduction to psychology: Gateways to mind and behavior (12thed.). USA: Wadsworth Cengage Learning.
3. Fernald, L. D., & Fernald, P.S (2005) Introduction to psychology. USA; WMC Brown Publishers.
4. Fredrickson, B., Nolen-Hoeksema, S., Loftus, G., &Wagenaar, W.(2009). Atkinson & Hilgard'sIntroduction to psychology (15th ed.). USA: Wadsworth.
5. Glassman, W.E. (2000). Approaches to psychology. Open University Press.
6. Hayes, N. (2000). Foundation of psychology (3rd ed.). UK: Thomson Learning.
7. Kalat, J. W. (2010). Introduction to psychology USA. Cengage Learning, Inc.
8. Lahey, B. B. (2004). Psychology: An introduction (8th ed.). UK: McGraw-Hill Companies,
9. Inc.
10. Myers, D. G. (2011).Psychology (10th ed.). USA: Wadsworth Publishers.
11. Ormord, J. E. (1995). Educational psychology: Developing learners. USA: Prentice Hall, Inc.
12. Rathus, S. (2011). Psychology: Concepts and connections (10th ed.). USA: Wadsworth CengageLearning.

COURSES OF SOCIAL SCIENCE

Only one course of Social Science from the below list will be taken depend upon the availability of faculty member.

S. No	Course Code	Course Title	Cr. Hrs.
1	GEOG-501	Fundamentals of Geography	3(3-0)
2	DMDS-501	Fundamental of Disaster Management	3(3-0)
3	IR-501	Introduction to International Relations	3(3-0)
4	SOC-501	Introduction to Sociology	3(3-0)
5	POLSC-501	Introduction to Political Science	3(3-0)
6	ECO-501	Fundamentals of Economics	3(3-0)

GEOG-501 FUNDAMENTALS OF GEOGRAPHY Credit hours: 2(2-0)
Social Science course

Contents:

1. **Introduction:** Nature and scope, the evolution of geography from ancient to modern times, branches of Geography and their relations with other disciplines
2. **Five Major Themes of Geography**: Location: Absolute and relative, Place: Physical and anthropogenic characteristics, Man-environment relationship, Movement, Region
3. **Earth as a planet:** Shape, size and movements, Earth's Satellite-Moon, Lunar and Solar Eclipses

4. **Location on Map and Globe:** Directions and scales, Geographical coordinates and their characteristics, World time zones: standard and local time
5. **Distribution of Land and Water:** Proportion of land and water on the planet earth, Fresh water; glaciers, rivers, lakes, swamps and underground water, Ocean water
6. **Elements of Geo-system**: Lithosphere, Atmosphere o Hydrosphere, Biosphere

Recommended Books

1. Strahlar, A.N., Strahlar, A.H. Physical Environment, John Wiley. New York (2004).
2. Stringer, E.T. "Modern Physical Geography," New York: John Wiley (2004).
3. Christopherson, R.W. "Geo-systems," Prentice-Hall, Inc, USA (2000).
4. Gabler, R.E, Sager, R.J and Wise, D.L. "Essentials of Physical Geography", Saunders College Publishing, New York (1997)
5. Thurman, H.V. &Mexrill "Essentials of Oceanography", Menson, London (1996).
6. Fraser,C. "Unlocking Five Themes of Geography", Globe Book Co. New Jersey (1993).
7. Taylor, J. "Integral Physical Geography", Longman, London (1993).
8. Mcliveen, J.F.R. "Fundamentals of Weather and Climate," Prentice Hall (1992).
9. Thompson, R.D. et al. "Process in Physical Geography", London, Longman (1986).

DMDS-501 FUNDAMENTAL OF DISASTER MANAGEMENT Credit hours: 2(2-0)

Social Science course

Contents:

1. **Introduction to Disaster Management:** Basics Concepts evolving terminologies in Disaster Management, Nature and Scope of Disaster Management, Historical Evolution
2. **Classification of Disasters:** Socio-Natural Disasters, Anthropogenic Disasters, Technological Disasters
3. **Concept of Risk, Vulnerability and Capacity:** Disaster Risk, Vulnerability (Types and Causes, Models), Capacity and Types of Capacity**,** Level of Capacities
4. **Disaster Risks Trends:** Global Disaster Risk Trends, Costs and Frequency, Historical Review of Disasters Trends
5. **Case Studies on Impacts of Disasters:** Economic, Social, Environmental, Physical Infrastructure

Recommended Books:

1. Comprehensive Risk Assessment for Natural Hazards. World Meteorological Organization 2006.
2. DAMON, P. C. (2006) International Disaster Management. Butterworth-Heinemann.
3. UNISDR. (2009). Global Assessment Report on Disaster Risk Reduction, United Nations International Strategy for Disaster Reduction.
4. Wisner, B., P. Blaikie, T. Cannon, and I. Davis. (2004). "At Risk: Natural Hazards, People's Vulnerability and Disasters (2nd Ed.)." Rutledge, London, UK.
5. W. N. Carter (1999) Disaster Management: Disaster Manager's Handbook, Manila: Asian Development Bank.

IR-501 INTRODUCTION TO INTERNATIONAL RELATIONS Credit hours: 2(2-0)
Social Science course

Contents:

Meaning, Definition, Nature, and Scope of International Relations, Evolution and Development of International Relations, Significance of International Relations, Concept of Nation State, International System and Sub-Systems, Foreign Policy, National Interest, and Diplomacy, Power and Balance of Power, Regionalism and Globalization**,** State and Non-State Actors, Human Rights in International Relations**,** Religion, Ethics, Morality and Justice in International Relations, The Role of Economics in International Relations**,** The Concept of War and Peace in International Relations

Recommended Books:

1. Columbus, Theodore. Introduction to International Relations: Power and Justice. New Delhi: Prentice Hall, 1992.
2. Goldstine, Josha. International Relation. Washington DC: Pearson Education, 2003 3. Lawson, Stephanie. International Relations; Cambridge; Polity, 2003.
3. Amstutz, Mark R. International Conflict and Cooperation: An Introduction to World Politics. (Chicago: Brown & Benchmark, 1995)
4. Griffiths, Martin, and Callaghan, Terry O'. International Relations: The Key Concepts. London, Routledge, 2003.
5. Henderson, Conway W. International Relations: Conflict & Cooperation at the Turn of the 21stCentury Boston: McGraw-Hill, 1998.
6. Jackson, Robert and Sorensen; Georg, Introduction to International Relations Theories and Approaches, Oxford: Oxford University Press, 2003.
7. Jackson, Robert and Dorreen Jackson. A Comparative Introduction to Political Science. New Jersey: Prentice – Hall, 1997.

SOC 501 INTRODUCTION TO SOCIOLOGY Credit hours: 2(2-0)
Social Science course

Contents:

1. Introduction: Definition, Scope, and Subject Matter, Sociology as a Science, Historical back ground of Sociology, Relationship of sociology with other social sciences
2. Basic Concepts: Group, Community, Society; Associations: Non-Voluntary, Voluntary; Organization: Informal, Formal; Social Interaction, Levels of Social Interaction, Process of Social Interaction: Cooperation, Competition, Conflict, Accommodation, Acculturation and diffusion, Assimilation, Amalgamation
3. Social Groups: Definition and Functions; Types of social groups: In and out groups, Primary and Secondary group, Reference groups, Informal and Formal groups, Pressure groups
4. Culture: Definition, aspects and characteristics of Culture, Material and non-material culture, Ideal and real culture
5. Elements of culture: Beliefs, Values, Norms and social sanctions
6. Organizations of culture: Traits, Complexes, Patterns, Ethos, Theme
7. Other related concepts: Cultural Relativism, Sub Cultures, Ethnocentrism and Xeno centrism, Cultural lag
8. Socialization and Personality: Personality, Factors in Personality Formation, Socialization, Agencies of Socialization, Role and Status
9. Deviance and Social Control: Deviance and its types, Social control and its need, Forms of Social control, Methods and Agencies of Social control
10. Collective Behaviour: Collective behaviour, its types, Crowd behavior, Public opinion, Propaganda, Social movements, Leadership

Recommended Books:

1. Anderson, Margaret and Howard F. Taylor. 2001. *Sociology the Essentials*. Australia: Wadsworth.
2. Brown, Ken 2004. *Sociology*. UK: Polity Press
3. Gidden, Anthony 2002. *Introduction to Sociology*. UK: Polity Press.
4. Macionis, John J. 2006. 10th Edition *Sociology* New Jersey: Prentice-Hall
5. Tischler, Henry L. 2002. *Introduction to Sociology* 7th ed. New York: The Harcourt Press.
6. Frank N Magill. 2003. *International Encyclopedia of Sociology*. U.S.A: Fitzroy Dearborn Publishers
7. Macionis, John J. 2005. *Sociology* 10th ed. South Asia: Pearson Education
8. Kerbo, Harold R. 1989. *Sociology: Social Structure and Social Conflict.* New York: Macmillan Publishing Company.
9. Koening Samuel. 1957. *Sociology: An Introduction to the Science of Society*. New York: Barnes and Nobel.
10. Lee, Alfred Mclung and Lee, Elizabeth Briant 1961. *Marriage and The family.*New York: Barnes and Noble, Inc.
11. Leslie, Gerald et al. 1973. *Order and Change: Introductory Sociology* Toronto: Oxford University Press.

POLSC-501 INTRODUCTION TO POLITICAL SCIENCE Credit hours: 2(2-0)

Social Science course

Contents:

1. Defining Social Sciences and differentiating it from natural and physical sciences
2. Defining Political Science, its history, method and subject matter.
3. Relationship of Political Science with other social sciences.
4. Major Fields of Political Science: Political Philosophy, Political Theory, Political Economy, Comparative Politics, International Relations
5. State: Its origin, evolution and types
6. Government: Legislature, Executive, Judiciary.
7. Sovereignty
8. Regime Types: Authoritarianism and Democracy
9. Forms of Democratic Governments: Presidential and Parliamentary forms.
10. Basic concepts of Political Science: Power, Authority, Legitimacy

Recommended Books:

1. Ellen Grigsby (2016) *Analysing Politics: An Introduction to Political Science*, Oxford University Press, London.
2. Ian Mackenzi (Ed.), Political Concepts: A Reader and Guide, Edinburgh, University Press, 2005.
3. Robert Jackson and Dorreen Jackson, A Comparative Introduction to Political Science, New Jersey, Prentice – Hall, 1997
4. V. D. Mahajan, Political Theory- Principles of Pol. Science, New Delhi, S. Chand & Co., 2006.

ECO-501 FUNDAMENTALS OF ECONOMICS Credit hours: 2(2-0)

Social Science course

Contents:

Basic Economic concepts: Nature and functions of every economic system. Nature and scope of economic analysis. Economic terms. The major segments of economic theory. Micro-economics and macro-economics. Micro-economic (Price Theory): The price of market mechanism. The influence of the price system on resource allocation, consumption patterns and income distribution. Determination of price by supply and demand. The assumption of perfect competition. The theory of demand and utility. Elasticity of demand and its measurement. The theory of cost and supply. Equilibrium of the firm Equilibrium of demand and supply in the short-run and long-term periods. Pricing of the productive factors. Wages, profits, interest and rent. Macro-economic (income and Employment Theory): Measurement of national income. Concept of GNP, and NNP. Circular flow of national income. Three approaches to national income measurement, income at factor cost, income at market price and expenditure approach. Determination of the national income and employment. Equilibrium level of national income, saving, consumption and investment schedules and their inter-section. Say's law of markets and its refutation by "Keynes" general theory of employment-aggregate demand, aggregate supply, effective demand. Consumption function: The propensity of consume. The multiplier and its calculation. Logical identity of saving and investment. Investment as determinant of effective demand: Determinants of investment. The marginal efficiency of capital. The accelerator and its interaction with the multipliers. The rate of interest and investment. Economics, Statistics and Mathematics:

Economic Planning in Pakistan: Economic Development through Planning: The concept of measurement of economic development. The imperfections of market economy. The need and objectives of economic Planning. Special features of Pakistan's economy: Primary production in population pressure, capital deficiency, Low income. Development Planning in Pakistan:

Recommended Books:

1. Samuelson, P.A. (1961). *Economics*. McGraw-Hill Compant, New York.
2. Stonier, A.H. and Huage, D.C: A Text- Book of Economic Theory (Longmans, London, 1964).
3. Adrus, J.R. and Mohammad, A.F: Trade, Finance and Development in Pakistan, (Karachi 1966).
4. Meenal, S.A: Money and Banking in Pakistan (Karachi, 1966).
5. Qureshi, Al (ed.): The Third Five Year Plans and other Papers (Rawalpindi, 1966).
6. Mahbub-ul-Haq: The Strategy of Economic Planning A Case Study of Pakistan. (Karachi, Oxford University Press, 1963).
7. Govt. of Pakistan: First, Second and Third Five-Year Plans of Pakistan Report of the Food and Agriculture Commission (Karachi, 1960).
8. Pakistan Economic Survey for the years 1963-64, 1964-65 and 1965-66.
9. Pakistan Budgets for the years 1964-65, 1965-66 and 1966-67.