Scheme of Studies for BS Physics Fall 2024-2025 and onwards

Course Code	Course Title	Credit Hour
Semester 1		
PHY-301	Mechanics-I	3 (3 – 0)
GSC-321	The Science of Global Challenges	3 (3 – 0)
MTH-301	Calculus-I	2 (2 – 0)
ENG-321	Functional English	3 (3 – 0)
ICP-321	Ideology and Constitution of Pakistan	2 (2 – 0)
CSI-321	Applications of Information and Communicative Technologies	3(2-1)
PES-302	Introduction to Physical Education	2 (1 – 1)
THQ-I	Teaching of the Holy Quran-I	1 (1 – 0)*
MTH-111	Basic Mathematics – I	3 (3 – 0)¶
	Total	**18/21¶ + 1***
Semester 2		
PHY-302	Mechanics-II	3 (3 – 0)
PHY-304	Heat and Thermodynamics	3 (3 – 0)
PHY-306	Waves and Optics	3 (3 – 0)
MTH-302	Calculus-II	2 (2 – 0)
MTH-326	Differential Equations-I	2 (2 – 0)
ENG-322	Expository English	3 (3 – 0)
ISL-322	Islamic Studies/Ethics	2 (2 – 0)
MTH-112	Basic Mathematics – II	3 (3 – 0)¶
	Total	**18/21¶**
Semester 3		
PHY-401	Electricity and Magnetism-I	3 (3 – 0)
PHY-403	Introduction to Programming for Physicists	3 (3 – 0)
PST-421	Pakistan Studies	2 (2 – 0)
QTR-421	Quantitative Reasoning-I	3 (3 – 0)
CCE-421	Civics and Community Engagement	2 (2 – 0)
ENT-421	Entrepreneurship	2 (2 – 0)
PHY-405	Mechanics, Heat & Vibrations Lab Course	3 (0 – 3)
THQ-II	Teaching of the Holy Quran-II	1 (1 – 0)*
	Total	**18 + 1***
Semester 4		
PHY-402	Electricity and Magnetism-II	3 (3 – 0)
PHY-404	Modern Physics	3 (3 – 0)
MTH-404	Differential Equations-II	2 (2 – 0)
MTH-406	Linear Algebra, Metric and Topological Spaces	4 (4 – 0)
PHY-408	Optics and Modern Physics Lab Course	3 (0 – 3)
QTR-422	Quantitative Reasoning-II	3 (3 – 0)

	Total	**18**
Semester 5		
PHY-501	Methods of Mathematical Physics-I	3 (3 – 0)
PHY-503	Classical Mechanics	3 (3 – 0)
PHY-505	Electrodynamics-I	3 (3 – 0)
PHY-507	Electronics-I	3 (3 – 0)
PHY-509	Nuclear Physics-I	3 (3 – 0)
PHY-511	Electromagnetism Lab Course	3 (0 – 3)
THQ-III	Teaching of the Holy Quran-III	1 (1 – 0)*
	Total	**18 + 1***
Semester 6		
PHY-502	Methods of Mathematical Physics-II	3 (3 – 0)
PHY-504	Statistical Mechanics	3 (3 – 0)
PHY-506	Nuclear Physics-II	3 (3 – 0)
PHY-508	Electrodynamics-II	3 (3 – 0)
PHY-510	Electronics-II	3 (3 – 0)
PHY-512	Atomic and Nuclear Physics Lab Course	3 (0 – 3)
	Total	**18**
Semester 7		
PHY-601	Solid State Physics-I	3 (3 – 0)
PHY-603	Quantum Mechanics-I	3 (3 – 0)
PHY-605	Electronics Lab Course	3 (0 – 3)
PHY-607	Relativity and Cosmology	3(3 – 0)
INT-631	Internship	3 (0 –3) †
THQ-IV	Teaching of the Holy Quran-IV	1 (1 – 0)*
	Total	**15 + 1***
Semester 8		
PHY-602	Solid State Physics-II	3 (3 – 0)
PHY-604	Quantum Mechanics-II	3 (3 – 0)
PHY-606	Computational Physics	3 (3 – 0)
PHY-***	Elective	4 (3 – 1) / 4 (4 – 0)
CAP-630	Capstone Project	3 (0 – 3) ††
	Total	**16**

Note:

* Non-credited course for Muslim students as per HEC letter No. HEC/CURR/SR-533/2023/4520, dated March 27, 2023.

¶ Deficiency course for F.Sc. Pre-Medical students.

† Internship of 48 hours to be completed in the summer after 6th semester or during 7th semester.

†† Capstone Project will be offered and completed in the 8th semester.

*** One elective course of 4 CH to be chosen in the 8th semester from the list provided below.

List of Elective Courses

PHY-608	Particle Physics	4 (4 – 0)

PHY-610	Health and Medical Physics	4 (4 – 0)
PHY-612	Advanced Electronics	4 (3 – 1)
PHY-614	Computational Materials Physics	4 (3 – 1)
PHY-616	Plasma Physics	4 (4 – 0)
PHY-618	Laser Technology and Applications	4 (4 – 0)

Course Contents for BS Physics Fall 2024-2025 and onwards

Course Code	Course Title	Credit Hour
	Semester 1	
PHY-301	Mechanics-I	3 (3 – 0)

Vectors in 3-dimensions & fundamental operations, Stoke's theorem, Gauss's Divergence theorem, Dynamics of Uniform circular motion, The Conical pendulum, The Rotor, The Banked curve, Equations of motion, Time-dependent forces, Velocity-dependent forces, Non-Inertial frames & Pseudo forces, projectile motion, Work done by constant & variable forces (one, & two dimension cases), K.E & the work-energy theorem, general proof of work-energy theorem, power, conservative forces, P.E, one-dimensional conservative system, Two & many particle system, calculation of c.m. of different objects, Linear momentum of Particle & system of particles, conservation of linear momentum, system of variable mass, Rocket equation, collision, impulse and momentum, Elastic and inelastic collisions in one dimension & two dimensions, centre of mass reference frame.

Recommended Books:

1. Halliday, Resnick and Walker, 2011. Fundamental of Physics 9th Ed. John Wiley and Sons Inc, New York.
2. Resnick, Halliday and Krane, 2002. Physics Vol. I, 5th Ed. John Wiley and Sons Inc, New York.
3. Sears, Zemansky and Young, 2000. University Physics 8th Ed. Addison-Wesley, Reading (MA), USA.
4. Alonso and Finn, 1999. Physics. Addison-Wesley, Reading (M.A), USA

GSC-321	The Science of Global Challenges	3 (3 – 0)

HEC model course available at

https://www.hec.gov.pk/english/services/students/UEP/Pages/Model-General-Education-Courses.aspx

MTH-301	Calculus-I	2 (2 – 0)

Prerequisites: knowledge of sets, relations and functions

Limits and Continuity: The fundamental concepts of limits, continuity, types of discontinuities.

Derivatives: Derivatives of functions, techniques of differentiation, proofs of Rolle'2 theorem, Mean value Theorem, Applications of derivatives.

Integration: Introduction to integration, fundamental theorem of calculus, define integrals, techniques of integration, indeterminate forms, improper integrals.

Sequence and Series: Sequence, results related to infinite series.

Recommended Books:

1. Anton, H., Bivens, I.C., & Davis. S. (2021). Calculus, (12th Edition), Wiley.
2. Finney, R. L., & Weir, M.D. (2001). Thomas Calculus: Early Transcendentals. Addison-Wesley.
3. Stewart, J., Clegg, D.K., & Watson. S. (2020). Calculus: Early Transcendentals. Brooks/Cole Publishing Company, Pacific Grove, CA.
4. Thomas, G.B., & Finney, R. L. (1998). Calculus and Analytical Geometry. Addison-Wesley.

ENG-321	Functional English	3 (3 – 0)

The contents will be provided by the concerned department.

ICP-321	Ideology and Constitution of Pakistan	2 (2 – 0)

The contents will be provided by the concerned department.

CSI-321	Applications of Information and Communicative Technologies	3(2-1)

DESCRIPTION

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.

COURSE LEARNING OUTCOMES

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

1. Explain the fundamental concepts, components, and scope of Information and Communication Technologies (ICT).

2. Identify uses of various ICT platforms and tools for different purposes.

3. Apply ICT platforms and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.

4. Understand the ethical and legal considerations in use of ICT platforms and tools.

SYLLABUS

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, Runkeeper, 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.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

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.

PES-302	Introduction to Physical Education	2 (1 – 1)

Objectives of Course

This course is designed to acquaint students with the objectives to make them understand the basic concepts of physical education and its relation to Health Education and provide preliminary awareness about physical, mental, and social developments involving students in various athletics and games practical as well as interpretation of biological and psychological effects of physical activities.

Course Outlines:

Unit# 1: Introduction to Physical Education

- Definition and Scope of Physical Education
- Aims, objectives and Importance of Physical Education
- Scientific Foundations of day life Physical Education

Unit# 2: Physical Motor Fitness

1) Definition of Motor Fitness
2) Importance of Physical Fitness
3) Components of Physical Fitness
    a) Cardiovascular Endurance
    b) Muscular Power
    c) Muscular Endurance
4) Motor Fitness
    a) Speed
    b) Agility
    c) Balance

Unit# 3: Games and Sports

1) Systems of Tournaments
    a) Knock our (Elimination) System
    b) Combination System

Unit# 4: Recreation

1) Definition, need and importance.
2) Introduction of Recreational activities, mental recreation (Indigenous games, small area Sports, indoor and outdoor games)
3) Utilization of Educational Institutions as Community Recreational Centers

Unit# 5: Practical Orientations

A. Track and Field Events

Select one Skill-efficiency from each group of Athletics (sprint races, throws, and jumps):

a) Sprint Races: 100m, 200m, 400m
b) Throws: Shot Put, Discus Throw
c) Jumps: Long Jump, Triple Jump

B. Skill Efficiency in Games

Select one Skill-efficiency from each group of Games (Indoor and Outdoor):

a) Indoor Games: Basketball, Volleyball, Badminton
b) Outdoor Games: Hockey, Football, Cricket

Books Recommended:

1. Human Kinetics. (2013). Introduction to recreation and leisure. Human Kinetics.
2. Zeigler, F. Z. E. F. (2016). Philosophy of physical activity education (including educational sport). Trafford Publishing.
3. Osada, N. (2019). Theory of International Physical Education and Sports Studies for the Achievement of Peace. CCB Publishing.
4. Barber, G. (2016). Getting started in track and field athletics: Advice & ideas for children, parents, and teachers. Trafford Publishing.
5. Griffin, L. L., & Butler, J. (2015). Teaching games for understanding: Theory, research, and practice. Human Kinetics.
6. Goldman, L. (2015). Raising our children to be resilient: A guide to helping children cope with trauma in today's world. Rutledge.
7. Lincoln, C. (2004). Playing the game: Inside athletic recruiting in the Ivy League. Nomad Press.
8. Kamlesh, M. L. (2004). Athletic Personality: A psychological probe. Khel Sahitya Kendra.

9. Guthrie, M. (2003). Coaching track & field successfully. Human Kinetics.
10. Carr, G., & Carr, G..A. (1999). Fundamentals of track and field. Human Kinetics.

THQ-I	Teaching of the Holy Quran-I	1 (1 – 0)*

Teaching of the Holy Quran - I

Topic	Details
Semester/Level	1st Semester
Course Code	ISL-311
Course Title	Teaching of the Holy Quran– I
Credit Hours	1(1-0)
Objectives	• To familiarize the students with the keys and fundamentals of recitation of the Holy Quran. • To develop the skill of the students for the recitation of the Holy Quran. • Students will learn the basic Arabic grammar in a practical way. • To develop an eagerness among the students to explore the last divine Book.
Course Contents:	• تیسواں پارہ-ناظرہ مع تجوید • بنیادی عربی گرامر اسم اور اسکے متعلقات: اسم فاعل، مفعول، تفضیل، مبالغہ فعل اور اسکی اقسام: ماضی، مضارع، امر، نہی حرف اور اسکی اقسام: حروف علت، حروف جارہ، مشبہ بالفعل
Memorization:	تیسویں پارے کی آخری بیس سورتیں (حفظ مع ترجمہ)

List of Translations of the Holy Quran

مجوزہ اردو تراجم قرآن

نام ترجمہ	مترجم
موضح القرآن	شاہ عبدالقادر دہلوی
فتح القرآن	فتح محمد جالندہری
ترجمہ بیان القرآن	اشرف علی تھانوی
ترجمہ قرآن مجید	سید ابوالاعلیٰ مودودی
ترجمہ ضیاء القرآن	محمد کرم شاہ الازہری
ترجمہ قرآن	حافظ نذر احمد
آسان ترجمہ القرآن	سید شبیر احمد
احسن البیان	مولانا محمد جوناگڑھی
ترجمہ تبیان القرآن	غلام رسول سعیدی
آسان ترجمہ قرآن	محمد تقی عثمانی
کشف الرحمن	مولانا احمد سعید دہلوی
مصباح القرآن	ڈاکٹر عبدالرحمان طاہر
معانی القرآن	دارالسلام
عرفان القرآن	ڈاکٹر طاہر القادری
احکام القرآن	مولانا محمد بشیر فاروق قادری
مطالعہ قرآن کریم برائے طلبہ وطالبات	دی علم فاؤنڈیشن کراچی

Suggested English Translations of the Holy Quran

Name	Translator
The Meaning of the Glorious Koran	Muhammad Marmaduke Pickthall
The Holy Quran	Abdullah Yousuf Ali
The Noble Qur'an	Dr. Muhammad Taqiuddin Al Hilali&Dr. M Muhsin Khan
The Noble Quran	Mufti Muhammad TaqiUsmani
Towards Understanding the Ever Glorious Quran	Dr.Muhammad Mahmud Ghali
The Study Quran	Seyyed Hossein Nasr

Preliminaries: Real and complex numbers, Introduction to sets, set operations, functions, types of functions. Matrices: Introduction to matrices, types of matrices, inverse of matrices, determinants, system of linear equations, Cramer's rule. Quadratic equations: Solution of quadratic equations, nature of roots of quadratic equations, equations reducible to quadratic equations. Sequence and Series: Arithmetic, geometric and harmonic progressions. Permutation and combinations: Introduction to permutation and combinations, Binomial Theorem: Introduction to binomial theorem. Trigonometry: Fundamentals of trigonometry, trigonometric identities. Graphs: Graph of straight line, circle and trigonometric functions.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.

2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & Sons, Inc. 2005.

3.Hughes-Hallett, Gleason, McCallum, et al, Calculus Single and Multivariable, 3rd Edition. John Wiley & Sons, Inc. 2002

4. Swokowski. E. W., 'Fundamentals of Algebra and Trigonometry', Latest Edition.

5. Kaufmann. J. E., 'College Algebra and Trigonometry', PWSKent Company, Boston, Latest Edition.

Semester 2		
PHY-302	Mechanics-II	3 (3 – 0)

Rotational dynamics, Relation between Linear & angular variables, K.E of Rotation & Rotational Inertia of Solid bodies, Torque acting on a particle, Parallel & Perpendicular axes theorem, combined Rotational & translational motion, rolling without slipping, Angular momentum of a Particle & system of Particles, Relation between torque & angular momentum. Conservation of angular momentum, spinning top, stability of spinning objects, Newton's law of universal gravitation, gravitational effects of spherical distribution of matter, gravitational P.E, Gravitational field & Potential, Motion of planets & satellites, Kepler's laws, Energy consideration in planetary & satellite motion, Bulk Properties of matter, Hook's Law , Types of elasticity, variation of pressure in earth's atmosphere, surface tension, general concepts of fluid flow, Bernoulli's equations, viscosity, Poiseuille's law.

Recommended Books:

1. Halliday, Resnick and Walker, 2011. Fundamental of Physics 9th Ed. John Wiley and Sons Inc, New York.

2. Resnick, Halliday and Krane, 2002. Physics Vol. I & II, 5th Ed. John Wiley and Sons Inc, New York.

3. Sears, Zemansky and Young, 2000. University Physics 8th Ed. Addison-Wesley, Reading (MA), USA.

4. Alonso and Finn, 1999. Physics. Addison-Wesley, Reading (M.A), USA.

PHY-304	Heat and Thermodynamics	3 (3 – 0)

Macroscopic properties of a gas and the ideal gas law, The ideal gas model, Kinetic calculations of pressure, Kinetic interpretation of the temperature, Work done on an ideal gas, The internal energy of an ideal gas, intermolecular forces, Statistical distributions and the mean values, Mean free path, The distribution of molecular speeds, The distribution of energies, The internal energy of an ideal gas, Brownian motion, Heat, The mechanical equivalent of heat, Heat capacity and specific heat, Heat of transformation, Heat capacities of solids, Heat capacities of an ideal gas, The first law of thermodynamics, Applications of the first law, The transfer of heat, Reversible and irreversible process, Heat engines and the second law, Refrigerators and the second law, The Carnot cycle, Carnot's theorem and the second law, The thermodynamic temperature scale, Entropy: Reversible process, Entropy : Irreversible Process, Entropy and the second law, Zeroth law, , Maxwell's thermodynamics relations, TDS equations, Clapeyron's equation, entropy and second law of thermodynamics, temperature scale, entropy, low temperature physics. Thermoelectricity, Seabeck effect, Peltier effect, thermocouple.

Recommended Books:

1. Halliday, Resnick and Walker, 2011. Fundamental of Physics 9th Ed. John Wiley and Sons Inc, New York.

2. Resnick, Halliday and Krane, 2002. Physics Vol. I & II, 5th Ed. John Wiley and Sons Inc, New York.

3. Sears, Zemansky and Young, 2000. University Physics 8th Ed. Addison-Wesley, Reading (MA), USA.

4. Alonso and Finn, 1999. Physics. Addison-Wesley, Reading (M.A), USA.

PHY-306	Waves and Optics	3 (3 – 0)

S.H.M & its applications, Energy consideration in SHM, SHM & uniform circular motion, combinations of Harmonic motion, Damped harmonic motion, Forced Oscillation & Resonance, Mechanical Waves, Traveling waves, wave speed , wave equation, Power & intensity in wave motion, principle of superposition, standing waves, Interference of waves, Beats, Doppler effect, visible light , speed of light in matter, double slit interference, intensity in Double slit interference, adding waves using phasors, interference from thin film, Single slit diffraction, Intensity in single slit diffraction using phasors, diffraction at circular aperture, diffraction grating, x-ray Diffraction, Polarization by Reflection, & Double Refraction, Polarization states, Rotation of Plane Polarization.

Recommended Books:

1. Halliday, Resnick and Walker, 2011. Fundamental of Physics 9th Ed. John Wiley and Sons Inc, New York.

2. Resnick, Halliday and Krane, 2002. Physics Vol. I, 5th Ed. John Wiley and Sons Inc, New York.

3. Sears, Zemansky and Young, 2000. University Physics 8th Ed. Addison-Wesley, Reading (MA), USA.

4. Alonso and Finn, 1999. Physics. Addison-Wesley, Reading (M.A), USA

MTH-302	Calculus-II	2 (2 – 0)
The contents will be provided by the concerned department.		
MTH-326	Differential Equations-I	2 (2 – 0)
The contents will be provided by the concerned department.		
ENG-322	Expository English	3 (3 – 0)
The contents will be provided by the concerned department.		
ISL-322	Islamic Studies/Ethics	2 (2 – 0)
The contents will be provided by the concerned department.		
MTH-112	Basic Mathematics – II	3 (3 – 0)¶

Preliminaries: Real Numbers and the Real Line, Functions and their graphs: Polynomial Functions, Rational Functions, Trigonometric Functions, and Transcendental Functions. Slope of a Line, Equation of a Line, Solution of equations involving absolute values, Inequalities. Limits and Continuity: Limit of a Function, Left Hand and Right Hand Limits, Continuity, Continuous Functions. Derivatives and its Applications: Differentiation of Polynomial, Rational and Transcendental Functions, Extreme Values of Functions. Integration and Indefinite Integrals: Integration by Substitution, Integration by Parts, Change of Variables in Indefinite Integrals. Least-Squares Line.

Recommended Books:

1. Thomas, Calculus, 11th Edition. Addison Wesley publishing company, 2005.

2. H. Anton, I. Bevens, S. Davis, Calculus, 8th edition, Jhon Willey & 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 Outline Series, 4th edition, 1999.

5. E. W. Swokowski, Calculus and Analytic Geometry PWS Publishers, Boston, 1983.

6. John H. Mathews, Numerical Methods for Mathematics Science and Engineering, Prentice-Hall, Second Edition 1992.

	Total	**18/21¶**
Semester 3		
PHY-401	Electricity and Magnetism-I	3 (3 – 0)

Electric charge, coulombs law, Electric field, continuous charge distributions, image charges, electric dipole, Gauss's Law and its applications, electric potential, electric properties of materials, capacitor, dielectric, capacitors in circuits, energy stored in capacitors, electric polarization, Gauss's Law for dielectrics, electric current, current density and Ohm's law, equation of continuity, DC circuits, analysis of circuits, electric fields in circuits, resistance in circuits, energy transfers in a circuit, RC circuits, magnetism, magnetic force on a charged particle, magnetic torque due to currents, magnetic dipole, Biot-Savart Law and its applications, Ampere's law and its applications, Gauss' law for magnetism, origin of atomic and nuclear magnetism, magnetization, magnetic materials: diamagnetic, paramagnetic, ferroamagnetic. Induced magnetic fields and displacement current.

Recommended Books:

1. Halliday, Resnick and Walker, 2011. Fundamental of Physics, 9th Ed , John Wiley and Sons Inc, New York,.

2. Griffiths D, 2003, Introduction to Electrodynamics, Prentice Hall.

3. Resnick, Hlliday and Krane, 2002, Physics Vol II, Ed. 5th, John Wiley and Sons Inc, New York.

4. Sears, Zemansky and Young, 2000, University Physics Ed. 11th, Addison-Wesley, reading (MA), USA.

PHY-403	Introduction to Programming for Physicists	3 (3 – 0)

Introduction to programming, Significance of computers in the present physical sciences scenario, Software and hardware domains, Scientific computing, high and low level languages, flow charts, scientific programming languages, introduction to C++, FORTRAN and Python, memory management in C++, structure of C++ program, Generic form, Header files, Constants, Local variables, Input/output statements, Simple program, Variables, Data types, variables, Operators, Loops, Break, Continue, If and if-else statements, Conditional operator, Switch statement, Flags and conditional testing, One-dimensional arrays, Multi-dimensional arrays, String manipulation functions, Arrays as lists, Sorting, Searching, functions, built-in and user defined functions, file system, pointer, inheritance, polymorphism, C++ for scientific programming. Lab work.

Recommended Books:

1. Deitel H M and P J Deitel, 2012, C++ How to Program, 8/e, Early Objects Version, Prentice Hall

2. Robert Lafore , 2002, Object-oriented Programming in C++, Ed. 4th, SAMS publishers.

3. Robert L, TURBO C++, 1991, Waite Group.

4. Harrison S P and G Steele Jr. 1987, C: A Reference Manual, Prentice-Hall.

5. Peter Norton, Introduction to computers, 6th Ed., McGraw Hill International Edition.

PST-421	Pakistan Studies	2 (2 – 0)
The contents will be provided by the concerned department.		
QTR-421	Quantitative Reasoning-I	3 (3 – 0)
HEC model course ("Exploring Quantitative Skills") available at https://www.hec.gov.pk/english/services/students/UEP/Pages/Model-General-Education-Courses.aspx		
CCE-421	Civics and Community Engagement	2 (2 – 0)
The contents will be provided by the concerned department.		
ENT-421	Entrepreneurship	2 (2 – 0)
The contents will be provided by the concerned department.		
PHY-405	Mechanics, Heat & Vibrations Lab Course	3 (0 – 3)

1. Measurement of Oscillation period of the pendulum as a function of the angle of oscillation Φ of the oscillation plane for two different pendulum lengths.

2. Projectile motion: (a) To determine the range as a function of the angle of inclination. (b) To determine the maximum height of projectile as a function of angle of inclination. (c) To determine the range / height as a function of initial velocity of projectile.

3. To determine the value of 'g' be compound pendulum (Kater's Pendulum).

4. To determine Horizontal/Vertical distance by Sextant.

5. To determine the frequency of A.C supply by Melde's experiment.

6. To determine the modulus of rigidity of a flat spiral spring.

7. To determine the modulus of rigidity of a wire by solid cylindrical rod.

8. Surface tension of water by capillary flow method.

Recommended Books:

1. Kraftmakers, Y. 2007. Experiments and demonstrations in Physics, World Scientific Publishing Co. Ltd.

2. Isenberg, C. 1996. Physics Experiments and Projects for students (Physics experiments & Projects). Taylor and Francis, USA.

THQ-II	Teaching of the Holy Quran-II	1 (1 – 0)*
The contents will be provided by the concerned department.		
	Total	**18 + 1***
Semester 4		
PHY-402	Electricity and Magnetism-II	3 (3 – 0)

Faraday's Law of Electromagnetic induction, review of emf, Lenz's Law, Induced electric fields, Inductance, Inductance of a Solenoid and Toroid. Transients, LR Circuits, Growth and Decay of current, Energy stored in a magnetic field, Energy density, Electromagnetic Oscillation, Qualitative and Quantitative analysis, Forced electromagnetic oscillations and resonance, Alternating current, AC current in resistive, inductive and capacitive elements, single loop RLC circuit, acceptor and rejecter circuits, Power in A.C circuits, Summarizing the electro-magnetic equations, Induced magnetic fields & displacement current, Maxwell's equations, Maxwell equations in a medium, dielectrics and magnetic materials, e.m spectrum, generating an electro-magnetic wave, Traveling waves and Maxwell's equations, energy transport and the Poynting Vector, Propagation of electromagnetic waves in conducting media and in ionized gases, reflection and transmission at normal and oblique incidence, absorption and dispersion of electromagnetic waves in a conductor.

Recommended Books:

1. Serway, Raymond A. and Jerry S. Faughn, 2003, College physics, 6th ed, Brooks/Cole Publishin

2. Resnick, Hlliday and Krane. 2002, Physics, Vol II, 5th Ed. John Wiley and Sons Inc, New York

3. Feynman R.P, R.B Leighton and M.Sands. The Fyenman Lectures of Physics; Electromagnetism and matter. Addison Wesley.

4. Griffiths D. 1989, Introduction to Electrodynamics. Prentice Hall.

5. Lorrain P and D.Corson. Electromagnetic Fields and Waves, 2nd Ed. Freeman publications.

PHY-404	Modern Physics	3 (3 – 0)

Black body radiation and Planck's Hypothesis, photoelectric and Compton effect, uncertainty principle, wave properties of particles, Double slit experiment, wave function, quantum particle under boundary conditions, concept of tunneling through a barrier, wave functions for hydrogen atom, physical interpretation of quantum numbers, Pauli's Exclusion principle and Periodic Table, Production of x-ray and lasers, Types of Spectrum, Types of bonding, free electron theory of metals, band theory of solids and semiconductors, concept of superconductivity and superconducting materials, nuclear models, radioactivity and decay processes, sub-atomic particles and their classification, fundamentals of Cosmology and cosmic connection and expanding universe, Einstein's principle of relativity, Special theory of relativity, Transformation equations and general theory of relativity.

Recommended Books:

1. Halliday Resnick, and Walker, 2011. Fundamental of Physics, 9th Ed, John Wiley and Sons Inc, New York,.

2. Raymond A. Serway and John W. Jewett, January 11, 2010, 8th Edition, Physics for Scientists and Engineers with Modern Physics.

3. Demtroder. W, 2005. Atoms, Molecules and Photons, publisher: Springer

4. Foot C J. 2005, Atomic Physics 1st Ed, Oxford University Press.

5. Haken H and H.C. 2004, The Physics of Atoms and Quanta, 7th Ed, Wolf, publisher: Springer

6. Beiser, A 2002, Concepts of Modern Physics. 6th Ed. McGraw-Hill, USA.

7. Bransden B H, and Joachain 2003. Atoms and Molecules 2nd Ed. publisher: Pearson Education.

8. Halliday Resnick, and Krane, 2002. Physics Vol. II, 5th Ed, John Wiley and Sons Inc, New York

MTH-404	Differential Equations-II	2 (2 – 0)
The contents will be provided by the concerned department.		
MTH-406	Linear Algebra, Metric and Topological Spaces	4 (4 – 0)
The contents will be provided by the concerned department.		
PHY-408	Optics and Modern Physics Lab Course	3 (0 – 3)

1. Characteristic x-rays of Molybdenum

2. Specific rotation of cane – sugar solution with Laurent's half shade polarimeter.

3. Ionization potential of mercury / Neon.

4. e/m Experiment (determination of charge to mass ratio of electron)

5. X-ray investigation of crystals

6. Characteristic curves of a solar cell.

7. Plank's constant using photocell method.

8. Wave length of sodium light using a diffraction grating.

Recommended Books.

1. Leimbach G, 2005. Physics Laboratory experiment, Germany.

2. Demtroder.W. 2005. Atoms, Molecules and Photon, Springer.

3. Beiser, A 2002, Concepts of Modern Physics. 6th Ed. McGraw-Hill, USA.

QTR-422	Quantitative Reasoning-II	3 (3 – 0)
HEC model course ("Tools for Quantitative Reasoning") available at https://www.hec.gov.pk/english/services/students/UEP/Pages/Model-General-Education-Courses.aspx		
	Total	**18**
Semester 5		
PHY-501	Methods of Mathematical Physics-I	3 (3 – 0)

Vector operations, Physical significance of DEL operator, Gauss's divergence theorem, Green's theorem, Stokes's theorem, Orthogonal curvilinear coordinates system, Gradient, Divergence, Curl and Laplacian in orthogonal curvilinear coordinates, Spherical polar and Cylindrical coordinates systems. Complex numbers, Euler's formula, De Moivre's theorem, elementary functions, analytic functions of complex variables, Cauchy-Riemann equation, harmonic functions, complex integration, Cauchy's theorem, Cauchy's integral formula, Taylor and Laurent series, Contour integrals, singularities and residues, residue theorem, branch points and integrals of multivalued functions. Tensors Analysis and applications.

Recommended Books:

1. Arfken G.B and H.J Weber, F.E Harris, 2012, 7th Edition, Mathematical Methods for Physicists, A. Press, New York.

2. Dass H.K, R. Verma, 2011, 6th Edition, Mathematical Physics, S. Chand& Company Ltd. New Delhi.

3. Kreyszig E. 2011, 10th Edition, Advanced Engineering Mathematics. Wiley, New York.

4. Collins R.E, 2011, 2nd Edition, Mathematical Methods for Physicists and Engineers, Dover Publications.

5. Tang K.T, 2010, 2nd Edition, Mathematical Methods for Engineers and Scientists 2, Springer.

6. Spiegel M.R 2009, 1st EditionAdvanced Mathematics for Engineers and Scientists, Schaum's outlines series, McGraw Hill.

7. Riley K F, M P Hobson and S J Bence. 2006, 3rd Edition, Mathematical Methods for Physics and Engineering, Cambridge University Press, Cambridge.

PHY-503	Classical Mechanics	3 (3 – 0)

Historical development of classical mechanics, Newtonian mechanics of single particle & system of particles, constraints, generalized coordinates, D'Alembert's Principle , Derivation of Lagrange's equations, simple applications of the lagrangian formulation, Hamilton's Principle, Techniques of the calculus of variation, Derivation of Lagrange's equation from Hamilton's principle, Applications of Hamilton's principle, shortest distance between two points in a plane and space, minimum surface of revolution, the Brachistochrone problem, conservation theorem , Two body central force problem & its reduction to the equivalent one body problem, Kepler's law as an inverse square law problem, Differential equation for the orbits and the different shapes of the orbit, planetary orbits & their equations, Legendre transformations and its applications, Derivation of Hamilton's equation of motion, Hamiltonian, cyclic coordinates, Routh's Procedure, The equations & examples of canonical transformations, Poisson's brackets & their properties, Poisson's brackets & other canonical invariants, Poisson's theorem, invariance of Poisson's bracket under canonical transformation.

Recommended Books:

1. Goldstein H, P Charle and J L Safko. 2001, Classical Mechanics. Addison-Wesley.

2. Hand L N and J.D Finch. 1998, Analytical Mechanics. Cambridge University Press, Cambridge.

3. Barger V D and M G Olsson. 1995, Classical Mechanics. McGraw-Hill, New York.

4. Landau L D and E M Lifshitz. Mechanics. 1960, Pergamon, Oxford.

5. Classical Mechanics by J.W. Leech Methuen and Co. Ltd., London, 1958.

PHY-505	Electrodynamics-I	3 (3 – 0)

Electric dipole, Electric field and electric potential at a point due to dipole, mutual interaction energy of two dipoles, Force and Couple on the dipole placed in an external electric field, Dielectrics: Polarization and polarization density vector, surface and volume charge densities due to polarization, electric field inside the dielectric, electric susceptibility and dielectric constant, Poisson and Laplace equations both for dielectric and space, Solution to Laplace equation in Cartesian, spherical and cylindrical coordinates, Uncharged conducting and dielectric sphere in uniform electric field, Electrostatic Images, Point charge near an infinite grounded conducting plane, Electric potential, electric field intensity and surface charge density in case of point charge and conducting sphere. Electric current: nature of electric current, current density, equation of continuity, Ohm's law, steady current in media without source of e. m. f., Approach to electrostatic equilibrium, Magnetic properties of steady current: Current carrying element, Force on current carrying conductor, Biot-savart law and their applications, Ampere's circuital law and their applications, Magnetic vector and scalar potential, Magnetic field of a distant circuit, Magnetic properties of matter: Magnetization vectors M, Magnetic current densities due to surface and volume currents and vector potential, Magnetic field due to the magnetized material, Magnetic scalar potential and pole density, Magnetic intensity vector H, Relation between H and M, Field equation, Magnetic susceptibility and permeability, Boundary conditions on the field vectors.

Recommended Books:

1. Bo Thide, 2011, The Electromagnetic filed theory 2nd Ed.

2. Martin Dressed, 2002, Electrodynamics of solids (optional properties of electron in matter), 1st Ed. Cambridge University, Press.

3. Griffiths D.J. 1999, Introduction to Electrodynamics, 3rd Edition

4. John R. Reitz, 1992, Foundations of Electromagnetic Theory, 4th Edition

PHY-507	Electronics-I	3 (3 – 0)

Linaer network analysis; superposition, Thevenin, Norton and Mill man's theorems, Electronics: the p-n junction, Bias the p-n junction diode, diode, characteristics of diode, different models and types of diodes, half-wave and full-wave rectifier, full-wave bridge rectifier, capacitor, inductive, and πR filters, Clipping and clamping circuits, Zener voltage regulators, regulated power supply, varactor diodes, Optical diodes, Light emitting Diodes. Bipolar junction transistor (BJT), transistor characteristics, biasing circuits such as base bias, emitter bias, voltage-divider bias, feedback bias circuits, amplifier classifications, common emitter amplifier, the emitter followers, the common base amplifier. RC-coupled amplifiers, Power amplifiers, (class A, class B amplifiers, class C amplifier), introduction to Junction field-effect transistors (JFET), JFET biasing circuits, the common source follower, introduction to MOSFET.

Recommended Books:

1. Floyd, T. L. 2010. Electronic Devices 9TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

2. Nashelsky, L. & Robert, L. B. 2009. Electronic Devices and Circuit Theory 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

3. Malvino, A. P. 2008. Electronic Principles. 7TH Ed. Glencoe-McGraw-Hill Book Co.

4. Grob, B. 2003. Basic Electronics 9TH Ed. McGraw-Hill.

PHY-509	Nuclear Physics-I	3 (3 – 0)

Nuclear mass, size, nuclear spin, Nuclear Binding energy, magnetic dipole moments, electric quadruple moments, parity and statistics. Observed phenomenon of radio activity, explanation of α-decay: Absorption, Range, Ionization and Stopping power of alpha particles, theory of alpha decay, Fermi theory of β-decay, theory of γ-decay, energetic of γ-decay, Nuclear isomerism, Internal conversion, Mossbauer Effect, Yukawa meson theory of nuclear forces, properties of nuclear forces, n-p and p-p scattering at low energies. Passage of charged particles through matter, Ionization chamber, proportional counter, GM counter, scintillation counter, semi-conductor detector, bubble chamber. Linear accelerator, van de Graff generator, Synchrocyclotron, proton synchrotron, betatron, photographic emulsion.

Recommended Books:

1. Zhang, Z..M, B.K. Tsai and G. Machin. 2010. Experimental Methods in Physical Science Vol.

2, Academic Press, USA. 2. Alejandro Garcia and Ernest M. Henley, (2007). Subatomic Physics, by publisher: World Scientific Publishing.

3. B R Martin, 2006. Nuclear and Particle Physics, publisher: New York: Wiley

4. David, W.I.F., K. Shankland, L.B McK usker and C. Baerloche. 2006. Structure Determination from Powder Diffraction Data. Oxford University Press, New York.

5. Hanlon, J. F. 2003. A User Guide to Vacuum Technology. John Wiley and sons, USA.

6. Kaplan Irving Nuclear Physics, latest edition.

7. lilley John 2001 Nuclear physics: Basic concepts and applications,

8. Povh B, Rith K, Scholz C and Zetsche F, 2006, Particles and Nuclei: an Introduction to the Physical Concepts, 5th Edition, publisher: Berlin Springer,.

9. S. Krane Kenneth. 1995. "Introducing Nuclear Physics,

PHY-511	Electromagnetism Lab Course	3 (0 – 3)

1. To determine the resistance of various DC conductors by recording their current/voltage characteristics.

2. To study the internal resistance and matching in various voltage sources and draw their power diagrams.

3. Establishment of relationship between electrostatic force and charge, electrostatic force and distance between charges and to determine the electric constant using Coulomb's Law / image charge.

4. To study the ferromagnetic hysterisis of a two ring-shaped iron cores by continuous adjustable direct current and to determine the remanence and coersive field strength.

5. Investigation of induced current and voltage in secondary coil of a transformer as a function of number of turns and current flowing in the primary coil.

6. To determine the inductance and phase displacement of coil (single, parallel and series formations) in AC circuit as a function of frequency of voltage source.

7. To determine the capacitance and phase displacement of capacitor (single, parallel and series formations) in AC circuit as a function of frequency of voltage source.

8. To determine the dielectric constants of different materials.

9. To study the ripple of the output voltage of various rectifier circuits as a function of the load current strength and the charging capacitance.

10. To study the frequency response of simple RC filters by point-by-point measurements and the sweep displayed on the oscilloscope.

11. To investigate the filter characteristics as a function of frequency of a coil, a capacitor, an Ohmic resistance and combinations of these components and to determine the phase displacement of the filters as a function of frequency.

12. To study the behavior of RLC series and parallel circuit and determination of its resonance frequency. (Optional: To determine the dielectric constant using RLC series circuit.)

Recommended Books:

1. Kraftmakers, Y. 2007. Experiments and demonstrations in Physics, World Scientific Publishing Co. Ltd.

2. David J. Griffiths, Introduction to Electrodynamics, 3rd Edition

3. Isenberg, C. 1996. Physics Experiments and Projects for students (Physics experiments & Projects). Taylor and Francis, USA.

THQ-III	Teaching of the Holy Quran-III	1 (1 – 0)*
The contents will be provided by the concerned department.		
	Total	**18 + 1***
Semester 6		
PHY-502	Methods of Mathematical Physics-II	3 (3 – 0)

Fourier Analysis, Fourier cosine and sine series, change of interval, Fourier integral, complex form of Fourier series, Fourier transform, Fourier transform of derivatives, Laplace transform, Inverse Laplace Transform, Convolution theorem, Initial boundary value problem, Laplace transform of derivatives. Physical significance along with examples of Fourier and Laplace transforms. Special functions, Hermite, Laguerre, Legendre and associate Legendre polynomial. Bessel function, Neumann function, and spherical Bessel function, Gamma function. Nonhomogeneous equations- Green's function, Green's function in terms of Eigen-function, the Sturm-Liouville problem, Green's function for Dirac Delta functions,

Recommended Books:

1. Arfken G.B and H.J Weber, F.E Harris, 2012, 7th Edition, Mathematical Methods for Physicists, A. Press, New York.

2. Dass H.K, R. Verma, 2011, 6th Edition, Mathematical Physics, S. Chand& Company Ltd. New Delhi.

3. Kreyszig E. 2011, 10th Edition, Advanced Engineering Mathematics. Wiley, New York.

4. Collins R.E, 2011, 2nd Edition, Mathematical Methods for Physicists and Engineers, Dover Publications.

5. Tang K.T, 2010, 2nd Edition, Mathematical Methods for Engineers and Scientists 2, Springer.

6. Spiegel M.R 2009, 1st Edition Advanced Mathematics for Engineers and Scientists, Schaum's outlines series, McGraw Hill.

7. Riley K F, M P Hobson and S J Bence. 2006, 3rd Edition, Mathematical Methods for Physics and Engineering, Cambridge University Press, Cambridge.

PHY-504	Statistical Mechanics	3 (3 – 0)

Laws of thermodynamics, thermodynamic variables, reversible adiabatic changes. Entropy, Microstates and macrostates, ensembles and ensemble averaging, approach to equilibrium. Classical probability, Statistical probability, binomial and Gaussian probability distributions, central limit theorem. Microcanonical systems, quantum state, entropy and equilibrium in a microcanonical system, Canonical ensemble, partition function, entropy in canonical system, Boltzmann distribution, thermodynamical averages, applications to single particle, factorization of partition function.Equipartition theorem, free energy and its minimization, Gibbs and Helmholtz free energy and applications. Maxwell distribution of molecular speeds, classical probability of a state, Maxwell-Boltzmann probability distribution, density of states in k-space, distribution of speeds in a classical gas. Black body radiation, Rayleigh-Jeans theory, Planck distribution, free energy of a photon gas, Stefan-Boltzmann formula, phonons. Systems with variable number of particles, chemical potential, grand canonical ensemble, relation to thermodynamic variables. Identical particles, fermions and bosons, partition function for identical particles, semi-classical approximations, identical particles localized on a lattice, thermodynamic properties of a Fermi gas, Bose condensation

Recommended Books:

1. Gould H and J Tobochnik.2010, Thermal and Statistical Physics, Princeton University Press.

2. Huang K.2001, Introductory Statistical Physics, 1st Ed. CRC.

3. Bowley R and M. Sanchez. 2000, Introductory Statistical Mechanics, 2nd Ed. Clarenden Press, Oxford.

4. Kittel C and H. Kroemer, 1980, Thermal Physics, second edition, W. H. Freeman.

PHY-506	Nuclear Physics-II	3 (3 – 0)

Types of nuclear reaction, Conservation laws of nuclear reaction, Q-values of nuclear reaction, threshold energy, transmutation by photons, protons, deuterons and α-particles, direct reactions, compound nuclear theory of nuclear reactions, limitation of compound nucleus, excited states of nucleus, bound and virtual energy levels, level width, cross-section for nuclear reactions, Breit-wigner formula. Liquid drop model, Semi-empirical mass formula, volume and surface energies, Shell model: magic numbers and closed shells, spin – orbit interaction, Collective nuclear model, nuclear deformations. The production and detection of neutrons, Fission and Fusion Reactions, discovery of nuclear fission, fission products, Bohr-wheeler theory of nuclear fission, mass and energy distribution of fission fragments, Description of nuclear fusion process, D-D and D-T reactions, Fusion processes in sun and stars, Nuclear fission and fusion as a source of energy, Basic of nuclear reactors, controlled nuclear fusion.

Recommended Books:

1. Henley E M and A Garcia.2007, Subatomic. World Scientific Publishing.

2. David, W.I.F., K. Shankland, L.B McK usker and C. Baerloche. 2006. Structure Determination from Powder Diffraction Data. Oxford University Press, New York.

3. Martin B R. 2006, Nuclear and Particle Physics. New York: Wiley.

4. Povh B, K Rith, C Scholz and F Zetsche, 2006, Particles and Nuclei: an Introduction to the Physical Concepts 5th Edition. Berlin Springer.

5. Hanlon, J. F. 2003. A User Guide to Vacuum Technology. John Wiley and sons, USA.

6. Krane K S, 1995, Introducing Nuclear Physics..

7. Lilley J. 2001, Nuclear physics: Basic concepts and applications.

8. Nuclear Physics, by Irving Kaplan latest edition.

9. Zhang, Z..M, B.K. Tsai and G. Machin.

PHY-508	Electrodynamics-II	3 (3 – 0)

Maxwell's equations, Differential form of Faraday law of electromagnetic induction, Maxwell correction of Amper's law and displacement current, Electromagnetic energy vector (Poynting vector), Wave equations for scalar and vector potential, Gauge transformations, Lorentz gauge and Coulombs gauge, Retarded scalar and vector potentials, Wave equations for E and H, Time dependent wave equation, Plane electromagnetic waves in a conducting and non-conducting media, Linear and circular polarization. Electromagnetic wave in matter: Propagation in linear media, Reflection and Transmission at the boundary of non-conducting media (Normal and Oblique incidence), Reflection at conducting surface, Frequency dependence of permittivity, Radiation: Electric and Magnetic dipole, Power radiated by a point charge, Radiation reaction, Electrodynamics and Relativity: Einstein's Postulates, Geometry of Relativity, Lorentz Transformations, Proper time and velocity, Relativistic energy, momentum, kinematics, and electrodynamics, Magnetism as a relativistic phenomenon.

Recommended Books:

1. Griffiths D.J. 1999, Introduction to Electrodynamics, 3rd Edition

2. John R. Reitz, 1992, Foundations of Electromagnetic Theory, 4th Edition

PHY-510	Electronics-II	3 (3 – 0)

An overview of operational amplifiers (op-amp), the differential amplifier, the inverting and non-inverting amplifiers, op-amp frequency response, negative feedback, comparators, integrators and differentiators, Instrumentation amplifier, Log and Antilog amplifiers, Constant current source, Current to Voltage and Voltage to Current converters, phase shift oscillators, the Wienbridge oscillator, the Colpitts & Hartley oscillators, the crystal oscillator, Schmitt triggers, the 555 timer, monostable, bistable, and astable multi vibrators, switching circuits, introduction to thyristors, silicon-controlled rectifiers, diacs and triacs, Number systems, digital circuits, Logic gates and Boolean algebra, arithmetic circuits, flip flops and latches, binary counters, Analog to Digital and Digital to analog conversion circuits.

Recommended Books:

1. Floyd T L. 2010, Electronic Devices 9TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

2. Floyd, T. L. 2010, Digital Fundamentals 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

3. Tocci R J. 2010, Digital Systems: Principles and Applications 11TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

4. Malvino, A P. 2008, Electronic Principles. 7TH Ed. Glencoe-McGraw-Hill Book Co.

5. Nashelsky, L and L B Robert. 2009, Electronic Devices and Circuit Theory 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

PHY-512	Atomic and Nuclear Physics Lab Course	3 (0 – 3)

1. To study the characteristics curves of GM counter.

2. To determine the absorption coefficient of lead for Gamma Rays using GM counter assembly.

3. To determine the maximum energy of Beta Particles using GM counter assembly.

4. To determine the range of an Alpha Particle and guess its energy using empirical relations using GM counter assembly.

5. To measure the half life of a radioactive nuclide.

6. To study of Random processes and fluctuations in Random processes (Gaussian distribution curve) using GM counter assembly.

7. To study radioactive equilibrium using Cs137/Ba137 mini generator using GM counter assembly.

8. Demonstration of Interaction of Radiations with matter using absorber kit using GM counter assembly.

9. Verification of inverse square law using GM counter assembly.

10. To study the wave characteristics of an electron. (Electron diffraction experiment.)

11. Determination of Planck's constant using He-Neon laser, and compare its results with Photo cell method.

12. Determination of velocity of light using He-Neon laser and compare it with other standard methods.

Recommended Books:

1. Gray T S. Applied Electronics (John-willey and Sons)

2. Higgings R J. Experimental Electronics (Mc Graw Hill)

3. Mark H and N.T Olson. Experiments in Modern Physics (Mc Graw Hill)

4. Melissienson A C. Experiments in Modern Physics (Academic)

5. Squares G L. Practical Physics 3rd Ed. Cambridge University Press.

	Total	**18**
	Semester 7	
PHY-601	Solid State Physics-I	3 (3 – 0)

Crystal structure in 2D and 3D, fundamental types of lattices, index system for crystal planes, simple crystal structures, X-ray diffraction, Braggs law, Ewald Construction, reciprocal lattice, Diffraction of waves by crystals, scattered wave amplitude, Brillouin zones, crystal binding and elastic constants, Classification of Solids, ionic crystals, covalent crystals, Ionic Radii, II-VI and III-V compounds, Molecular crystals, metals, Cohesive energy, The Lenard Jones Potential, Density, Cohesive energy and Bulk Modulus of crystalline solids, The Madelung constant, Cohesion in Covalent crystals, elastic waves in cubic crystals. Brief Introduction to Defects in Solids, Color Center, Vibration of crystals with monatomic basis, two atoms per primitive basis, quantization of elastic waves, normal vibration modes and phonon, phonon momentum, inelastic scattering by phonons, Phonon heat capacity, lattice heat capacity, Einstein and Debye models.

Recommended Books:

1. M. Ali Omer, 2009 "Elementary Solid State Physics", 6th Edition. D. Kindersley Pvt.Ltd.

2. H. Ibach, H. Luth, 2009 " Solid State Physics:An introduction to the principles of material science" 4th Edition by Springer.

3. C. Kittle, 2004 "Introduction to Solid State Physics", 8th Edition by John Wiley and Sons Inc.

PHY-603	Quantum Mechanics-I	3 (3 – 0)

Review of concepts of classical mechanics, The state of a system, Dynamical variables and operators, Linear vector space, orthogonal systems, linear transformations, matrices, change of basis, Hilbert space, Commuting and noncommuting operators, Heisenberg uncertainty relations, Functions and expectation values, Dirac notation, Hermitian operators, Symmetry principles and conservation laws, Orbital angular momentum, Spin, The eigenvalues and eigen functions of L2 and Lx, Matrix representation of angular momentum operators, Addition of angular momenta. Properties of one dimensional potential functions, Solutions of Schrödinger equation for free particles, the potential barrier problems, The linear harmonic oscillator, Particle in a box. Schrödinger Equation in Three Dimensions, Separation of Schrodinger equation in Cartesian coordinates, Central potentials, The free particle, Three dimensional square well potential, The hydrogen atom, Three dimensional isotopic oscillator.

Recommended Books:

1. Zettli N. 2009, Quantum Mechanics Concepts and applications. J Willy.

2. Bransden B H and Joachain C J. 1990, Introductory Quantum mechanics. Longman Scientific & Technical London.

3. Greiner W.1980, An Introduction Quantum Mechanics. Addison Wesley Publishing Company, Reading Massachusetts.

4. Liboff, R.L. 1980. "Introductory quantum Mechanics", by Addison Wesley Publishing Company, Reading Massachusetts,

PHY-605	Electronics Lab Course	3 (0 – 3)

1. Design and measure the equivalent resistance and capacitance of parallel series resistive and capacitive circuits respectively. 2. Design a full-wave rectifier and study its output without and with a capacitor filter. 3. Design a full-wave rectifier and study its output with a π filter. 4. Design a regulated power supply using Zener diode and study its regulation. 5. Design clipper and clamping circuits and study the output wave shapes. 6. Design circuits for logic gates (NOT, OR, NOR, AND, NAND, XOR) using discrete components. 7. Design a CE amplifier and study its frequency response. Determine its low- and upper-limit frequencies and also the bandwidth. 8. Design a common source FET amplifier and determine its input and output impedance. 9. Design an RC phase-shift oscillator and determine its frequency by Lissajous figures. 10. Design an astable multi vibrator and determine its frequency. 11. Design a transformer-coupled class A power amplifier and determine its ac power delivered to the load and percent efficiency. 12. Design inverting and non-inverting amplifiers using operational amplifiers using 741 IC's. 13. Design differentiator and integrator circuits and study output wave shapes using 741 IC's. 14. Design Half adder and full adder circuits 15. Design half subtractor and Full Subtractor circuits.

Recommended Books:

1. Floyd, T.L. 2010. Electronic Devices 9TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

2. Malvino, A. P. 2008. Electronic Principles. 7TH Ed. Glencoe-McGraw-Hill Book Co.

3. Nashelsky, L. and Robert, L. B. 2009. Electronic Devices and Circuit Theory 10TH Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

4. Grob, B. 2003. Basic Electronics 9TH Ed. McGraw-Hill.

PHY-607	Relativity and Cosmology	3(3 – 0)

Special Relativity, Galilean relativity, Einstein's postulates of special relativity. Consequences of special relativity. Michelson-Morley experiment, Lorentz transformations, consequences of Lorentz transformations (the relativity of length, the relativity of time, concept of simultaneity) Relativistic Mechanics, Transformation of relativistic velocities, addition of relativistic velocities, Relativity of mass, Force equation in relativity, rest mass ,KE and total energy, conservation of energy and momentum, the conversion of mass to kinetic energy in Uranium Fission, pair production and annihilation, The Cerenkov Effect and Cerenkov radiation, Einstein's mass-energy relationship and its practical examples, particle of Zero rest mass, Relativistic Doppler Effect, Aberration of Light, Tachyons, structure of space time, Geometry of space time, Minkowski space time tensors, the light cone, and four vectors (position four vector, four velocity, four momentum, four force). General relativity, Gravity as a Geometry, The equivalence principle, clocks in a gravitation field, space time is curved, geodesics, the geodesic equation, equation of geodesic deviation, Einstein field equation Manifolds and coordinates, curves and surfaces, tensor fields, metric tensor. Cosmology cosmological redshift, Hubble's law, microwave background, the Big Bang, Theory, Historical background of universe, stars , neutron stars, pulsars , black holes, quasars, singularity, measuring the distance to stars, concept of open, closed and flat universe, dark matter(MACHOs and WIMPs-)

Recommended Books:

1. James B. 2005, An Introdu ing to Einstein's General Relativity. Hartle Pearson Education.

2. Beiser A. 2002. 6th E. Perspectives of Modern Physics. McGraw-Hill.

3. Resnick, Halliday and Krane. 2002, Physics Vol. I, 5th Ed. John Wiley and Sons Inc, New York.

4. McComb W D. 1999, Dynamics and Relativity. Oxford University Press.

5. Inverno R.D. Introducing Einstein's Relativity.1992, Oxford University Press.

6. Narlikar J V. 1989, Introduction to Cosmology. Cambridge University Press.

INT-631	Internship	3 (0 –3) †
THQ-IV	Teaching of the Holy Quran-IV	1 (1 – 0)*
The contents will be provided by the concerned department.		
	Total	**15 + 1***
Semester 8		
PHY-602	Solid State Physics-II	3 (3 – 0)

Solid state problem, Born-Oppenheimer approximation, free electron approximation, density of states, Fermi Dirac distribution, k-space, concept of Fermi energy and the Fermi surface, free electron description of Heat capacity, electrical conductivity of metals, Hall effect, Nearly free electron model, origin of the energy gap, , Bloch functions, motion of electrons in electron in a periodic potential, crystal momentum, effective mass, physical interpretation of the effective mass, Augmented Plane Wave method, Semiconductors, intrinsic and extrinsic semiconductors, intrinsic carrier concentration, mobility, impurity conductivity donor states, acceptor states, thermal ionization of donors and acceptors, simple description pf pn-junction and rectification, Transistors, Semiconductors heterostructure and outline of solid state lasers, Diamagnetism and Paramagnetism, Larmor Diamagnetism, Adiabatic Diamagnetism, Pauli Paramagnetism, Conduction electrons Diamagnetism, introduction to superconductivity. Qualitative aspects of BCS Theory.

Recommended Books:

1. M. Ali Omer, 2009 "Elementary Solid State Physics", 6th Edition.

2. D. Kindersley Pvt. Ltd. H. Ibach, H. Luth, 2009 "Solid State Physics:An introduction to the principles of material science" 4th Edition by Springer.

3. C. Kittle, 2004 "Introduction to Solid State Physics", 8th Edition by John Wiley and Sons Inc.

PHY-604	Quantum Mechanics-II	3 (3 – 0)

Matrix representation of operators, digitalization, Identical Particles, Second Quantization, Indistinguishability of identical particles, Systems of identical particles, Quantum dynamics of identical particle systems, statistics, Symmetry of states, Fermions, Bosons. Time evolution of a system, Schrödinger and Heisenberg pictures, Time independent perturbation theory for non-degenerate and degenerate levels, Time dependent perturbation theory, Variational method, The WKB approximation and its applications. Theory of Scattering, Scattering experiments and cross sections, Potential scattering, the method of partial waves, The Born's approximation

Recommended Books:

1. Bransden B H and C J Joachain. 1990, Introductory Quantum mechanics, Longman Scientific & Technical London.

2. Greiner W. 1980, An Introduction Quantum Mechanics, Addison Wesley Publishing Company, Reading Massachusetts.

3. Liboff, R.L. 1980. Introductory quantum Mechanics, Addison Wesley Publishing Company, Reading Massachusetts,

4. Zettli N. 2009, Quantum Mechanics Concepts and applications, J Willy.

PHY-606	Computational Physics	3 (3 – 0)

Introduction, Scientific programming methodology, Scientific programming languages, Numerical solutions of ODEs, Euler Method, Numerical errors and instabilities, Euler Improved Method, Runge Kutta 4th order Method, Adaptive integration technique, Runge Kutta Fehlberg Method. Numerical quadrature, Riemann's Sum, Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule. Random number, Random walk, introduction to Monte Carlo techniques, Monte Carlo Integration and Cubatures. Numerical Solution of Nonlinear Equations f(x) = 0. Numerical Solution of Linear System of equations, Gauss Jordan Method, Jacobi Method, Gauss Seidel iterative Method. Numerical solutions of PDEs, Finite elements method, Laplace equation, Heat Equation, Explicit and Implicit methods, Crank-Nicholson Scheme, Wave equation. Interpolation and data fitting, Polynomial interpolation, Newton's Polynomial, Newton-Gregory Forwards Polynomial, Lagrange Interpolating polynomial, Chi square fitting, Linear Fit. Computer algebra and Introduction to MATHEMATICA, Introduction to MATLAB. Algorithm development using C++. Simulation techniques and computer graphics, computational techniques in investigating and visualizing fundamental physics.

Recommended Books:

1. Harvey M. Deitel and Paul J. Deitel, 2012, C++ How to Program, 8/e, Early Objects Version, Prentice Hall 2. Richard Fitzpatrick, 2011, Introduction to Computational Physics, University of Texas.

3. Paul L. Devries and Javier E. Hasbun, 2010, A First Course in Computational Physics, John Willey and Sons. N. Y.

4. R. H. Landau, M. J. Paez and C. C. Bordieanu , 2007, Computational Physics: Problem solving with Computers, Ed. 2nd, Wiley VCHVerlag GmbH & Co KgaA.

5. Andi Klein and Alexander Godunov, 2006, Introductory Computational Physics, Cambridge University Press.

6. William H. Press, Brian P. Flannery, Saul A. Teukolsky, and William T, 1998, Numerical Recipes: The Art of Scientific Computing, Vetterling Cambridge University Press.

PHY-***	Elective	4 (3 – 1) / 4 (4 – 0)
CAP-630	Capstone Project	3 (0 – 3) ††
	Total	**16**

Note:

* Non-credited course for Muslim students as per HEC letter No. HEC/CURR/SR-533/2023/4520, dated March 27, 2023.

¶ Deficiency course for F.Sc. Pre-Medical students.

† Internship of 48 hours to be completed in the summer after 6th semester or during 7th semester.

†† Capstone Project will be offered and completed in the 8th semester.

*** One elective course of 4 CH to be chosen in the8th semester from the list provided below.

List of Elective Courses

PHY-608	Particle Physics	4 (4 – 0)

Particle Classification, Quantum numbers, leptons, hadrons, baryons, mesons, quarks. The fundamental interactions the electromagnetic coupling, the strong coupling, the weak coupling. Symmetry Transformation and Conservation Laws: Translation in space, rotation in space, the group SU (2), systems of identical particles, parity, isospin charge conjugation, time reversal, G parity, CPT theorem. The Electromagnetic Filed: Gauge invariance and Maxwell's equations, polarization ad

photon spin, angular momentum, parity and C parity of the photon. The Klein-Gordan Equation. Interpretations for E < O solutions. The Dirac Equation: Covariant form of the Dirac Equation, Dirac γ-matrices, conserved current and the adjoint equation, free particle spinors, anti-particles, normalization of spinors and the completeness relations, bilinear covariant, zero mass fermion, the two-component neutrino. Electrodynamics of spinless and spin ½ Particles. the origin of the propagator: the electron propagator, the photon propagator. The Quark Model: The group SU (3), quarks, hadrons (baryons, mesons in quark model, heave meson spectroscopy, the quarkonium model. The Standard Model (qualitative treatment only): Unification of weak and electromagnetic interactions Glashow-Salam-Weinberg Model. Feynman diagram and rules for quantum electrodynamics.

Recommended Books:

1. Michael E. Peskin, (2019) "Concepts of Elementary Particle Physics" Oxford University Press, USA.

2. Das, A. and Ferbel, T, (2003) "Introduction to Nuclear and Particle Physics", Johan Wiley and Sons.

3. Burcham, E.E. and Jobes, M., J. (1995) "Nuclear and Particle Physics",

4. Longman. Gottfired, K. and Weisskopt, F. (1986) "Concepts of Particle Physics", vol. 1, Oxford University Press.

5. Griffiths, D. (1987). "Introduction of elementary Particles", , John Wiley and Sons.

6. Francis Halzen, Alan D. Martin (1984) "Quarks and Leptons - An Introductory Course in Modern Particle Physics" Johan Wiley and Sons.

PHY-610	Health and Medical Physics	4 (4 – 0)

Interactions of lionizing Radiation with Matter: Introduction; Beta-rays, range-energy relationship, mechanism of energy loss, Ionization and excitation, Bremsstrahlung, Alpha, rays, Rang-energy relation – ship, Energy transfer, Gamma-rays, exponential absorption, interaction mechanism, Pair production. Compton scattering, photoelectric absorption, photodisintegration, Combined effect, Neutrons, Production classification, interaction, Scattering, Absorption. Radiotherapy: Introduction, The development of radiotherapy, Radio therapeutic aims, External beam therapy, Brach therapy, unsealed source therapy, Requirements for accuracy and precision, Quality assurance, The role of medical physics. Medical Imaging: Diagnostic X-rays, Production of X-rays, Absorption of x-ray to other planes, Partial volume effect, Artifacts, Contrast agent in conventional radiography and CT, Diagnostic Ultrasound, Doppler effect, radionuclide imagine, positron emission tomography (PET), single photon Emission tomography (SPECT), Radiation Dosimetry: History of Absorbed Dose, Stochastic and Non-stochastic quantities, units for absorbed Dose, Absorbed Dose Calorimeters, Exposure and its measurements. Basic radiation safety criteria, effective dose-equivalent, allowable limit on intake (ALI), inhaled radioactivity, derived air concentration, Gastrointestinal tract, Basis of radiation safety regulations, The free-air chamber, Exposure measurement with calibrated cavity chamber. The concept of Kerma, absorbed Dose in air, Absorbed dose in other Materials, Factors converting Exposure to Absorbed Dose to wake, High energy calibrations. The Bragg-Gray Cavity theory. Methods of Dosimetry: Calorimeters, Ionization chambers, chemical Dosimetry, Thermo luminescence Dosimetry (TLD), Photographic Dosimeter, Scintillation Detectors, other Dosimetry Systems. PET and SPECT, Chemotherapy, Radiotherapy, chemical distribution, chemotherapy, phototherapy, Photodynamic therapy, MRI imaging, Optical Coherence Tomography, Tissue optical properties by using double integrating sphere, absorption coefficient, anisotropy factor, kubelca Munk theory, laproscopy, endoscopy, equation of continuity, ultrasound imaging, X-rays and pregnancy.

Recommended Books:

Health Physics: Radiation-Generating Devices, Characteristics, and Hazards by Joseph John Bevelacqua, by WILEY-VCH, Published Date: April, 2016, ISSN NO: 978-3-527-69434-1
Medical Physics by John M. Boone, publisher WILEY-VCH, Published Date: April, 2016; ISSN NO: 9780JRNL76870
Forty R. 2010,ICFA, Instrumentation School.
RIEGLER W. 2008,CERN, Academic Training Course.
Joran C. 2003, CERN, summer student lecturers.
Laser Tissue Interaction, Fundamentals and Applications Third Enlarged Edition, Springer by M. H. Niems, Verlag Berlin Heidelberg 2004, 2007
The Science of Phototherapy: An Introduction by L. I. Grossweiner @2005 Springer, I SBN 1-4020-2885
Cember H. 1996, Introduction to Health Physics. 3rd Ed. McGraw Hill, New York.
Williams J R and D I Thwaits, 1993, Radiotherapy Physics. Oxford University Press, New York.
Armstrong P and L Martin. Diagnostic Imaging 4th Ed. Blackwell Science Ltd.
Bushong S C. 1993, Radiologic Science of Technologists. 5th Ed. Mosby.
Greening J R. 1985, Fundamentals of Radiation Dosimetry. 2nd Ed. Adam Hilger Ltd., Bristol

PHY-612	Advanced Electronics	4 (3 – 1)

Introduction to Digital Electronics: Introduction to analog and digital quantities and data, merits and demerits of analog and digital data, examples of analog, digital and mixed electronic systems. Number Systems and

Codes: Binary, Octal, Decimal and Hexadecimal number systems, conversion of one system to other, and arithmetical operations, Binary coded decimal (BCD), SCII code, Extended ASCII code, Gray code. Review of Logic Gates: Basic logic gates, Universal logic gates, Exclusive OR and Exclusive NOR gates. Boolean Algebra: De Morgan's theorem, different types of Boolean expressions and their simplification using rules of Boolean algebra and k-map, different parity methods like simple even/odd parity, Hamming parity method. 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 Circuits: Adders, subtractors, multiplexer, demultiplexers, decoders, encoders, code convertors. Sequential Logic Circuits: Latches and Flip Flops, asynchronous and synchronous counters, full modulus and truncated modulus counters, BCD counter, up/down counters, Shift registers, Analog to Digital and Digital to Analog convertors. Memory Devices: Introduction to RAM and its types, Introduction to ROM and its types, Magnetic and Optical Storage devices, Micro Computers and Micro Controllers: Basic concept of micro-processor, various families of microprocessor, Basic structure of computer, Introduction to Embedded microcontroller based systems, features of a general purposes microcontroller

Experiments:

Design and study of a half and full adder with different Boolean expression using IC's.
Designing of synchronous and asynchronous BCD counters
Designing of memory shift register with IC's.
Designing of frequency counters and digital clock.
Design and construct and analog to digital and digital to analog converters using IC's.
Design and study of decoder and encoder circuits and compare the input output waveforms.
Design and study of multiplexer and de-multiplexer circuits and compare the input output waveforms.
To construct and understand an operation of arithmetic logic unit and study of different arithmetic logic operations.
To construct and study of data storage and retrieved using semiconductor memory and understand the process of fetching an instruction and its operand with ALU.
Using microprocessor trainer's study of microprocessor application working form host personal computers.

Recommended Books:

Floyd, T. L. 2020. Digital Fundamentals 10Th Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
Tocci, R. J. 2010. Digital Systems: Principles and Applications 11Th Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).
Lathi, B. P. 2021. Modern Digital and Analog Communication Systems 5Th Ed. Oxford University Press.
Mano, M. M. 2018. Digital Design Global Ed. Prentice-Hall Intern. Inc., Englewood Cliffs (USA).

PHY-614	Computational Materials Physics	4 (3 – 1)

Classification of Bravais lattices and crystal structures, reciprocal lattice and reciprocal space, total energy, relationship between structural and thermodynamic properties, the electronic structure of solids, band structure, electronic states in materials and physical properties which can be derived from them. The elementary quantum many-body problem, Schrödinger equation, ground state energy, wave function methods, Hartree method, Hartree-Fock method, exchange and correlation effects, Density Functional Theory (DFT), Thomas-Fermi approximation, Hohenberg-Kohn theorems, Kohn-Sham equation, exchange-correlation functionals, local density approximation, generalized gradient approximation, self-interaction correction, hybrid functionals. Bloch's theorem, the tight binding method, pseudopotentials method, augmented plane wave method, linearized augmented plane wave plus local orbitals method. Survey of the available DFT codes, computer implementation of DFT codes, carrying out large scale computations using preexisting electronic structure codes in Linux environment.

Experiments:

1. To visualize and manipulate crystallographic data and determine structural properties using software for crystalline and molecular structure (VESTA or XCrySDen).
2. To study the effect of density functional theory calculations parameters like k points, energy cutoff etc. on the calculated physical properties.
3. To test the performance of standard exchange-correlation functionals of DFT in determining structural properties of solids.
4. To structurally optimize a binary or ternary semiconductor material and determine its opto-electronic properties.

Recommended Books:

1. Sholl, D. S. and Steckel, J. A. 2023. Density Functional Theory: A Practical Introduction. 2nd Edition, JohnWiley & Sons, USA.
2. Tilley, R. J. D. 2021. Understanding Solids: The Science of Materials. 3rd Edition, John Wiley & Sons, USA.
3. Martin, R. M. 2020. Electronic Structure – Basic Theory and Practical Methods. Vol. 1. 2nd Edition, Cambridge University press, UK.

4. Ashkroft, N. W. and Mermin, N. D. 2011. Solid State Physics. Reprint, Cengage Learning, USA. 5. Kittle, C. 2018. Kittel's Introduction to Solid State Physics. Global 8th Edition. John Wiley & Sons, USA.
6. Hergert, W., Ernst, A. and Däne, M. (ed). 2004. Computational Materials Science: From Basic Principles to Material Properties. Springer, USA.

PHY-616	Plasma Physics	4 (4 – 0)

Introduction. Occurrence of plasmas in nature. Definition of plasma. Concept of temperature. Debye shielding. The plasma parameter. Criteria for plasma. Applications of plasma physics. Single-particle motions in electromagnetic field. Uniform and nonuniform E and B fields. Time-varying E and B fields. Fluid description of plasma. Wave propagation in plasma. Derivation of dispertion relations for simple electrostatic and electromagnetic modes. Introduction to Controlled Fusion: Basic nuclear fusion reactions, reaction rates and power density, radiation losses from plasmas, operational conditions.

Recommended Books:

1. Bittencourt J A, 2004 Fundamentals of Plasma Physics" (second Edition) INPE.
2. Krall N A and A W Trivelpiece, 1986 Principles of Plasma Physics" by (McGraw-Hill).
3. Glasstone S and R H.Lovberg, 1975 Controlled Thermonuclear Reactions (D.Van Nestrand).
4. CHEN F F, 1974 Introduction to Plasma Physics and control fusion, (Plenum).

PHY-618	Laser Technology and Applications	4 (4 – 0)

Review of quantum mechanics, interaction of radiation with matter,Spontaneous and stimulated emission, absorption, cavity, gain medium, population inversion, threshold condition, Three and four level laser, pumping mechanisms, properties of a laser beam, Modes of a rectangular cavity, Raleigh-Jeans and Planck radiation formula, mode density, homogeneous and inhomogeneous broadening of atomic transitions, amplitude fluctuations and spiking, Rate equation approach to Laser theory, stationary solution, time-dependent solution, lasing condition, hole burning effect, Matrix formulation of Geometrical optics , optical resonators, Q-switching and mode locking, active and passive mode-locking, fresnal number, types of laser, laser applications

Recommended Books:

1. Svelto O. 2010, Principles of Lasers. 5th Ed. Springer New York Dordrecht Heidelberg London.
2. Hooker S and C Webb. 2010, Laser Physics Oxford University Press, Inc. New York.
3. Abramczyk H. 2005, .Introduction to laser spectroscopy. Elsevier.
4. Silfvast W T. 2004, Laser Fundamentals. Cambridge University Press.