Curriculum

of

BS Physics

2016-onwards

Division of Science and Technology

University of Education, Lahore

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BS Physics

Mission Statement:

The mission of the our program, is to recruit diverse students and provide them with a demanding and detailed understanding of the methods and ideas of physics, as well as the vital role of the findings of physics as they are related to society in the terms of technology, medicine, engineering, energy crisis and our joint understanding of the origin and fundamental nature of the universe. A graduate of BS Physics will exhibit the habits of a scientist and will be entirely prepared to continue his education to MS Physics or related fields.

Rationale:

Physics is the foundation for virtually all technology. Our technologically-based society must have an adequate supply of workers who understand physics, and equally important, know how to use their knowledge. In an effort to encourage the study of physics by a broader range of students, we have started career paths for physics majors. Physics Department has been in the forefront of this effort to strengthen the interest in studying physics by broadening its application. The new BS Physics program builds directly on this success, serving as a transition from the more foundational fields of physics to the applied problems in industry. It will give physics majors the knowledge, skills and experiences that are in great demand in high-tech industry.

Program Objectives:

The objectives of the program are:

1. To learn the fundamental principles of Physics.
2. To develop problem solving skills among students.
3. To develop habit of independent learning and get motivation for self-education.
4. To develop in-depth understanding of specialized areas of Physics.

Program Design:

Duration:	4 years (8 Semesters)
Semester Duration:	16 -18 weeks
Total Credit Hours:	138

Eligibility Criteria:

- FSc/A-level with Physics and Mathematics or equivalent as per UE rules.

Program Template

Sr. No.	Categories	No. of Courses	Credit Hours
1.	Compulsory Courses	9	25
2.	General Courses from other Disciplines	8	24
3.	Foundation Courses	12	28
4.	Major Courses	16	49
5.	Elective Courses	2	6
6.	Thesis / Special Papers / Research Project*	2	6
	Total	**40**	**138**

* Students opting research project in Semester VIII should have studied one Special Paper in Semester VII

Program Layout

Compulsory Courses		
Sr. No.	**Course Title**	**Credit Hours**
1	Functional English	3
2	Communication Skills	3
3	Technical Writing and Presentation Skills	3
4	Introduction to Information Technology	3
5	Computing Tools for Mathematics	2+1
6	Pakistan Studies	2
7	Islamic Studies/Ethics	2
8	Calculus-I	3
9	Calculus-II	3
	Total	**25**

General Courses from other Disciplines		
Sr. No.	**Course Title**	**Credit Hours**
1	Foundations of Education	3
2	General Methods of Teaching	3
3	Educational Assessment	3
4	Curriculum Design and Instruction	3
5	Ordinary Differential Equations	3
6	Analytic Geometry	3
7	Calculus-III	3
8	Fundamentals of Physical Chemistry	3
	Total	**24**

Foundation Courses		
Sr. No.	**Course Title**	**Credit Hours**
1	Mechanics-I	4
2	Waves and Oscillations	3
3	Mechanics-II	4
4	Heat and Thermodynamics	3
5	Electricity and Magnetism-I	4
6	Modern Physics and Electronics	4
7	Electricity and Magnetism-II	3
8	Atomic and Molecular Physics	3
	Total	**28**

Major Courses		
Sr. No.	**Course Title**	**Credit Hours**
1	Mathematical Methods of Physics-I	3
2	Classical Mechanics	3
3	Thermal and Statistical Physics	3
4	Circuit Analysis	3
5	Modern Physics Lab	3
6	Mathematical Methods of Physics-II	3.
7	Electromagnetic Theory-I	3
8	Introduction to Quantum Mechanics	3
9	Solid State Physics	3
10	Electronics Lab	3
11	Electronics	3
12	Electromagnetic Theory-II	3
13	Nuclear Physics-I	3
14	Advanced Quantum Mechanics	3

15	Nuclear Physics-II	3
16	Computational Physics	4
	Total	**49**
Elective Courses*& Special Papers		
Sr. No.	**Course Title**	**Credit Hours**
1	Elective A (From Table A)	3
2	Elective B (From Table B)	3
3	Thesis / Special Paper I (From Table C)	3
4	Thesis / Special Paper II (From Table C) /Research Project	3
	Total	**12**

*Elective courses will be chosen from the Tables A and B

Table A		
Sr. No.	**Course Titles**	**Credit Hours**
1	Relativity and Cosmology	3
2	Experimental Nuclear Physics	3
3	Environmental Physics	3
4	Methods of Experimental Physics	3
5	Fluid Dynamics	3
Table B		
1	Particle Physics	3
2	LASERS	3
3	Introduction to Material Sciences	3
4	Introduction to Nano Technologies	3
5	Introduction to Photonics	3

*Students will be offered one of the following set of Special papers from Table C

Table C		
Sr. No.	**Course Title**	**Credit Hours**
1	Digital Logic and Design	3
	Advanced Digital Electronics	3
2	Plasma Physics-I	3
	Plasma Physics-II	3
3	Advanced Solid State Physics-I	3
	Advanced Solid State Physics-II	3

Scheme of Studies

Semester-I						
Sr. No.	**Course Code**	**Course Title**	**Credit Hours**			**Page No.**
			Theory	**Lab**	**Total**	
1	ENGL1114	Functional English	3	0	3	14
2	ISLA1111	Islamic Studies/Ethics	2	0	2	15
3	EDUC3111	Foundations of Education	3	0	3	17
4	MATH1111	Calculus-I	3	0	3	19
5	CHEM1112	Fundamentals of Physical Chemistry	3	1	4	20
6	PHYS1111	Mechanics-I	3	1	4	22
		Total	**19**			
Semester-II						
Sr. No.	**Course Code**	**Course Title**	**Credit Hours**			**Page No.**
			Theory	**Lab**	**Total**	
1	ENGL1119	Communication Skills	3	0	3	24
2	PAKS1111	Pakistan Studies	2	0	2	25
3	EDUC1112	General Methods of Teaching	3	0	3	26
4	MATH1112	Calculus-II	3	0	3	28
5	PHYS1114	Mechanics-II	3	1	4	29
6	PHYS1115	Waves and Oscillations	3	0	3	31
		Total	**18**			
Semester-III						
Sr. No.	**Course Code**	**Course Title**	**Credit Hours**			**Page No.**
			Theory	**Lab**	**Total**	
1	ENGL2115	Technical Writing and Presentation Skills	3	0	3	32

2	EDUC3143	Educational Assessment	3	0	3	34
3	MATH2111	Calculus-III	3	0	3	36
4	COMP1111	Introduction to Information Technology	3	0	3	37
5	PHYS2111	Electricity and Magnetism-I	3	1	4	38
6	PHYS2112	Heat and Thermodynamics	3	0	3	40
		Total	**19**			

Semester-IV

Sr. No.	Course Code	Course Title	Credit Hours			Page No.
			Theory	Lab	Total	
1	EDUC2118	Curriculum Design and Instruction	3	0	3	41
2	MATH2116	Analytic Geometry	3	0	3	43
3	MATH2117	Ordinary Differential Equations	3	0	3	44
4	COMP1113	Computing Tools for Mathematics	2	1	3	45
5	PHYS2114	Modern Physics and Electronics	3	1	4	46
6	PHYS2115	Electricity and Magnetism-II	3	0	3	48
		Total	**19**			

Semester-V

Sr. No.	Course Code	Course Title	Credit Hours			Page No.
			Theory	Lab	Total	
1	PHYS3111	Mathematical Methods of Physics-I	3	0	3	49
2	PHYS3112	Classical Mechanics	3	0	3	50
3	PHYS3113	Thermal and Statistical Physics	3	0	3	52
4	PHYS3114	Circuit Analysis	3	0	3	53

5	PHYS3115	Modern Physics Lab	0	3	3	54
		Total	**15**			

Semester-VI

Sr. No.	Course Code	Course Title	Credit Hours			Page No.
			Theory	Lab	Total	
1	PHYS3116	Mathematical Methods of Physics-II	3	0	3	56
2	PHYS3117	Electromagnetic Theory-I	3	0	3	57
3	PHYS3118	Introduction to Quantum Mechanics	3	0	3	59
4	PHYS3119	Solid State Physics	3	0	3	61
5	PHYS1113	Electronics	3	0	3	62
6	PHYS3121	Electronics Lab	0	3	3	64
		Total	**19**			

Semester-VII

Sr. No.	Course Code	Course Title	Credit Hours			Page No.
			Theory	Lab	Total	
1	PHYS4111	Nuclear Physics-I	3	0	3	66
2	PHYS4112	Advanced Quantum Mechanics	3	0	3	68
3	PHYS4113	Atomic and Molecular Physics	3	0	3	69
4	PHYSxxxx	Elective A (From Table A)	3	0	3	13
5	PHYSxxxx/ PHYS4114	Special Paper (from Table C) / Thesis	3	0	3	13
		Total	**15**			

Semester-VIII

Sr. No.	Course Code	Course Title	Credit Hours			Page No.
			Theory	Lab	Total	

1	PHYS4120	Electromagnetic Theory-II	3	0	3	70
2	PHYSxxxx	Elective B (From Table B)	3	0	3	11
3	PHYS4121	Nuclear Physics-II	3	0	3	71
4	PHYS4122	Computational Physics	3	1	4	72
5	PHYSxxxx/ PHYS4123 PHYS4114/	Special Paper (from Table C) / Thesis / Research Project	3	0	3	13
		Total	**16**			

* Students opting research project in Semester VIII should have studied one Special Paper in Semester VII

Table A						
Sr. No.	**Course Code**	**Course Titles**	**Credit Hours**			**Page No.**
			Theory	**Lab**	**Total**	
1	PHYS4115	Relativity and Cosmology	3	0	3	82
2	PHYS4116	Experimental Nuclear Physics	3	0	3	84
3	PHYS4117	Environmental Physics	3	0	3	88
4	PHYS4118	Methods of Experimental Physics	3	0	3	86
5	MATH 4136	Fluid Dynamics	3	0	3	89
Table B						
Sr. No.	**Course Code**	**Course Titles**	**Credit Hours**			**Page No.**
			Theory	**Lab**	**Total**	
1	PHYS4124	Particle Physics	3	0	3	83
2	PHYS4125	LASERS	3	0	3	85
3	PHYS4126	Introduction to Material Sciences	3	0	3	90
4	PHYS4127	Introduction to Nano Technologies	3	0	3	92
5	PHYS4128	Introduction to Photonics	3	0	3	93
Table C						
Sr. No.	**Course Code**	**Course Titles**	**Credit Hours**			**Page No.**
			Theory	**Lab**	**Total**	
1	PHYS4129	Digital Logic and Design	2	1	3	71
	PHYS4134	Advanced Digital Electronics	2	1	3	73
2	PHYS4130	Plasma Physics-I	3	0	3	75
	PHYS4131	Plasma Physics-II	3	0	3	76
3	PHYS4132	Advanced Solid State Physics-I	3	0	3	79
	PHYS4142	Advanced Solid State Physics-II	3	0	3	81

*Students will be offered one of the above set of special papers from Table C

Note: 1. Six credit hours teaching practice (non-creditable) will be mandatory to fulfill the requirement of the degree.

2. Teaching practice comprising of three weeks will be mandatory before the start of semester III and V.

Detail of Courses

Course Title: **Functional English**

Course Code: **ENGL1114**

Credit Hours: **3**

Objectives:

The main objective of this course is to:

- Enhance language skills and develop critical thinking

Course Outline:

Use of grammar in context: Parts of speech, Tenses: meaning and use, Use of active and passive voice, Use of articles and prepositions, Different sentence patterns, Combining sentences

Oral Communication Skills (Listening and Speaking): Express ideas/opinions on topics related to students' lives and experiences, Participate in classroom discussions on contemporary issues.

Reading and Writing Skills: Skimming, Scanning, Identifying main idea/topic sentence, Inference and prediction , Recognizing and interpreting cohesive devices, Note taking and note making, Generating ideas using a variety of strategies e.g. brainstorming .

Developing a paragraph outline (topic sentence and supporting details): Vocabulary building skills **To develop the ability to use a dictionary**

Recommended Books:

- Collins COBUILD Students' Grammar. London: Longman
- Eastwood, J. 2004. Oxford Practice Grammar. New Ed., with tests and answers. O UP
- Fisher, A. 2001. Critical Thinking. C UP 16
- Goatly, A. 2000. Critical Reading and Writing: An Introductory Course. London: Taylor & Francis
- Hacker, D. 1992. A Writer's Reference. 2nd Ed. Boston: St. Martin's
- Hewing, M. Advanced Grammar in Use. New Ed. C UP
- Murphy, Raymond. Grammar in Use. C UP
- Swan, M. and Walter C. How English Works. Oxford: O UP
- Thomson & Martinet. Practical English Grammar. O UP
- Wallace, M. 1992. Study Skills. C UP
- Yorky, R Study Skills

Course Title: **Islamic Studies**

Course Code: **ISLA1111**

Credit Hours: **2**

Objective:

The main objectives of this course are:

- To provide basic information about Islamic Studies.
- To enhance understanding of the students regarding Islamic civilization.
- To improve student's skill to perform prayers and other worships.
- To enhance the skill of the students for understanding of issues related to faith and religious life.

Course Outlines:

Introduction to Quranic Studies: Basic concepts of Quran, History of Quran, Uloom-ul-Quran.

Study of Selected Text of Holy Quran: Verses of Surah Al-Baqra related to faith (Verse No-284-286), Verses of Surah Al-Hujrat related to Adab Al-Nabi (Verse No-1-18), Verses of Surah Al-Mumanoon related to characteristics of faithful (Verse No-1-11), Verses of Surah Al-Furqan related to social ethics (Verse No.63-77), Verses of Surah Al-Inam related to Ihkam (Verse No-152-154).

Study of Selected Text of Holy Quran: Verses of Surah Al-Ihzab related to Adab Al-Nabi (Verse No.6,21,40,56,57,58.), Verses of Surah Al-Hashar (18,19,20) related to thinking, Day of judgment, Verses of Surah Al-Saf related to Tafakar, Tadabar (Verse No-1,14).

Seerat of Holy Prophet (S.A.W) I: Life of Muhammad Bin Abdullah (before Prophet Hood), Life of Holy Prophet (S.A.W) in Makkah, Important lessons derived from the life of Holy Prophet in Makkah.

Seerat of Holy Prophet (S.A.W) II: Life of Holy Prophet (S.A.W) in Madina, Important events of life Holy Prophet in Madina, Important lessons derived from the life of Holy Prophet in Madina.

Introduction to Sunnah: Basic concepts of Hadith, History of Hadith, Kinds of Hadith, Uloom-ul-Hadith, Sunnah & Hadith, Legal position of Sunnah, Selected study from text of Hadith.

Introduction to Islamic Law & Jurisprudence: Basic concepts of Islamic law & jurisprudence, History & importance of Islamic law & jurisprudence, Sources of Islamic law & jurisprudence, Nature of differences in Islamic law, Islam and sectarianism.

Islamic Culture & Civilization: Basic concepts of Islamic culture & civilization, Historical development of Islamic culture & civilization, Characteristics of Islamic culture & civilization, Islamic culture & civilization and contemporary issues.

Islam & Science: Basic concepts of Islam & science, Contributions of Muslims in the development of science, Quran & science.

Islamic Economic System: Basic concepts of Islamic economic system, Means of distribution of wealth in Islamic economics, Islamic concept of riba, Islamic ways of trade & commerce.

Political System of Islam: Basic concepts of Islamic political system, Islamic concept of sovereignty, Basic institutions of Govt. in Islam.

Islamic History: Period of Khlaft-e-Rashida, Period of Ummayyads, Period of Abbasids.

Social System of Islam: Basic concepts of social system of Islam, Elements of family, Ethical values of Islam.

Recommended Books:

- Nawaz, M. Tafheem Islamiyat Compulsory. Qureshi Brothers Publishers.
- Akhtar, H. M. Mehyari Islamiyat Compulsory.
- Dr. Tahir-Ul-Qadri Seeriat-ai-Rasool.; Dr. Tahir-Ul-Qadri, Minhajussavi.
- Prof. Ghulam Rasul Islam ka Taleemi Nizam.
- Dr. Khalid Naqvi, Islamic Social System.
- Prof. Khursheed, Islamic Nazria Hayat.
- Hafiz Jalundri, Shahnama Islam.
- Hameed Ullah Muhammad, Emergence of Islam, IRI, Islamabad.
- Hameed Ullah Muhammad, Muslim Conduct of State.
- Hameed Ullah Muhammad, Introduction to Islam.
- Hussain Hamid Hassan, An Introduction to the Study of Islamic Law, leaf Publication Islamabad, Pakistan.
- Ahmad Hasan, Principles of Islamic Jurisprudence, Islamic Research Institute, International Islamic University: Islamabad, 1993.
- Mir Waliullah, Muslim Jrisprudence and the Quranic Law of Crimes, Islamic Book Service, 1982.
- H.S. Bhatia, Studies in Islamic Law, Religion and Society, Deep & Deep Publications: New Delhi, 1989.
- Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University: Islamabad, 2001..

Course Title: **Foundations of Education**

Course Code: **EDUC3111**

Credit Hours: **3**

Objectives:

The main objectives of this course are to:

- Understand and analyze the elements and the processes of education.
- Comprehend the process of education in philosophical, psychological, sociological and economical perspectives.
- Discuss the philosophical thoughts of educational thinkers.
- Discuss the significant educational initiatives from 2002 to date.

Course Outline:

Concept, Types and Process of Education: Concept of Education Meaning, Scope and Importance, Modes of Education Informal, Formal and Non-formal, Elements of the Process of Education, Aims and objectives, Curriculum, Pedagogy, Evaluation.

Philosophical Perspective: What is philosophy? Explaining Educational Philosophy, Branches of Philosophy, Metaphysical, Epistemology and Axiology.

Educational Philosophies: Assumptions, curriculum, role of teacher and student, classroom management, and evaluation, Perennialism, Progressivism, Essentialism, Reconstructionism.

Psychological Perspective: Educational Psychology, Concept and meaning, Role of Psychology in selecting content, Role of Psychology in Pedagogy.

Socio-economic Perspective: Educational Sociology, Concept and meaning, Sociological Roles in Education (conservative, critical and creative), Economic foundations of Education, Education as investment, Education and national development: Pakistani perspective.

Significant Educational Initiatives: Education Sector Reform, Current education Policy and Vision 2025.

Teaching and Learning Strategies: In general, collaborative, and interactive approaches. Discussion/assignments/ presentations, projects using "learner-centered" methods, "Reflective Journals" on each session, Maintaining course portfolios.

Recommended Books:

- Ahmed, K. (1972). *Principles of Islamic Education*. Lahore: Islamic Publications Ltd.
- Canestrari, A. (2009). *Foundations of Education*. New York: Sage Publications.

- Goldblatt, P.F., & Smith, D. (2005). *Cases for teacher development*. New York: Sage Publications.
- Gutek, G. L. (2004). *Philosophical and Ideological Voices in Education*. Boston: Pearson.
- Government of Pakistan, Ministry of Education (2002). Education Sector Reforms Action Plan. Islamabad.
- Government of Pakistan. (2009). National education policy 2009. Islamabad.
- Mangal, S.K. (2012). *Advanced Educational Psychology*. PHI learning: New Delhi.
- Ornstein, A.C and Levine, D.U (1995). *An Introduction to the Foundations of Education. Boston*: Houghton Mifflin Company.
- Semel, S. F. (2010). *Foundations of education*: The essential texts. USA: Routledge.

Course Title: **Calculus-I**

Course Code: **MATH1111**

Credit Hours: **3**

Objectives:
The main objectives of this course are to:

- Apply the definition of limit to evaluate limits by multiple methods and use it to derive the definition and rules for differentiation and integration.
- Use derivatives to analyze and graph algebraic and transcendental functions.
- Apply the definition of definite integral to evaluate basic integrals.

Course Outlines:

Preliminaries: Intervals, Inequalities, Functions, Graphs of Functions, Lines, Circles, Parabolas, Shifting and Scaling of Graphs

Limits and Continuity: The Precise Definition of a Limit, Calculating Limits Using the Limit Laws, One-Sided Limits, Limits at Infinity, Infinite Limits and Vertical Asymptotes, Continuity

Differentiation: Secant and Tangent Lines, Rates of Change, The Derivative, Physical and Geometric Interpretation of a Derivative, Techniques of Differentiation, The Chain Rule, Implicit Differentiation, Linearization, Differentials

Applications of Derivatives: Extreme Values of Functions, Monotonic Functions and the First Derivative Test, Concavity, Rolle's Theorem, The Mean-Value Theorem, Curve Sketching: Graphs of Polynomials and Rational Functions, Applied Optimization Problems, Indeterminate Forms and L'Hôpital's Rule

Derivatives of Transcendental Functions: Logarithmic and Exponential Functions, Derivatives of Logarithmic and Exponential Functions, Graphs Involving Logarithmic and Exponential Functions, Inverse Functions, Derivatives of Hyperbolic and Inverse Hyperbolic Functions, Derivatives of Inverse Trigonometric Functions

Recommended Books:

- Anton, H. (2012). *Calculus.* Laurie Rosatone
- Stewart, J. (2015). *Calculus.* Cengage Learning

Course Title: **Fundamentals of Physical Chemistry**

Course Code: **CHEM1112**

Credit Hours: **4(3+1)**

Objectives:

The students will acquire knowledge:

- To understand the fundamental principles and laws of thermodynamics and chemical equilibria.
- To investigate the physical properties of ideal/non-ideal binary solutions.
- About the rates of reactions and perform related calculations.

Course Outlines:

Chemical Thermodynamics: Equation of states, Ideal and real gases, Virial equation and the Vander Waals equation for real gases, Critical phenomena and critical constants, Four laws of thermodynamics and their applications, Thermochemistry, Calorimetry, Heat capacities and their dependence on temperature, Pressure and volume, Reversible and non-reversible processes, Spontaneous and non-spontaneous processes, Relations of entropy and Gibbs free energy with equilibrium constant, Gibbs Helmholtz equation, Fugacity and activity.

Chemical Equilibrium: General equilibrium expressions, Reaction quotients, Examples of equilibrium reactions in solid, Liquid and gas phases, Extent of reactions and equilibrium constants, Gibbs energies of formation and calculations of equilibrium constants, Effect of temperature and pressure on the equilibrium constants/compositions, Van't Hoff equation, Le-Chatelier's principle.

Solution Chemistry: Physical properties of liquids, Surface tension, Viscosity, Refractive index, Dipole moment and their applications, Brief account of interactions among the molecules in liquids, Ideal and non-ideal solutions, Raoult's law and its applications, Lowering of vapor pressure, Elevation of boiling point, Depression of freezing point, Osmotic pressure, Vapor pressure of non-ideal solutions and Henry's law, Abnormal colligative properties, Degrees of association and dissociation of solutes, Osmotic pressure and its measurement, Fractional distillation and concept of azeotropic mixtures.

Chemical Kinetics: The rates of reactions zero, First, Second and third order reactions with same and different initial concentrations, Half-lives of reactions, Experimental techniques for rate determination and methods for determination of order of reaction,Arrhenius equation.

Practical:

1. Determination of viscosity and refractive index of liquids.
2. Determination of percent composition of liquid solutions viscometrically.
3. Determination of refractive index and molar refractivity.
4. Determination of percent composition of liquid solutions by refractive index measurements.
5. Determination of molecular weight of a compound by elevation of boiling point (ebullioscopic method).

6. Determination of molecular weight of a compound by lowering of freezing point (cryoscopic method).
7. Determination of heat of solution by solubility method.
8. Determination of heat of neutralization of an acid with a base.
9. Kinetic study of acid catalyzed hydrolysis of ethyl acetate.
10. Determination of partition coefficient of a substance between two immiscible liquids.

Recommended Books:

- Atkins, P; Paula,J.D. Atkin's Physical Chemistry. Oxford University Press, 2010; 9th ed.
- Shoemaker, D. Experiments in Physical Chemistry.McGraw Hill, 2003; 8thed.
- Silbey, R; Alberty, R; Bawendi, M. Physical Chemistry.2005,4thed.
- Glasstone, S. Textbook of Physical Chemistry. Macmillan London, 1960.
- James, A.M; Prichard, F.E. Practical Physical Chemistry. Longman Group Limited: New York, 1974;3rded.
- Chaudhary, S.U. Ilmi Textbook of Physical Chemistry, Ilmi Kitab Khana: Lahore, 2013;2nd ed.
- Atkins, P; Jones, L. Chemical Principles: The Quest for Insight. W.H. Freeman: New York, 2010; 5th ed.

Course Title: **Mechanics-I**

Course Code: **PHYS1111**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this course are;

- To understand the different motions of objects on a macroscopic scale
- To develop simple mathematical formalisms to analyze such motions.

Course Outline:

Vectors: Vectors and scalars, components of vectors, addition of vectors, vector multiplication, vector derivatives and operations, divergence theorem, Stokes' theorem

Particle dynamics: Effect of frictional and drag forces on motion, non-inertial frames and pseudo forces.

Kinetic Energy and Work: Work-energy theorem, conservative and non-conservative forces,

Center of Mass and Linear Momentum: center of mass, Newton's second law for a system of particles, linear momentum, two particle and many-particle systems, center of mass of solid objects, momentum changes in a system of variable mass. Collisions in the center of mass reference frame.

Gravitation: Newton's law of gravitation, gravitational effect of a spherical mass distribution, Kepler's laws of planetary motion.

List of Experiments:

- The Harmonic Oscillation of Helical spring's parallel and series connection of spring
- Measuring moment of inertia of different bodies; disc, hollow and solid cylinders
- Measurement of the speed of sound in air
- Coherence & width of spectral lines
- Diffraction intensity at slit of double slit system
- Stephen-Boltzmann's law of Radiation
- Characteristics curve of a solar cell
- Magnetic field of paired coils in Helmholtz coils

Recommended Books:

- Resnick, Halliday & Krane (1992). *Physics Vol. I&II*, 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday & Krane (2002). *Physics Vol. I & II*,5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick &Krane (2010). *Fundamental of Physics*, 9th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young (2000), *University Physics*, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso & Finn. (1999) *Physics.* USA: Addison-Wesley, Reading (MA).

Course Title: **Communication Skills**

Course code: **ENGL1119**

Credit Hours: **3**

Objectives:

The main objective of this course is to enable the students to meet their real life communication needs.

Course Outline:

Oral presentation skills (prepared and unprepared talks)

Preparing formal letters

Writing different kinds of applications (leave, job, complaint, etc.)

Preparing a Curriculum Vitae (CV), (bio-data)

Writing short reports

for interviews (scholarship, job, placement for internship, etc.)

Writing

Recommended Books:

- Ellen, K. 2002. Maximize Your Presentation Skills: How to Speak, Look and Act on
- Your Way to the Top
- Hargie, O. (ed.) Hand book of Communications Skills
- Mandel, S. 2000. Effective Presentation Skills: A Practical Guide Better Speaking
- Mark, P. 1996. Presenting in English. Language Teaching Publications.

Course Title: **Pakistan Studies**

Course Code: **PAKS1111**

Credit Hours: **2**

Objectives:

The main objectives of this course are:

- To impart an understanding of the fundamental principles and teaching of Pakistan studies.
- To take an analytical view in the history and development of Muslim society and culture in the subcontinent, emergence of Pakistan and its constitutional development.
- To develop an appreciation of the issues of challenges currently being faced in Pakistan.
- To look at the strength of its people and strategies to deal with the impedements to progress.
- To have a view on International Relations of Pakistan.

Course Outline:

Historical Perspectives: Ideological rationale with special reference to Sir Syed Ahmad Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah, Factors leading to Muslim separation, Indus Civilization, Muslim advent, Location and Geo-physical features

Government and Politics in Pakistan: Political and constitutional phases: 1947-58; 1958-71; 1971-77; 1977-88; 1988-99; 1999 onward

Contemporary Pakistan: Economic institutions and issues, Society and social structure, Ethnicity, foreign policy of Pakistan and challenges, Futuristic outlook of Pakistan

Recommended Books:

- Shahid Javed Burki (1980) *State and Society in Pakistan*, The Macmillan Press Ltd.
- Akbar Zaidi (2000) *Issue in Pakistan's Economy*, Oxford University Press, Karachi.
- S.M. Burke and Lawrence (1993) *Pakistan's Foreign Policy: An Historical analysis by Ziring*, Oxford University Press.
- Safdar Mehmood (1994) *Pakistan's Political Roots and Development*
- Ansar Zahid, (1980) *History and Culture of Sind*, Royal Book Company, Karachi.
- Khali bin Sayeed, (1967) *Political systems of Pakistan*, Houghton Mifflin, Boston.

Course Title: **General Methods of Teaching**

Course Code: **EDUC1112**

Credit Hours: **3**

Objectives:

The main objectives of this course are to:

- Describe the importance of the efficient teaching methodology in the overall teaching learning process.
- Appreciate the characteristics of various methods of teachings.
- Select a suitable method or strategy to make his/her teaching effective in local context.
- Apply various teaching methods and strategies during teaching of their subjects.

Course Outlines:

The Concept and Principles of Teaching: Concept of teaching, Features of teaching, Planning for teaching, Principles of teaching.

Teaching Methods/Strategies and their Selection: Concept of methods, Strategies, Tactics and techniques, Criteria for selection of a method/strategy, Selection of method/technique.

Methods of Teaching: Lecture method, Textbook method, Discussion method, Team teaching, Demonstration method, Project method, Activity method, Assignment method, Problem solving method, Inductive & deductive method, Drill method, Socratic method, Simulated teaching, Program instruction, Computer assisted instruction, Personalized system of instruction.

Lesson Planning: Introduction to lesson planning, Steps of lesson planning, Types of lesson planning, Evaluation of lesson planning, Instructional objectives in behavioral terms (Blooms Taxonomy).

Planning Instruction in the Relevant Content Area: The students will learn to teach different topics in their relevant subject. For example, BS Mathematics students will learn and plan how to teach numbers, Geometry, Fraction etc. The students will also micro teach before going for teaching practice.

Teaching Learning Strategies: Lecture method followed by discussion and question, Answer method, Cooperative learning, Students are required to prepare and maintain course portfolio, Assignments and presentations/quizzes based on the content of the course outline and project using “do-it-yourself” or “learner-centered” methods.

Recommended Books:

- Westwood, P. What teachers need to know about teaching methods, Australia. Camberwell, Vic. ACER Press, 2008.

- Mukalel, J.C. Creative Approaches to Classroom Teaching. Discovery Publishing House: Delhi, 2003.
- Smith, B.O. Elements of Teaching. Columbia Teacher’s College Press, 1983.

Course Title: **Calculus-II**

Course Code: **MATH1112**

Credit Hour: **3**

Objectives:
The main objectives of this course are to:

- Gain basic knowledge of the fundamental concepts behind definite and indefinite integration, i.e. Riemann Sums and the Fundamental Theorem of Calculus.
- Know the rules of integral calculus.
- Have knowledge of sequences and series including tests for convergence.
- Have basic knowledge of power and Taylor series, including test for convergence and methods of approximation of sums.

Course Outline:

Integration: The Indefinite Integral, Estimating with Finite Sums, Sigma Notation and Limits of Finite Sums, Areas as Limits, The Definite Integral, The Fundamental Theorem of Calculus

Applications of Definite Integrals: Area between Two Curves, Volumes by Slicing; Discs and Washers, Volumes by cylindrical Shells, Length of a Plane Curve, Area of a Surface of Revolution

Techniques of Integration: Integration by Parts, Integration of Rational Functions by Partial Fractions, Integrating Powers of Sine and Cosine, , Integrating Powers of Secant and Cosecant, Trigonometric substitutions, Improper Integrals, Evaluating Integral

Infinite Sequences and Series: Sequences, Monotone Sequences, Infinite Series, The Integral Test, Comparison Tests, The Ratio Test, The Root Test, Alternating series, Absolute and Conditional Convergence, Power Series, Taylor and Maclaurin Series, Convergence of Taylor Series; Error Estimates, Applications of Power Series, Fourier Series

Recommended Books:

- Anton, H. (2012). *Calculus.* Laurie Rosatone.
- Stewart, J. (2015). *Calculus.* Cengage Learning

Course Title: **Mechanics-II**

Course Code: **PHYS1114**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this course are;

- 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 for solving problems.

Course Outline:

Rotational Dynamics: Rotational variables, Rotation with constant angular momentum, relating linear and angular variables, Torque, Newton's second law for rotation. Work and rotational Kinetic energy. Kinetic energy of rotation, moment of inertia, moment of inertia of bodies of various shapes, parallel axis and perpendicular axis theorems, Rotational dynamics of rigid bodies, Equation of motion and effects of applications of torques

Rolling, Torque, and Angular Momentum: Forces and Kinetic energy of rolling objects, Angular momentum, Newton's Second Law in Angular Form, The Angular Momentum of a System of Particles, Conservation of angular momentum.

Equilibrium and Elasticity: Equilibrium, The Requirements of Equilibrium, The Center of Gravity, Some Examples of Static Equilibrium, Elasticity, stress and strain.

Relativity: Inertial and non-inertial frames, postulates of special relativity, Galilean and Lorentz transformation, length contraction and time dilation, relativistic mass, Relativistic momentum and relativistic energy.

List of experiments:

1. Interference of light Fresnel Biprism
2. Measurement of wavelengths of sodium light, difference of wavelengths and thickness of thin film e.g. mica using Michelson interferometer.
3. The determination of Cauchy's constants using spectrometer.
4. Determining the modulus of elasticity.
5. Determining resistances using a Wheatstone bridge.

Recommended Books:

- Resnick, Halliday & Krane (1992). *Physics Vol. I&II*, 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday & Krane (2002). *Physics Vol. I & II*,5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick &Krane (2010). *Fundamental of Physics*, 8th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young (2000), *University Physics*, 8th Edition. USA: Addison-Wesley, Reading (MA).

Course Title: **Waves and Oscillations**

Course Code: **PHYS1115**

Credit Hours: **3**

Objectives:

The main objective of this course is;

- To develop a unified mathematical theory of oscillations and waves in physical systems.
- Student will be capable of understanding electric, mechanical resonance, beats, damped undamped oscillators etc.

Course Outline:

Oscillations: Simple Harmonic Motion, Longitudinal and transverse Oscillation, Energy conservation in SH Motion, Applications of SH Motion, forced, Simple and damped harmonic oscillations and resonance.

Waves Motion: Transverse waves, mechanical waves, traveling waves, phase velocity of travelling waves, wave equation and power and intensity in wave motion, principle of superposition, Interference of waves, Standing waves, phase change on reflection, Beats Phenomenon, two coupled pendulums, two coupled masses, many coupled oscillators, tansverse vibration in a string, longitudinal vibration of a rod,

Sound Waves: Speed of sound, vibrating systems and sources of sound, Beats, Doppler effect of sound waves.

Recommended Books:

- Resnick, Halliday & Krane (1992). *Physics Vol. I&II*, 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday & Krane (2002). *Physics Vol. I & II*,5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick &Krane (2010). *Fundamental of Physics*, 8th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young (2000), *University Physics*, 8th Edition. USA: Addison-Wesley, Reading (MA).

Course Title: **Technical Writing and Presentation Skills**

Course Code: **ENGL2115**

Credit Hours: **3**

Objectives:

The main objective of this course is to:

- Enhance language skills and develop critical thinking

Course Outline:

Presentation skills: Elements of an effective speech, Getting ready for presentation (organizing data), During the Presentation. (Gaining attention, presenting data, working with visuals etc.), after the presentation (revision, question answer session, feedback), Presentation ethics

Essay writing: Descriptive, narrative, discursive, argumentative, Parts of essay

Academic writing: How to write a proposal for research paper/term paper, How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency).

Report Writing: Types of Reports, Formats

Note: Extensive reading is required for vocabulary building

Recommended books:

- Technical Writing and Presentation Skills
- Essay Writing and Academic Writing
- Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992.ISBN 0194354073 (particularly suitable for discursive, descriptive, argumentative and report writing).
- College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
- Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. MandelLSt.-Martin's Press
- The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Advanced Academic Writing

Advanced writing skills and strategies building on English I & II in semesters I and II:

- Writing summaries of articles
- report writing
- Analysis and synthesis of academic material in writing
- Presenting an argument in assignments/term-papers and examination answers

Recommended Readings:

- Aaron, J. 2003. The Compact Reader. New York: Bedford
- Axelrod, R. B and Cooper, C.R. 2002. Reading Critical Writing Well: A Reader and Guide
- Barnet, S. and Bedau, H. 2004. Critical Thinking, Reading and Writing: A Brief Guide to Writing. 6th Edition.
- Behrens & Rosen. 2007. Reading and Writing Across the Curriculum.
- Gardner, P. S. 2005. New Directions: Reading Writing and Critical Thinking
- George, D. and Trimbur, J. 2006. Reading Culture: Context for Critical Reading and Writing. 6th Edition
- Goatly, A. 2000. Critical Reading and Writing: An Introductory Course. London: Taylor & Francis
- Grellet, F., Writing for Advanced Learners of English. CUP
- Jordan, K. M. and Plakans, L. 2003. Reading and Writing for Academic Success
- Jordon, R. R. 1999. Academic Writing Course. CUP.
- Smith, L. C. 2003. Issues for Today: An Effective Reading Skills Text
- Withrow J., Effective Writing. CUP

Course Title: **Educational Assessment**

Course Code: **EDUC3143**

Credit Hours: **3**

Objectives:

The main objectives of this course are to:

- Understand different concepts used in educational assessment.
- Differentiate between the various forms of assessment.
- Understand classification of the types of assessment and their usability.
- Design and construct assessment that measures a variety of learning outcomes.
- Apply principles of assessment in planning a classroom assessment.
- Apply strategies to construct valid and reliable test items.
- Recognize both the potentialities and the limitations of the various types of tests & assessment procedures used in the schools.
- Interpret assessment results effectively.

Course Outline:

Introduction to Educational Assessment: Introducing the Concepts; Test, Measurement, Assessment & Evaluation, Instructional Process and &Role of Assessment, Assessment of and Assessment for Learning, Principles of Assessment, Classification of Assessment on the basis of Nature of Assessment, Purpose of Assessment, Forms of Assessment, Methods of Interpreting Results, Teacher made vs standardized test.

Planning Classroom Assessment: Instructional Aims, Goals and Objectives, General vs Specific Learning Outcomes, Taxonomy of Education Objectives, Developing Assessment Framework, Developing Test Specifications, Selecting appropriate type of test items.

Types of Achievement Test: Subjective Vs Objective; Constructing Objective Test Items, Characteristics, Different Types, Rules to construct, Scoring, Advantages and Limitations, Constructing Subjective Test Items, Characteristics, Different Types, Rules to construct, Developing Scoring Rubrics and Scoring, Advantages and Limitations.

Assessment Techniques in Affective and Psychomotor Domains: Observation, Self-reports, Questionnaire, Interview, Rating scales, Anecdotal record, Checklists, Peer appraisal.

Test Appraisal: Qualities of good test, Validity, Reliability, Usability, Item analysis for achievement test, Item discrimination, Item difficultly, Building item bank.

Interpreting Test Scores: Functions of Grading and Reporting, Types of Grading and Reporting, Relative Vs Absolute Scoring, Assigning Letter Grades, Record Keeping and Grading Software, Use of Feedback of Assessment.

Teaching Learning Strategies: Lecture method followed by discussion and question answer method, Cooperative learning, Students are required to prepare and maintain course portfolio, Assignments and presentations / quizzes based on the content of the course outline and project using "do-it-yourself" or "learner-centered" methods, Development of test items.

Recommended Books:

- Ebel, Robert (2004). *Essentials of Educational Measurement.* India: Prentice hall.
- Freeman, Richard, (2004). *Planning and Implementing Assessment.* New York: Rout ledge Flamer.
- Linn, R. L. (2008). *Measurement and assessment in teaching*. India: Pearson Education.

Course Title: **Calculus-III**

Course Code: **MATH2111**

Credit Hours: **3**

Objectives:
The main objectives of this course are to:

- Perform operations with vectors in two and three dimensional space and apply to analytic geometry.
- Differentiate and integrate vector-valued functions and apply calculus to motion problems in two and three dimensional space.
- Determine the limits, derivatives, gradients, and integrals of multivariate functions.
- Solve problems in multiple integration using rectangular, cylindrical, and spherical coordinate systems.
- Work with Green's, Divergence, and Stoke's theorems.

Course Outline:

Partial Derivatives: Functions of Two or More Variables, Limits and Continuity, Partial Derivatives, Differentiability and Chain Rule for Two Variables, Differentiability of Three Variables, Directional Derivatives of Three Variables, Gradients for Functions of Three, Maxima and Minima of Functions of Two Variables

Multiple Integrals: Double Integrals, Double Integrals over Non Rectangular Regions, Double Integrals in Polar Coordinates, Surface Area, Triple Integrals, Centroid, Triple Integrals in Cylindrical and Spherical Coordinates, Change of Variables in Multiple Integrals

Integration in Vector Fields: Line Integrals, Vector Fields, Green's theorem, Parameterized surfaces, Stokes' Theorem, The Divergence Theorem

Recommended Books:

- Anton, H. (2012). *Calculus.* Laurie Rosatone.
- Stewart, J. (2015). *Calculus.* Cengage Learning

Course Title: **Introduction to Information Technology**

Course Code: **COMP1111**

Credit Hours: **3**

Objectives:

The main objectives of this course are to:

- Understand the fundamentals of Information Technology
- Learn about upcoming technologies in different disciplines
- Understand word processing, spreadsheet, databases and presentation softwares.
- Get the knowledge about networking and internet.
- Get the knowledge about computer risks and safety, system failure and backup.

Course Outline:

Computers: Introduction to Computers, History of Computers, Types of Computers, Advantages and Disadvantages of using Computers
Computer Hardware: System unit, Central Processing Unit (CPU), Memory, Storage, Input Devices, Output Devices and Communication Devices
Softwares: System Softwares, Application Softwares which includes Microsoft Word, Excel, Access, PowerPoint, Outlook and discipline related softwares.
Networking: Network types, LAN, MAN and WAN, Internet, email, World-Wide Web, E-Commerce, Video Conferencing, Computer-based Training, Distance learning
Computer Security, Safety, Ethics and Privacy: Computer Security Risks, Cyber Crimes, Ethics and Society
System Failure and Backup: Surge Protectors, Uninterruptible Power Supply (UPS), Backup Full, differential, incremental, Disaster recovery plan

Recommended Books:

- Intro to Computers, Peter Norton, latest edition.
- Discovering Computers Complete, latest edition. Shelly Cashman series.
- Exploring Computers Complete latest edition by Floyd Fuller, Brian Larson.
- Steve Lambert and M Dow Lambert, Microsoft® Office Access(TM) Step by Step (Step By Step (Microsoft)), 2007.
- Microsoft Office 2010: Ultimate Tips and Tricks by Matt Smith.

Note: in addition to the above, any other text or book referred by Instructor may also be included.

Course Title: **Electricity and Magnetism-I**

Course Code: **PHYS2111**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this course are

- To understand the Physics of Electromagnetism
- 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.

Course Outline:

Electric field: Electric field due to a point charge, electric dipole**,** line of charge and a charged disk, a point charge in an electric field, electric field of continuous charge distributions, dipole in an electric field

Gauss' Law: Electric Flux, Gauss' Law, Applications of Gauss' law

Electric Potential: Equipotential Surfaces, Calculating the Potential from the Field, Potential due to a Charged Particle**,** group of Charged Particles, Electric Dipole and Continuous Charge Distribution, Calculating the Field from the Potential, Electric Potential Energy of a System of Charged Particles, Potential of Charged Isolated Conductor.

Capacitance: Capacitors in Parallel and in Series, Energy Stored in an Electric Field, Capacitor with a Dielectric, Dielectrics and Gauss' Law.

Circuits: Calculating the Current in a Single-Loop Circuit, Multi-loop Circuits, The Ammeter and the Voltmeter, RC Circuits.

Magnetic Fields: The Hall Effect, A Circulating Charged Particle, Magnetic Force on a Current-Carrying Wire, Torque on a Current Loop, The Magnetic Dipole Moment, Biot-Savart law, Amperes law.

List of Experiments:

- Measurement of resistance using a Neon flash bulb and condenser
- Conversion of a Galvanometer into Voltmeter and Ammeter.
- To study the characteristics of Photoemission and determination of Plank's constant using a Photo cell.
- Caliberation of an ammeter and a voltmeter by potentiometer.
- Charge sensity of a ballistic galvanomater.
- Measurement of self/mutual inductance.
- Study of electric circuit by black box.

Recommended Books:

- Resnick, Halliday & Krane. (1992). *Physics Vol. I&II*, 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday & Krane. (2002). *Physics Vol. I & II*, 5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick &Krane. (2010). *Fundamental of Physics*, 8th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young. (2000). *University Physics*, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso and Finn. (1999). *Physics.* USA*:* Addison-Wesley, Reading (MA).

Course Title: **Heat and Thermodynamics**

Course Code: **PHYS2112**

Credit Hours: **3**

Objectives:

The main objective of this course is;

- To understand the fundamentals of heat and thermodynamics.
- To understand the basic concepts of refrigerators, diesel and petrol engines.

Course Outline:

Temperature, Heat, and the First Law of Thermodynamics: Heat, specific heat, molecular specific heat, laws of Temperature, The Zeroth Law of Thermodynamics, The First Law of Thermodynamics, Some Special Cases of the First Law of Thermodynamics.

The Kinetic Theory of Gases: Ideal Gases, Kinetic theory of the ideal gas, work done on an ideal gas, internal energy of an ideal gas, intermolecular forces.

Introduction to Statistical Mechanics: Statistical distribution and mean values, distribution of molecular speeds, distribution of energies, Brownian motion.

Entropy and the Second Law of Thermodynamics: Reversible and Irreversible Processes and Entropy, Change in Entropy, The Second Law of Thermodynamics, temperature-entropy diagram, entropy and second law of thermodynamics, reversible, Thermodynamic temperature scale, Carnot Cycle, Carnot engine.

Thermodynamic relations: Maxwell's thermodynamics relations, TDS equations, Clapeyron's equation.

Thermoelectricity: Thermoelectricity, Seebeck effect, Peltier effect, thermocouple.

Recommended Books:

- Resnick, Halliday & Krane. (1992). *Physics Vol. I&II*, 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday & Krane. (2002). *Physics Vol. I & II*, 5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick &Krane. (2010). *Fundamental of Physics*, 8th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young. (2000). *University Physics*, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso and Finn. (1999). *Physics.* USA*:* Addison-Wesley, Reading (MA).

Course Title: **Curriculum Design and Instruction**

Course Code: **EDUC2118**

Credit Hours: **3**

Objectives:

The main objectives of this course are to:

- Explain the concept of curriculum and instructions.
- Understand models of curriculum.
- Know the existing school curriculum components.
- Implement curriculum in real context.

Course Outlines:

Introduction to Curriculum and Instruction: Curriculum as product, Process, Program, Intended Learning and experience of Learner, Difference between course, Syllabus and curriculum, Elements of curriculum, Concept of instruction, Relationship between curriculum and Instruction.

Designs of Curriculum: Subject centered curriculum, Learner centered curriculum, Core curriculum, Activity based curriculum, Integrated curriculum, Hidden curriculum.

Processes of Curriculum Development and Implementation: Need assessment, Foundations of curriculum, Philosophical, Psychological, Sociological, Economic objectives of curriculum, Content selection, Implementation strategy, Evaluation strategies.

Composition of National School Curriculums: Competencies, Standards, Benchmarks, Student Learning Outcomes, Analysis of current national curriculum documents of relevant subjects.

Selecting and Implementing Strategies of Instruction: Styles of teaching and learning, Selection of instructional strategies, Organization, Presentation and implementation of instruction.

Teaching Learning Strategies: Lecture method followed by discussion and question answer method, Cooperative learning, Students are required to prepare and maintain course portfolio, Assignments and presentations/quizzes based on the content of the course outline and project using “do-it-yourself” or “learner-centered” methods.

Recommended Books:

- Oliva, P. F; Gordon II, W. R. Developing the curriculum. Pearson Higher Ed, 2012.
- Marsh, C.J. Key Concepts for Understanding Curriculum. Routledge Taylor and Francis Group: London, 2010; 4th ed.
- Prattg, D. Curriculum Design and Development. Harcourt Brace Jovandovich, INC: New York, 2009.
- Chaube, S.N. Curriculum Planning and Instruction. Wisdom Press: NEW Delhi, 2011.

Course Title: **Analytic Geometry**
Course Code: **MATH2116**
Credit Hours: **3**

Objectives:
The main objectives of this course are to:

- Understand geometry and its applications in the real world.
- Communicate geometric ideas in the language of the mathematician.
- Select and use units of appropriate size and type to measure angles, perimeter, surface area, and volume.
- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

Course Outline:

Conic sections and polar coordinates: Conic sections, classifying conic sections by quadratic equations and eccentricity, quadratic equations and rotations, conics and parametric equations, cycloid, polar coordinates, graphing in polar coordinates, areas and lengths in polar coordinates, conic sections in polar coordinates

Vectors and geometry of space: Three-dimensional coordinate system, vectors, the dot product, the cross product, Projections, lines and planes in space, Parametric Equations of Lines, Distance of Point from a Line, Distance Between Two Parallel Lines, Skew Lines, Planes in 3-space, Distance of a Point from a Plane, Distance between Two Parallel Planes, Line as an Intersection of Two Planes, cylinders and quadric surfaces

Recommended Books:

- Anton, H. (2012). *Calculus.* Laurie Rosatone
- Stewart, J. (2015). *Calculus.* Cengage Learning

Course Title: **Ordinary Differential Equations**

Course Code: **MATH2117**

Credit Hours: **3**

Objectives:
The main objectives of this course are to:

- Find general solutions to first-order, second-order, and higher-order homogeneous and nonhomogeneous differential equations by manual and technology-based methods.
- Select and apply appropriate methods to solve differential equations; these methods will include, but are not limited to, undetermined coefficients, variation of parameters, eigenvalues and eigenvectors, Laplace and inverse Laplace transforms.

Course Outline:

Introduction to Differential Equations: Differential Equation (DE), Classification of DEs by Type, Order, and Linearity; Solutions of DEs: Trivial, Explicit, Implicit, Particular, Singular, and General; Introduction to Initial-Value and Boundary-Value Problems, Existence of a Unique Solution; Introduction to Mathematical Modeling with DEs

First-Order Differential Equations: Solutions of Separable, Homogeneous, Exact, and Linear DEs; Solutions of Bernoulli's, Ricatti's, and Clairaut's DEs

Linear Differential Equations of Higher Order: n^{th} Order Homogeneous Linear DEs: Superposition Principle, Linear Dependence, Linear Independence, Wronskian, Fundamental Set of Solutions, General Solution; n^{th} Order Nonhomogeneous Linear DEs: Superposition Principle, General Solution; Constructing a Second Solution from a Known Solution; Homogeneous Linear DEs with Constant Coefficients; Undetermined Coefficients; Applications of Second-Order DEs; Solving DEs.

Differential Equations with Variable Coefficients: Cauchy-Euler Equation, Power Series Solutions, Solutions about Ordinary and Singular Points, Solutions of Bessel and Legendre Equations; Finding Power Series Solutions of DEs.

Laplace Transform: Laplace Transform, Inverse Laplace Transform, Transforms of Derivatives and Integrals, Solving DEs Using Laplace Transforms; Evaluating Laplace Transforms.

Systems of Linear Differential Equations: Operator Method, Laplace Method, Matrices and Systems of Linear First-Order DEs, Homogeneous Linear Systems; Solving systems of DEs.

Recommended Books:

- Dennis, G. Z. and Michael, R. C. (2009). *Differential Equations with Boundary-Value Problems***.** Cengage Learning

Course Title: **Computing Tools for Mathematics**

Course Code: **COMP1113**

Credit Hours: **3(2+1)**

Objectives:

The main objectives of this course are to:

- Handle polynomials.
- Do differentiation and integration.
- Produce two- and three-dimensional plots.
- Produce animating plots.

Course Outline:

The contents of the course are not fixed, however the following points should be kept in mind while teaching the course. The course should be taught in a computer lab setting. Besides learning to use the software, the students must be able to utilize the software to solve computationally difficult problems in calculus and other areas of mathematics. At the end of the course, the students should have a good command on at least two of the three programs mentioned above.

Recommended Books:

- Garvan, F. (2002). *The Maple Book*. Chapman & Hall/CRC
- Kaufmann, S. (1994). *Mathematica As a Tool: An Introduction with Practical Examples.* Springer, New York
- Etter, D. M. Kuncicky, D. and Hull, D. (2001). *Introduction to MATLAB 6*. Prentice Hall, Englewood Cliffs, NJ, USA

Course Title: **Modern Physics and Electronics**

Course Code: **PHYS2114**

Credit Hours: **4 (3+1)**

Objectives:

The main objectives of this courses are

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

Course Outline:

Photons and Matter Waves: Thermal radiation (black body radiation), quantization of energy, The photoelectric effect, Compton effect, line spectra, wave behavior of particles, Testing de Broglie's hypothesis, waves packets and particles, Heisenberg's uncertainty principle, Wave function, Schrödinger equation, dual nature of matter (waves and particles).

More About Matter Waves: Wave Functions of a Trapped Electron, An Electron in a Finite Well, The atomic structure of hydrogen, Bohr's theory, spin, X-ray spectrum.

Electronics: Basic crystal structure, free electron model, energy band in solid and energy gaps, p-type and N-type semiconductors, diode, tansistor, positive and negative feed back R.C Oscillator, Monostable multivibrator, logic gates and their applications

List of Experiments:

1. To determine the ionization potential of mercury.
2. Setup of an RLC series circuit. Draw its frequency response curve and find the values of resonance frequency bandwidth and quality factor.
3. Setup of an R.L.C parallel circuit. Draw its frequency response curve and find the values of resonance band – width and quality factor.
4. To set up a half-wave and full-wave rectifier and demonstrate the wave shape on C.R.O. Also study the effect of smoothing current (capacitive filter) and the ripple voltage.
5. To set up the triode value as a single as a single stage voltage amplifier, and measurement of its gain by an oscilloscope.

Recommended Books:

- Resnick, Halliday & Krane. (1992). *Physics Vol. I&II*, 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday & Krane. (2002). *Physics Vol. I & II*, 5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick &Krane. (2010). *Fundamental of Physics*, 8th Edition. New York: John Wiley and Sons.
- Sears, Zemansky & Young. (2000). *University Physics*, 8th Edition. USA: Addison-Wesley, Reading (MA).
- Alonso and Finn. (1999). *Physics.* USA*:* Addison-Wesley, Reading (MA).
- A. Beiser (1988), *Concepts of Modern Physics.* New York*:* McGraw-Hill USA.

Course Title: **Electricity and Magnetism-II**

Course Code: **PHYS2115**

Credit Hours: **3**

Objectives:

The main objectives of this course are;

- To understand the Physics of Electromagnetism
- 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.

Course Outline

Magnetic Fields Due to Currents: Solenoids and Toroids, A Current-Carrying Coil as a Magnetic Dipole.

Induction and Inductance: Faraday law and Lenz's law, induced electric fields, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductance**,** Self-Induction**,** *RL* Circuits, Energy Stored in a Magnetic Field, Energy Density of a Magnetic Field, Mutual Induction.

Electromagnetic Oscillations and Alternating Current: *LC* Oscillations, Damped Oscillations in an *RLC* Circuit, The Series *RLC* Circuit, Power in Alternating-Current Circuits, Transformers.

Maxwell's Equations; Magnetism of Matter: Gauss' Law for Magnetic Fields, Induced Magnetic Fields, Displacement Current, Maxwell's Equations, Magnets, Magnetism and Electrons, Magnetic Materials, Diamagnetism, Paramagnetism, Ferromagnetism.

Electromagnetic Waves: The Traveling Electromagnetic Wave, Energy Transport and the Poynting Vector, Radiation Pressure, polarization. Reflection and Refraction, Total Internal Reflection, Polarization by Reflection

Recommended Books:

- Resnick, Halliday and Krane. (1992). *Physics Vol. II (extended).* 4th Edition. New York: John Wiley and Sons.
- Resnick, Halliday and Krane (2002). *Physics Vol.II* (*extended).* 5th Edition. New York: John Wiley and Sons.
- Halliday, Resnick and Krane (2010). *Fundamental of Physics.* 9th Edition. New York: John Wiley and Sons.
- Sears, Zemansky and Young (2000). *University Physics.* 8th Edition. USA: Addison-Wesley, Reading (MA).

Course Title: **Mathematical Methods of Physics-I**

Course Code: **PHYS3111**

Credit Hours: **3**

Objectives:

Objectives of the course are given below;

- To provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering.
- To prepare the student with mathematical tools and techniques that is required in courses offered in the applied physics and engineering programs.

Course Outline:

Vector Analysis: Divergence theorem, Green's Theorem, Stock's theorem, Cylindrical, spherical and curvilinear coordinates. Orthogonal curvilinear coordinates. Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinates.

Special Functions-I: Helmohltz Equation. Legendre's Differential Equation and its Solution, Legendere's Polynomials, Associated Legendere functions and Spherical harmonics.

Functions of Complex Variable: Complex functions, Analyticity, Cauchy-Riemann equations, Harmonic Function, Multi-valued Functions, Complex Integration, Cauchy's integral formula and its problems, Taylor and Laurent series, Contour integrals, Singularities and Residue theorem and its applications.

Boundary Value Problem: Boundary value problems in Physics, The Sturm-Liouville Problems.

Group Theory: Introduction to group, Invariant Subgroup, Discrete groups, Continuous group, GL(n), SU(2), SU(3), O-group's O (2) group.

Recommended Books:

- F. Riley, M. P. Hobson & S. J. Bence. (2006). *Mathematical Methods for Physics and Engineering: A Comprehensive Guide* Cambridge University Press.
- E. Butkov. (1973). *Mathematical Physics.* Addison-Wesley Publishing Company.
- G. Arfken and H. J. Weber. (1995). *Mathematical Methods for Physicists.* Academic Press.
- Bruce-R. Kusse & Eric. (2010). *Mathematical Physics*. Academic Press San deigo: CA.

Course Title: **Classical Mechanics**

Course Code: **PHYS3112**

Credit Hours: **3**

Objectives:

Its objectives are given below;

- To develop fundamental concepts in mechanics more rigorously as needed for other courses of the program.
- To apply advanced mathematical and computational techniques to complex problems.
- To contribute to the development of the student's thinking process through the understanding of the theory and application of this knowledge to the solution of practical problems.

Course Outline:

Lagrangian Formalism: Brief survey of Newtonian mechanics of a single and system of particles, constraints, D.Alembert's principle, Lagrange's equation and its application, calculus of variation and Hamilton's principle, derivation of Lagrange's equation from Hamilton's principle, contact transformations.

Central Force Problem: Two-body central force problem and its reduction to the equivalent one body problem, equation of motion and solution for one body problem laboratory and center of mass co-ordinate systems and their mutual transformation, Rutherford scattering formula.

Hamiltonian Formalism: Legendre transformation and Hamilton equation of motion, cyclic co-ordinates, conservation theorems and physical significance of the Hamiltonian for simple cases.

Canonical Transformations: The canonical transformations and their examples, the Lagrange's and the Poisson's brackets, integrals of motion, Poisson's theorems.

Recommended Books:

- David Morin (2008). *Introduction to Classical Mechanics: With Problems and Solutions.* Cambridge University Press.
- John R. Taylor (2005). *Classical Mechanics.* University Science Books.
- H. Goldstein. (1950). *Classical Mechanics.* Addison-Wesley.
- Tai L. Chow. (1995). *Classical Mechanics* John Wiley & Sons Inc.
- L. D. Landau & E. M. Lifshitz. (1960). *Mechanic.* Oxford: Pergamon.
- J. W. Leech Methuen and Co. Ltd. (1958). *Classical Mechanics.* London.

- V. D. Barger & M. G. Olsson. (1995). *Classical Mechanics.* New York: McGraw-Hill.
- L. N. Hand & J. D. Finch. (1998). *Analytical Mechanics.* Cambridge University Press, Cambridge.

Course Title: **Thermal and Statistical Physics**

Course Code: **PHYS3113**

Credit Hours: **3**

Objectives:

Objectives of the course are given below;

- To teach how to apply thermodynamic principles and the standard formulae to analyze thermal behavior of simple physical systems.
- To explain the origin of the laws of thermodynamics from the fundamental principles of equilibrium statistical mechanics.
- To teach how the computed results relate to understanding of thermal properties of a wide variety of physical systems, such as classical and quantum gases, crystalline solids, magnetic systems, thermal radiation, electrons in metals and even exotic astrophysical systems including white dwarf stars, neutron stars and black holes.

Course Outline:

Equilibrium Thermodynamics: Basic Postulates, Fundamental equations and equation of states, Response functions, Maxwell's relations, Reduction of derivative.

Elements of Probability Theory: Probabilities, Distribution functions, Statistical interpretation of entropy, Boltzmann H-Theorem.

Formulation of statistical Mechanics: Ensembles, Counting of states (in classical and quantum mechanical systems), Boltzmann Distribution.

Partition Function: Relation with thermodynamics variables, Examples (Collection of Simple Harmonic Oscillators, Pauli and Van Vleck Paramagnetic), Theorem of equipartition of energy.

Statistical Systems: Maxwell-Boltzmann, Bose Einstein, Fermi Dirac and Plank Statistical systems, Examples of these systems (Black Body Radiations, Gas of electrons in solids)

Recommended Books:

- Frederick Reif. (2008). *Fundamentals of Statistical and Thermal Physics.* Waveland Pr Inc.
- Charles Kittel. (2004). *Elementary Statistical Physics.* Dover Publications.
- F. Reif.. (1988). *Physics course on Statistical and thermal Physics*. Berkley.
- Gould, H., Spornick, L. & Tobochnik. (1995). *Thermal and statistical Physics Simulations.* New York: John Wiley & Sons.

Course Title: **Circuit Analysis**

Course Code: **PHYS3114**

Credit Hours: **3**

Objectives:

Objectives of the course are given below;

- To enrich student's knowledge to analyze basic circuits from the time domain or frequency domain.
- To strengthen students' capacity and ability for using calculus tools for circuit analysis. To make students able to understand and analyze frequency response graphics.
- To build students' capacity for synthesizing passive circuits using the basic techniques.

Course Outline:

Basic laws and Simple DC Circuits: Nodes, branches and loops, Kirchhoff's laws, Series circuits, Series resistors, Parallel resistor, Current divider rule, Voltage divider rule; Short and open circuits, Delta-wye conversion, Wye-delta conversion.

Method of Analysis: Node analysis, Node analysis with voltage source, Supernode, Nodal analysis with dependent sources, Mesh analysis, Mesh analysis with current source, Supermesh, Mesh analysis with dependent sources.

Circuit Theorem: Superposition theorem, Thevenin theorem with dependent sources, Norton theorem, Maximum power transfer theorem.

Multiple Loop of AC Circuits: RL Series circuit, RC Series circuit, RLC Series circuit, Impedence and admittance, Kirchhoffs laws in AC Circuit, Series impedance and admittance, Parallel impedance and admittance.

AC Circuit Analysis: Nodal analysis, Mesh analysis, Superposition theorem, Thevenin and Norton theorems, Maximum power transfer theorem.

Recommended Books:

- Thomas, R. E., Rosa, A. J., & Toussaint, G. J. (2016). *The Analysis and Design of Linear Circuits, Binder Ready Version*. John Wiley & Sons.
- R. T. Paynter. (1998). *Introductory Electric Circuits*. Prentice Hall.
- Alexander, C. K., Sadiku, M. N., & Sadiku, M. (2008). *Fundamentals of electric circuits*. McGraw-Hill Higher Education.
- Nahvi, M., & Edminister, J. A. (2003). *Schaum's outline of theory and problems of electric circuits*. McGraw-Hill.

Course Title: **Modern Physics Lab**

Course Code: **PHYS3115**

Credit Hours: **3**

Objectives:

The main objectives of this course are;

- To prepare the students for experimental research projects in the final year.
- After completion of the course, the students should be able to design experiments and to handle the experimental data statistically.

Course Outline:

Note:

(i) The students must perform at least 4 experiments from the list given below.

(ii) 50% weight-age must be given to viva-voce about apparatus, theory of experiments and estimation of errors.

List of Experiments:

1. Measurement of wavelengths of sodium light, difference of wave lengths and thickness of thin film e.g. mica using Michelson interferometer.
2. The determination of Cauchy's constants using spectrometer.
3. To study some aspects of Ferromagnetism by drawing B. H. curve.
4. The study of spectra using Fabry-Perot interferometers.
5. Determination of dielectric constant of liquid and solid.
6. Characteristics of G.M. counter and study of fluctuations in random process.
7. To determine charge of an electron by Millikan's oil drop method.
8. Measurement of speed of light using laser source rotating mirror method.
9. To study Zeeman Effect.
10. To determine e/m of an electron using a fine beam tube.
11. To study Hall effect in an n-type/p-type semiconductor or a metal.
12. To measure the critical potential of mercury by Frank-Hertz method.
13. To measure Planck's constant by studying photoelectric effect.
14. To measure work function of a metal and verification of Richardson's equation.
15. To determine the characteristic of G. M. tube and measure the range and maximum energy of β particles.
16. Measurement of half-life of a radioactive source.

Recommended Books:

- Melissinos, A. C., & Napolitano, J. (2003). *Experiments in Modern Physics*. Gulf Professional Publishing.
- Moore, J. H., Davis, C. C., Coplan, M. A., & Greer, S. C. (2009). *Building scientific apparatus.* Cambridge University Press.
- Squires, G. L. (2001). *Practical Physics*. Cambridge university press.

Course Title: **Mathematical Methods of Physics-II**

Course Code: **PHYS3116**

Credit Hours: **3**

Objectives:

Objectives of the course are given below;

- To advance student's knowledge with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied physics and engineering.
- To strengthen students' knowledge about advanced mathematical tools and techniques that is required in courses offered in the applied physics and engineering programs.

Course Outline:

Fourier series and Transforms: Fourier series and its complex form, Applications of Fourier series, Representations of a function, Fourier integral theorem, Fourier transforms, Fourier Sine and Cosine transforms, Applications of Fourier transform, Laplace transforms, Application of Laplace Transform.

Tensor Analysis: Cartesian Tensors, Coordinate Transformation, Rank of a Tensor, Tensor Algebra, Quotient Theorem, Tensor Density, Covariant and contravariant tensor.

Green's Function: Definition of Green's functions, Problems of Green's Function, Green's Functions in Electrodynamics.

Special Functions-II: Bessel's Differential Equation, Solution of Bessel's Differential Equation, Bessel's Functions, Neumann functions, Hermite Differential Equation, Solution of Hermite differential Equation, Hermite Polynomials.

Recommended Books:

- Riley, K. F., Hobson, M. P., & Bence, S. J. (2006). *Mathematical methods for physics and engineering: a comprehensive guide*. Cambridge University Press.
- E. Butkov. (1968). *Mathematical Physics.* Addison-Wesley Publishing Company.
- G. Arfken & H. J. Weber. (1995). *Mathematical Methods for Physicists*. Academic Press.
- Byron, F. W., & Fuller, R. W. (2012). *Mathematics of classical and Quantum Physics*. Courier Corporation.
- Spiegel, M. R. (1970). *Laplace transforms*. New York: McGraw-Hill.

Course Title: **Electromagnetic Theory-I**

Course Code: **PHYS3117**

Credit Hours: **3**

Objectives:

Objectives of the course are as follows;

- To deepen students understanding of Electromagnetic theories.
- To strengthen student's problem solving skills for electromagnetic problems that are considerably more abstract and difficult than the problems encountered in introductory Physics.
- To find both physical and formal mathematical similarities and connections between Electromagnetic Theory and other areas of Physics.

Course Outline:

Electrostatic: Electric dipole, potential energy of a dipole in an electric field, force and couple on the dipole placed in an external electric field, multipole expansion of electric fields external field of a dielectric displacement vector, electric susceptibility and dielectric constant, boundary conditions on the field vectors, potential energy of a group of point charges, electrostatic energy of a charge distribution, energy of an electrostatic field, energy of a system of charged conductors, stress in the electrostatic field and dielectric media, coefficients of potential, capacitance and inductance.

Equation of Poisson and Laplace, applications of Laplace's equation to problems (conductors and dielectrics) having spherical cylindrical and cartesian symmentry, electrical images (conductors and dielectrics).

Electric Current: Nature of the current, current density and equation of continuity, Ohm's law, steady current in media without sources of e.m.f., approach to electrostatic equilibrium.

Magnetism: Magnetic induction, force on current carrying conductors, Biot-Sawart law, Ampere's circuital law, the magnetic vector and scaler potentials, the magnetic field of a distant circuit, Magnetisation, vectors M and H produced by magnetized materials field equation, boundary conditions on the field vectors.

Recommended Books:

- Reitz, J. R., Milford, F. J., & Christy, R. W. (2008). *Foundations of electromagnetic theory*. Addison-Wesley Publishing Company.
- Maxwell, J. C. (2009). *A treatise on electricity and magnetism (Vol. 1)*. Clarendon Press.

- Page, L. (1922). *An Introduction to Electrodynamics from the Standpoint of the Electron Theory*. Forgotten Books.
- Maxwell, J. C. (2007). *A treatise on electricity and magnetism (Vol. 1)*. Clarendon Press.
- Grant, I. S., & Phillips, W. R. (2013). *Electromagnetism*. John Wiley & Sons.

Course Title: **Introduction to Quantum Mechanics**

Course Code: **PHYS3118**

Credit Hours: **3**

Objectives:

The main objective of this course is;

- To provide understanding of the basic principles and techniques in quantum mechanics.
- Special emphasis is put on providing the student with skills to independently perform quantum mechanical analysis of atomic and electro-magnetic systems.

Course Outline:

Review of Breakdown of Classical Concepts and Old Quantum Theory: Particle aspects of radiation and Planck's hypothesis, wave aspects of matter and de Broglie's hypothesis, discrete levels and Bohr's hypothesis.

Formulation of Quantum Mechanics: Mathematical preliminaries, quantum mechanical wave function, observables and operators, operator equations, the eigen value equation, commutation relations, expectation value, postulates of quantum mechanics, correspondence principle, complimentarily principle, Schrodinger equation and discrete energy levels, uncertainty principle, parity.

One Dimensional Systems: The potential step, reflection and transmission coefficients, potential well and bound states, potential barrier, and tunneling, harmonic oscillator, raising and lowering operators.

Angular Momentum: Angular momentum operator, z-component, total angular momentum; eigenvalves, Eigen functions and vector diagram, connection between rotation and angular momentum operators.

Recommended Books:

- Zettili, N. (2009). *Quantum mechanics: concepts and applications*. John Wiley & Sons.
- Liboff, R. L. (1987). *Introductory quantum mechanics*.
- Cohen-Tannoudji, C., Diu, B., & Laloe, F. (1978). *Quantum Mechanics, Volume 1*.
- Gasiorowicz, S. (2007). *Quantum Physics*. John Wiley & Sons.
- Dicke, Robert Henry & James P. Wittke. (1974). *Introduction to Quantum Mechanics.*
- Sokolov, A. A., Loskutov, Y. M., & Ternov, I. M. (1996). *Quantum Mechanics.* Holt, Rinehart abd Winston.

- G. Aruldhas. (2008). Quantum Mechanics. PHI Learning Pvt. Ltd.
- Powell, J. L. (1961). *Quantum Mechanics*. Addison-Wesley.
- Bransden, B. H., & Joachain, C. J. (2000). *Quantum Mechanics*. Pearson Education.

Course Title: **Solid State Physics**

Course Code: **PHYS3119**

Credit Hours: **3**

Objectives:

Objectives of the course are given below;

- To describe simple structures in terms of a lattice and unit cell, calculate the cohesive energy of these structures and understand (in outline) how they are determined experimentally.
- To describe the basic features of the coupled modes of oscillation of atoms in a crystal lattice using the one-dimensional chain as a model and relate crystal properties (specific heat, thermal conductivity) to the behavior of these oscillations.
- To explain the basic features of semiconductors and relate this to simple semiconductor devices. To explain the magnetic and superconducting properties of materials using simple models of the underlying mechanisms.

Course Outline:

Crystal Structure: Periodic arrays of atoms, fundamental types of lattices, index system for crystal planes, simple crystal structures, direct imaging of atomic structure, non-ideal crystal structures, reciprocal lattice, diffraction of waves by crystals, scattered wave amplitude, Brillion zones, Fourier analysis of the basis, quasi crystals.

Crystal Binding and Elastic Constants: Crystals of inert gases, ionic crystals, covalent crystals, metals, hydrogen bonds, analysis of elastic strains, elastic compliance and stiffness constants, elastic waves in cubic crystals.

Crystal Vibrations: Phonons I: Vibrations of crystals with monatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonons.

Thermal Properties: Phonons II: Phonon heat capacity, anharmonic crystal interactions, thermal conductivity, and electronic heat capacity.

Recommended Books:

- Ibach, H., & Lüth, H. (2009). *Solid-state physics: an introduction to principles of materials science*. Berlin: springer.
- Madelung, O. (2012). *Introduction to solid-state theory (Vol. 2).* Springer Science & Business Media.
- Mihály, L., & Martin, M. C. (2009). *Solid State Physics*. John Wiley & Sons.
- Kittel, C. (2005). *Introduction to solid state Physics*. Wiley & Sons.
- Ashcroft, N. W., & Mermin, N. D. (2005). *Solid state Physics*. Publishing Asia Ltd.

Course Title: **Electronics**

Course Code: **PHYS1113**

Credit Hours: **3**

Objectives:

After completion of the course, the students should understand;

- The working of active and passive components in electronic circuits
- The designing of rectifiers, amplifiers, oscillators, and multi-vibrators

Course Outline:

Special diodes: Zener diodes, zener regulators, Schottky diodes, light emitting diodes, photo diodes, tunnel diodes and their applications.

Transistor circuits: Junction transistors, the volt ampere curve of a transistor, the current amplification factors, relations between the amplification factors, the load line and Q-point, the basic transistor amplifiers, simplification of the equivalent Common Emitter circuit, the Transconductance common meter amplifier, the conversion of the h parameter, the common collector amplifier

DC bias for the transistor: Choice of the Q point, variation of the Q point, fixed transistor bias, the four resistor bias circuit, voltage feedback bias, emitter follower bias circuit.

FET: Field effect Transistors, Junction FET, and MOSFET, Operation, construction, Biasing, Common source and common drain amplifiers.

Operational amplifiers: Op-amp, Parameters of Op-amp, non-inverting and inverting circuit, Applications of Op-amp, comparators, summing, subtract or, integrator and differentiator.

Frequency response RC amplifiers: Cascaded amplifier, amplifier passband low frequency response, low frequency limit, unpassed emitter resistor, miller effect, high frequency response, frequency limit of the transistor.

Oscillators: Armstrong, Hartely, Colpit's, Phase shift oscillators.

Recommended Books:

- Kasap, S. O. (2006). *Principles of electronic materials and devices*. McGraw-Hill.
- Floyd, T. L. (2008). *Electronic devices: conventional current version*. PEARSON Prentice hall.
- Peebles, P. Z., Read, J., & Read, P. (2001). *Probability, random variables, and random signal principles (Vol. 3)*. Boston, Mass, USA: McGraw-Hill.
- Ryder, J. D. (1980). *Electronic fundamentals and applications*. Prentice-Hall.

- Boylestad, R. L., & Nashelsky, L. (2002). *Electronic Devices and Circuit Theory, Eight Edition*. Prentice Hall (Pearson Education Inc.).

Course Title: **Electronics Lab**

Course Code: **PHYS3121**

Credit Hours: **3**

Objectives:

After completion of the course, the students should

- Understand the working of active and passive components in electronic circuits.
- Be capable of designing rectifiers, amplifiers, and wave-shaping circuits.
- Be able to design circuits with systems approach.

Course Outline:

Note: (i) The students must perform at least 4 experiments

(ii) 50% weight age must be given to viva-voce about apparatus, theory of experiments and estimation of errors.

List of experiments:

1. To construct a power supply and study the rectified wave form (measurement of peak value), ripple factor and regulation (without regulator).
2. To construct a voltage-regulated power supply with Zener diode.
3. To construct a single stage CE transistor voltage amplifier and study gain, input impedance, output impedance, and half power points by sine/square wave testing and effect of bias on the output and measurement of distortion.
4. To construct a source follower FET voltage amplifier and study gain, input impedance, output impedance, half power points by sine/square wave testing.
5. Study of wave shaping circuits of diode, integrators and differentiators.
6. To construct an R-C oscillator and compare it with a standard frequency.
7. To construct a Hartley or Colpitts oscillator and measure its frequency.
8. To construct and study the wave forms at the base and collector of the transistors of a free running a multivibrators.
9. To construct and study of the height, duration and time period of the output pulses in a monostable and bistable multivibrators with reference to the input Trigger.
10. To construct from discrete components OR, AND, NOT, NAND, NOR exclusive OR Circuits and verify their truth tables.
11. To construct the operational amplifier (741) by using discrete components and study its frequency response.

Recommended Books:

- Floyd, T. L. (2011). *Digital Fundamentals*, 10/e. Pearson Education India.
- Dueck, R., & Reid, K. (2011). *Digital electronics*. Cengage Learning.
- Kleitz, W. (2007). *Digital electronics: a practical approach*. Prentice Hall.
- Roger, L. T. (2005). *Digital Electronics: Principles and Applications*, Career Education, 7 editions.
- Miani, A. K. (2007). *Digital Electronics: Principles, Devices and Applications*. Wiley.

Course Title: **Nuclear Physics-I**

Course Code: **PHYS4111**

Credit Hours: **3**

Objectives:

Objectives of this course are;

- The student should understand different nuclear Phenomena.
- They should be capable to understand the application of nuclear physics in everyday life; and be able to study a higher course in nuclear physics.

Course Outline:

Basic Properties of Nucleus: Size and mass of the nucleus, nuclear spin, magnetic dipole moment, electric quadruple moment, parity and nuclear statistics.

Passage of charged particles through matter, Introduction to detectors and practical accelerators

Radio-Active Decay: Theory of alpha decay, and explanation of observed phenomena, measurement of β-ray energies, the magnetic lens spectrometer, Fermi theory of β-decay, neutrino hypothesis, theory of gamma decay, multi polarity of gamma-rays, nuclear isomerism.

Nuclear Forces: Yukawa theory, proton-proton and neutron-proton scattering, charge independence and spin dependence of nuclear force, isotopic spin, Nuclear Models:

Nuclear models, Liquid drop model, shell model, collective model.

Recommended Books:

- Lilley, John. (2013). *Nuclear Physics: principles and applications*. John Wiley & Sons.
- Heyde, K. (2004). *Basic Ideas and Concepts in Nuclear Physics: An Introductory Approach*, Third Edition. CRC Press.
- Krane, K. S. (2008). *Introductory Nuclear Physics*. Willey India.
- Physics, T.C.A.O.N. and Astronomy, B.P. and Sciences, D.E.P. and Council, N.R. (2013). *Nuclear Physics: Exploring the Heart of Matter*.National Academies Press.
- Lewis, E. E. (2008). *Fundamentals of Nuclear Reactor Physics*. Academic Press.
- Smith, C. M. H. (1965). *A textbook of Nuclear Physics*. Pergamon Press.
- Kaplan, I. (1963). *Nuclear Physics* (No. QC 776. K35 1955.). Reading: Addison-Wesley.

- Krane, K. S. (1987). *Introductory Nuclear Physics*.
- Beiser, A. (2003). *Concepts of Modern Physics*. Tata McGraw-Hill Education.

Course Title: **Advanced Quantum Mechanics**

Course Code: **PHYS4112**

Credit Hours: **3**

Objectives:

Main objectives of this course are;

- To provide a more advanced understanding of the basic principles and techniques in quantum mechanics.
- To provide special emphasis to enhance skills of students to independently perform quantum mechanical analysis of atomic and electromagnetic systems.

Course Outline:

Central Potential: Motion in a central potential, the hydrogen atom, energy spectrum, quantum numbers and degeneracies.

Spin and Statistics: The Zeeman effect, matrix operators, spin statistics and exclusion principle, Pauli's two components formalism, identical particles, fermions and bosons, symmetry and antisymmetry of wavefunctions.

Approximation Methods in Quantum Mechanics: Time independent perturbation theory and its applications, damped linear harmonic oscillator, hydrogen like atoms in magnetic field, time dependent perturbation theory, transition probability, emission and absorption of radiation, WKB approximation and its applications, variational method and its applications.

Formal Theory of Quantum Systems: Dirac delta-function, completeness, expectation value, degeneracy, compatible and incompatible observables, discrete and continuous spectra.

Recommended Books:

- Zettili, N. (2009). *Quantum Mechanics: concepts and applications*. John Wiley & Sons.
- Gasiorowicz, S. (2007). *Quantum Physics.* John Wiley & Sons.
- Sokolov, A. A., Loskutov, Y. M., & Ternov, I. M. (1996). *Quantum Mechanics*. Holt, Rinehart and Winston.
- Bransden, B. H., & Joachain, C. J. (2000). *Quantum Mechanics*. Pearson Education.
- Townsend, J. S. (2000). *A modern approach to Quantum Mechanics*. University Science Books.
- G. Aruldhas. (2008). Quantum Mechanics. PHI Learning Pvt. Ltd.

Course Title: **Atomic and Molecular Physics**

Course Code: **PHYS4113**

Credit Hours: **3**

Objectives:

After completion of the course, the student should;

- Understand different nuclear phenomena.
- Be capable to understand the applications of nuclear physics in technology (particularly power generation) and everyday life.

Course Outline:

Structure of Atoms: Review of Bohr's theory, Somerfield Model, Frank Hertz Experiment, Approximation Method

One Electron System: Review of Schrodinger equation for Hydrogen atom, Fermi Golden rule, Quantum Numbers, Atoms in Radiation Field, Radiative transitions, Einstein coefficients, Selection rule, Normal Zeeman effect, Stark effect, Hyperfine structure.

Many Body Systems: Pauli exclusion principle, Periodic system of the elements, Stern Garlic experiment, Spin orbit coupling, Central Field approximation, Hertree-Fock Method and self-consistent field, Thomas Fermi potential, LS coupling, JJ coupling and other types of coupling, X-Ray Spectra.

Molecules: Ionic and covalent bonding, Diatomic Molecules rotational, vibrational and electronic spectra, Born Openheimmer approximation, Transition probabilities of diatomic molecules, electron spin and Hund's cases, Raman effect, LCAO approximation

Recommended Books:

- Drake, G. W. (Ed.). (2006). *Springer handbook of atomic, molecular, and optical Physics*. Springer Science & Business Media.
- Foot, C. J. (2005). *Atomic Physics*. Oxford University Press.
- Bransden, B. H. & Joachain, C. J. (2008). *Physics of Atoms and Molecules*. 2nd ed. Pearson Education.

Course Title: **Electromagnetic Theory-II**

Course Code: **PHYS4120**

Credit Hours: **3**

Objectives:

Objectives of this course are

- To strengthen understanding of electricity and magnetism
- To enhance problem solving skills for electromagnetic problems that is considerably more abstract and difficult than the problems encountered in introductory Physics.
- To strengthen student's abilities to find both physical and formal mathematical similarities and connections between Electromagnetic Theory and other areas of Physics.

Course Outline:

Maxwell's Equations and their Applications: Maxwell's equations and the generalization of the Ampere's law, electromagnetic energy, vector and scalar potentials, retarded scalar and vector potentials, radiation from an oscillating dipole

Electromagnetic waves: plane electromagnetic wave, plane waves in a conducting and non-conducting media, linear and circular polarization, and superposition of waves in one dimension, boundary conditions, reflection and refraction of electromagnetic waves at a plane interface between dielectrics, waves polarization by reflection and total internal reflection, reflection from a conducting medium and non-conducting medium.

Formulation of electrodynamics: Covariant formulation of electrodynamics, transformation laws of electromagnetic fields, the field of a uniformly moving and accelerated electron.

Recommended Books:

- Reitz, J. R., Milford, F. J., & Christy, R. W. (2008). *Foundations of electromagnetic theory*. Addison-Wesley Publishing Company.
- Maxwell, J. C. (2009). *A treatise on electricity and magnetism (Vol. 1)*. Clarendon Press.
- Page, L. (1922). *An Introduction to Electrodynamics from the Standpoint of the Electron Theory*. Forgotten Books.
- Maxwell, J. C. (2007). *A treatise on electricity and magnetism (Vol. 1)*. Clarendon Press.
- Jackson, J. D. (1999). *Classical Electrodynamics*. Wiley.
- Duffin, W. J. (1990). *Electricity and Magnetism*. McGraw-Hill College.
- Grant, I. S., & Phillips, W. R. (2013). *Electromagnetism*. John Wiley & Sons.

Course Title: **Nuclear Physics-II**

Course Code: **PHYS4121**

Credit Hours: **3**

Objectives:

After completion of the course, the student should;

- Understand different nuclear phenomena.
- Be capable to understand the applications of nuclear physics in technology (particularly power generation) and everyday life.

Course Outline:

Nuclear Reactions: Conservation laws of nuclear reactions, Q-value of nuclear reaction, threshold energy, transmutation by photons, protons, deuterons and alpha particles, excited states of nucleus, energy levels, level width, Cross section from nuclear reactions, compound nucleus theory of nuclear reactions, limitations of compound nucleus theory, resonances, Breit-Wigner formula, direct reactions.

Neutron Physics: Neutron sources, radioactive sources, photo neutron sources, charged particle sources, reactor as a neutron source, neutron detectors, slowing down of neutron, nuclear fission, description of fission reaction, mass distribution of fission energy, average number of neutrons released, theory of fission and spontaneous fission.

Thermonuclear Reactions: Fusion and thermonuclear process, energy released in nuclear fusion, carbon nitrogen & oxygen cycle, controlled nuclear fusion, D-D & D-T reactions.

Recommended Books:

- Lilley, John. (2013). *Nuclear Physics: principles and applications*. John Wiley & Sons.
- Basdevant, J. L., Rich, J., & Spiro, M. (2005). *Fundamentals in Nuclear Physics: From nuclear structure to Cosmology*. Springer Science & Business Media.
- Lewis, E. E. (2008). *Fundamentals of Nuclear Reactor Physics*. Academic Press.
- Smith, C. M. H. (1965). A textbook of Nuclear Physics. Pergamon Press.
- Kaplan, I. (1963). *Nuclear Physics* (No. QC 776. K35 1955.). Reading: Addison-Wesley.
- Krane, K. S. (1987). *Introductory Nuclear Physics*.
- Beiser, A. (2003). *Concepts of Modern Physics*. Tata McGraw-Hill Education.

Course Title: **Computational Physics**

Course Code: **PHYS4122**

Credit Hours: **4(3+1)**

Objectives:

After completion of the course, students should

- Understand how to program in C++ and MATLAB for solving physics and numerical methods problems;
- Be capable of writing algorithms and flowcharts and translation to C++ and MATLAB programs;
- Be able to write C++ and MATLAB programs for solving complex physics and mathematics problems; and
- Be able to learn different graph plotting techniques using MATLAB.

Course Outline:

Realistic Projectile Motion: The effect of Air resistance; Projectile Motion; Motion of Batted Ball; The effect of spin

Oscillatory Motion and Chaos: Simple Harmonic Motion; Chaos in the Driven Nonlinear Pendulum; Lorenz Model; The Billiard Problem; Bounce Balls; Chaos and Noise

The Solar System: Kepler's Laws; The Inverse Square Law and the stability of Planetary Orbits; The three body problem

Random Systems: Introduction; Generation of Random Numbers; Monte Carlo Method; Random Walks; Self Avoiding Random Walks; Diffusion and Entropy

Recommended Books:

- Nicholas J. Giordano and Hisao Nakanishi. (2005). *Computational Physics*. Benjamin Cummings, 2nd edition.
- Pang, T. (2008). *An Introduction to Computational Physics.* Cambridge University Press.
- R. Landau, M. Paez, C. Bordeianu. (2008). *A Survey of Computational Physics*. Princeton University Press.

Course Title: **Digital Logic and Design**

Course Code: **PHYS4129**

Credit Hours: **3 (2+1)**

Objectives:

The students will be able to understand:

- Digital circuits using Boolean algebra and to implement digital circuits with different logic gates and capable of designing both sequential and combinational circuits for microprocessor based systems.
- Design considerations for the telecommunication systems using analog integrated circuits.

Course Outline:

Review of number systems: Binary, octal and hexadecimal number system their inter conversion basic logic sgates.

Boolean algebra: Demorgan 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.

Combinational logic circuit: Logic circuits based on AND-OR, OR-AND, NAND, NOR Logic gates design, addition, subtraction, 2's compliments, half adder, full adder, half subtractor, full subtractor, encoder, decoder, multiplexer and demultiplexer.

Sequential logic circuit: Flip- flop, latches, J-K, T and D flip flops, Master- slave flips-flops.

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, TTL, CMOS).

List of Experiments:

1. Design and study of a half and full with different bollean expression
2. Construct and study RS, JK, T, D Flip Flops by using IC's
3. To construct and understand an operation of arithmetic logic unit and study different operation of it.
4. Design and study the application of operational amplifier (current to voltage converter, voltage clamp, integrator and differentiator)

Recommended Books:

- Nashelsky, L. (1972). *Introduction to digital computer technology*.
- Debenham, M. J. (2013). *Microprocessors: principles and applications*. Elsevier.
- Mano, M. M. (1988). *Computer engineering hardware design*. Prentice-Hall, Inc.
- Tokheim, R. (2007). *Digital Electronics*. 7th ed McGraw Hill.

Course Title: **Advanced Digital Electronics**

Course Code: **PHYS4134**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- The simplification of digital circuits using Boolean algebra and to implement digital circuits with different logic gates and capable of designing both sequential and combinational circuits for microprocessor based systems
- Design considerations for the telecommunication systems using analog integrated circuits.

Course Outline:

Shift registers: Basic shift register serial in/ serial out shift register, serial in/ parallel out shift register, parallel in/ serial out shift register, shift register application.

Counters: A synchronous counter, Synchronous counter, up/ down synchronous counter, design of synchronous counter, cascaded counter ring counter.

Interfacing: Digital and analog interfacing, digital to analog conversion, analog to digital conversion, conversion errors.

Micro computer and microprocessor: Computer and its types, all generation of computers, microprocessor (ALU, UP register, control and time section), the 8085,8086/8088 microprocessor family.

Memory and programeable logic: ROM, PROM, EAPROM, EEROM and RAM, memory decoding, PLD, PLA and PAL.

List of Experiments:

1. To construct and study synchrous and asynchrous BCD counters with IC's.
2. To design and study of decoder, encoder and multiplexer circuits
3. Frequency counter and optional digital clock.

Recommended Books:

- Floyd, T. L. (2008). *Electronic devices: conventional current version*. PEARSON Prentice hall.
- Dueck, R., & Reid, K. (2011). *Digital electronics*. Cengage Learning.
- William Kleitz (2007) *Digital Electronics: A Practical Approach*, 8 editions. Prentice Hall.

- Roger, T. (2007). *Digital Electronics: Principles and Applications, Student Text with MultiSIM CD-ROM*, Career Education; 7th edition.
- Anil, K. (2007). *Digital Electronics: Principles, Devices and Applications*, Wiley.
- Debenham, M. J. (2013). *Microprocessors: principles and applications*. Elsevier.

Course Title: **Plasma Physics-I**

Course Code: **PHYS4130**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Plasma Physics in order to study any higher course in Applied Nuclear Physics, Medical Physics, theoretical Nuclear Physics and Atomic and Molecular Physics.
- Different nuclear phenomena.
- The applications of plasma physics in technology and everyday life.

Course Outline:

Introduction: Occurrence of Plasma in nature, Definition of Plasma, concept of temperature, Debye shielding, the plasma parameter, criteria for plasma, Application of plasma.

Single Particle Motion: Uniform **E** and **B** field, Non uniform **B** field, Non uniform **E** field, Time varying **E** field, Time varying **B** field.

Plasma as Fluid: Relation of Plasma Physics to ordinary Electromagnetism, The Fluid equation of motion, Fluid Drift Perpendicular to B, Fluid Drift Parallel to **B**, The Plasma approximation.

Recommended Books:

- Bittencourt, J. A. (2004). *Fundamentals of Plasma Physics*, Springer; 3rd edition.
- Bellan, P. M. (2008). *Fundamentals of Plasma Physics*. Cambridge University Press.
- Chen, F. F., & Smith, M. D. (2006). *Plasma.* John Wiley & Sons, Inc., 2nd Edition.

Course Title: **Plasma Physics-II**

Course Code: **PHYS4131**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Plasma Physics in order to study any higher course in Applied Nuclear Physics, Medical Physics, theoretical Nuclear Physics and Atomic and Molecular Physics.
- Different nuclear phenomena.
- The applications of plasma physics in technology and everyday life.

Course Outline:

Waves in Plasmas: Representation of waves, group velocity, Plasma Oscillations, Electron Plasma waves, Sound waves, Ion waves, Validity of Plasma approximation, Comparison of Ion and Electron waves, Electrostatic Electron Oscillations perpendicular to B, Electrostatic Ion Oscillations perpendicular to B, The Lower Hybrid frequency, Electromagnetic waves perpendicular to $B_{0,}$ Cutoffs and Resonance, Electromagnetic waves perpendicular to B_0.

Diffusion and Resistivity: Diffusion and mobility in weakly ionized gases, Decay of plasma by Diffusion, Diffusion across a magnetic field, steady state solution, Recombination, Diffusion across a magnetic field, collisions in fully Ionized plasma, The single fluid MHD equation, Diffusion in fully Ionized plasma and its solution

Equilibrium and Stability: Hydro magnetic equilibrium, the concept of β, Diffusion of Magnetic field into Plasma, Classification of Instability, two stream instability, the gravitational instability.

Recommended Books:

- Bittencourt, J. A. (2004). *Fundamentals of Plasma Physics*, Springer: 3rd edition.
- Bellan, P. M. (2008). *Fundamentals of Plasma Physics*. Cambridge University Press.
- Chen, F. F., & Smith, M. D. (2006). *Plasma.* John Wiley & Sons, 2nd Edition.

Course Title: **Advanced Solid State Physics-I**

Course Code: **PHYS4132**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Different Solid State Phenomena.
- Application of Solid State Physics in everyday life.
- Research in the area of solid state or condensed matter physics.

Course Outline:

Electrical Properties of Metals: Classical free electron theory of metals, energy levels and density of orbital's in one dimension, effect of temperature on the Fermi–Dirac distribution function, properties of the free electron gas, electrical conductivity and Ohm's Law, thermal and electrical conductivities of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with applications.

Dielectric Properties of Solids: Polarization, Depolarization, Local and Maxwell field, Lorentz field, Clausius-Mossotti relation, Dielectric Constant and Polarizability, Masurement of dielectric constant, ferro electricity and ferroelectric crystals, Phase Transitions, First and 2nd order phase transitions.

Semiconductors: General properties of semiconductors, intrinsic and extrinsic semiconductors, their band structure, carrier statistics in thermal equilibrium, band level treatment of conduction in semiconductors and junction diodes, diffusion and drift currents, collisions and recombination times, superconductors

Optical Properties: Interaction of light with solids, Optical Properties of Metals and Non-Metals, Kramers Kronnig Relation, Excitons, Raman Effect in crystals, optical spectroscopy of solids.

Non-crystalline Solids: Diffraction pattern, glasses, amorphous Ferro magnets and semiconductors, low energy excitations in amorphous solids, fiber optics.

Point Defects: Lattice vacancies, diffusion, color centers.

Dislocations: Shear strength of single crystals, dislocations, strength of alloys, dislocations and crystal growth, hardness of materials.

Recommended Books:

- Ibach, H., & Lüth, H. (2009). *Solid-state Physics*: an introduction to principles of materials science. Berlin: springer.

- Madelung, O. (2012). *Introduction to Solid-State theory* (Vol. 2). Springer Science & Business Media.
- Mihály, L., & Martin, M. C. (2009). *Solid State Physics*. John Wiley & Sons.
- Kittel, C. (2005). *Introduction to Solid State Physics*. Wiley.
- Ashcroft, N. W., & Mermin, N. D. (2005). *Solid State Physics*, Publishing Asia Ltd.
- JS Blakemore (1991), *Solid State Physics*, Cambridge University Press.

Course Title: **Advanced Solid State Physics-II**

Course Code: **PHYS4133**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Different Solid State Phenomena;
- Application of Solid State Physics in everyday life;
- Research in the area of solid state or condensed matter physics.

Course Outline:

Free Electron Fermi Gas: Energy levels in one dimension, effect of temperature on the Fermi-Dirac distribution, free electron gas in three dimensions, heat capacity of the electron gas, experimental electrical resistivity of metals, umklap scattering, motion in magnetic fields, Hall effect, thermal conductivity of metals, ratio of thermal to electrical conductivity, nanostructures.

Energy Bands: Nearly free electron model, origin of the energy gap, magnitude of energy gap, Bloch functions, wave equation of an electron in periodic potential, crystal momentum of an electron, solution of the central equation, empty lattice approximation, approximate solution near boundary, number of orbital in band, metals and insulators.

Homogeneous Semiconductors: Band gap, equation of motion, effective mass, physical interpretation of the effective mass, effective masses in semiconductors, silicon and germanium, intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor states, acceptor states, thermal ionization of donors and acceptors, thermoelectric effects, semimetals, superlattices.

Recommended Books:

- Ibach, H., & Lüth, H. (2009). *Solid-state Physics: an introduction to principles of materials science*. Berlin: springer.
- Madelung, O. (2012*). Introduction to solid-state theory (Vol. 2).* Springer Science & Business Media.
- Mihály, L., & Martin, M. C. (2009). *Solid State Physics*. John Wiley & Sons.
- Kittel, C. (2005). *Introduction to solid state Physics.* Wiley.
- Omar, M. A. (1993). *Elementary solid state Physics: principles and applications*.
- Addison-Wesley Ashcroft, N. W., & Mermin, N. D. (2005). *Solid State Physics*, Publishing Asia Ltd.

Course Title: **Relativity and Cosmology**

Course Code: **PHYS4115**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Basic features of special relativity and geometric structure of space time and the relativistic kinematics and
- Einstein's general theory of relativity, the structure of Riemannian geometry, applications of general relativity in cosmology and basic theories of origin and evolution of the universe.

Course Outline:

Relativity: Special Relativity, Galilean relativity, concept of ether, Michelson-Morley experiment, Einstein's postulates of special relativity, Lorentz transformations, structure of space-time, Minkowski space-time tensors, the light-cone, line element, four-vectors, relativity of simultaneity, time dilation, proper time, length contraction, twin paradox, velocity transformation and velocity addition. Relativistic Mechanics, Force equation in relativity, rest mass, kinetic and total energy, conservation of energy and momentum.

Elements of Tensor Calculus: Manifolds and coordinates curves and surfaces, tensor fields, geodesics, Riemann tensor, metric tensor, Einstein's tensor, relativistic electrodynamics.

General Relativity: Principles of general relativity, equation of geodesics deviation, Einstein's field equations.

Cosmology: Newtonian cosmology, cosmological red shift, Hubble's law, microwave background, the Big Bang, FRW metric, density parameter.

Recommended Books:

- Macomb, W. D. (1999). *Dynamics and Relativity*, Oxford University Press.
- Narlikar, J. V. (1989). *Introduction to Cosmology*, Cambridge University Press.
- Inverno, R. D. (1992). *Introducing Einstein's Relativity*, Oxford University Press.

Course Title: **Particle Physics**

Course Code: **PHYS4124**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Basic concepts of particle physics and relativistic quantum mechanics.
- Elementary concepts of particle physics such as their classification symmetries and the fundamental interactions and able to do calculations of scattering cross-sections of different processes.

Course Outline:

Particle Classification: Quantum numbers, leptons, hadrons, baryons, mesons, quarks. 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, iso-spin charge conjugation, time reversal, G parity, CPT theorem.

The Electromagnetic Field: Gauge invariance and Maxwell's equations, angular momentum, parity and C parity of the photon.

The Klein-Gordon Equation: Non relativistic quantum mechanics, Lorentz covariance

And 4 vector notation, the Klein Gordon equation, the Feynman-Stuckelberg interpretation of $E < 0$ solutions, non relativistic perturbation theory (brief review), and rules for scattering amplitudes in the Feynman-Stuckelberg approach.

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 covariants, zero mass fermion, the two-component neutrino, Standard Model and Quark Model

Recommended Books:

- Bjorken, J. D. & Darrel, S. D. (1964). *Relativistic Quantum Mechanics*, McGraw-Hill, International Edition.
- Halzen, F. and Martin, A.D. (1984). *Quarks and Leptons*, John-Wiley and Sons.
- Riazuddin and Fayazudin (1990). *Quantum Mechanics*, World Scientific.
- Griffiths, D. (1987). *Introduction to Elementary Particles*, John-Wiley and Sons.

Course Title: **Experimental Nuclear Physics**

Course Code: **PHYS4116**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Nuclear detection system and techniques for their measurements
- Charged particles accelerators and nuclear reactors

Course Outline:

Nuclear Radiation Detection and Measurement: Interaction of nuclear radiation with matter, photographic emulsions, gas-filled detectors, Scintillation counters and solid states detectors, Cloud Chambers, Bubble Chambers

Charged Particle Accelerators: Linear and Orbital accelerators Van de Graaff, Cyclotron, Betatron, Synchrocyclotron; Electron-Synchrotrons, Proton-Synchrotrons, Alternating-gradient Synchrotron

Elementary Reactor Physics: Controlled fission reactions, types of nuclear reactors (Power and research), and detailed study of PWR and CANDU type reactors

Recommended Books:

- Knoll, G. F. (2010). *Radiation detection and measurement*. John Wiley & Sons.
- Leo, W. R. (2012). *Techniques for nuclear and particle physics experiments: a how-to approach*. Springer Science & Business Media.
- Elton, L. R. B.(1961). *Nuclear Sizes*. London: Oxford University Press.
- Krane, K. S. (1987). *Introductory Nuclear Physics*.

Course Title: **LASERS**

Course Code: **PHYS4125**

Credit Hours: **3**

Objectives:

The students will be able to understand:

- Fundamental concept of LASERS.
- Principles of spectroscopy of molecules and semi-conductors.
- Optical resonators and laser system.
- Applications of lasers.

Course Outline:

Introductory Concepts: Spontaneous emission, absorption, stimulated emission, pumping schemes, absorption and stimulated emission rates, absorption and gain coefficient, resonance energy transfer, Properties of laser beams

Spectroscopy of molecules and semiconductors: Electronic energy level, molecular energy levels, level occupation at thermal equilibrium, stimulated transition, selection rules, radiative and non-radiative decay, semiconductor

Optical resonators: Plane parallel resonator, concentric resonator, Confocal, resonator, Generalized spherical resonator, ring resonator, stable resonator, unstable resonator, matrix formulation of geometrical optics

Pumping processes: Optical pumping, flash lamp and lasers, threshold pump power, pumping efficiency, electrical pumping: longitudinal and transverse configuration

Continuous waves and pulsed lasers: Rate equations, threshold condition and output power, optimum output coupling, laser tuning, oscillation and pulsation in lasers

Laser systems: Solid state lasers, semiconductor lasers, double-hetero structure lasers, gas lasers, excimer lasers, laser applications

Recommended Books:

- Bjorken, O. S. (1992). *Principles of LASERS*, New York London.
- Milonni, P. W., Shih, M. L., & Ackerhalt, J. R. (1987*). Chaos in LASER-matter interactions (Vol. 6)*. Singapore: World Scientific.
- Haken, H. (1970). *LASER theory*, Springer Berlin Heidelberg.

Course Title: **Methods of Experimental Physics**

Course Code: **PHYS4118**

Credit Hours: **3**

Objectives:

The main objectives of this course are;

- To learn about the vacuum techniques.
- To learn the detection techniques about radiation, temperature.
- To learn about the measuring techniques along with data analysis.

Course Outline:

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, xrays/ 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:

- F. James. (2006). *Statistical Methods in Experimental Physics*. 2nd edition. World Scientific Company.
- M. H. Hablanian. (1997). *High-Vacuum Technology*, 2nd edition. Marcel Dekker.
- P. Bevington and D. K. Robinson. (2002). *Data Reduction and Error Analysis for Physical Science.* 3rd edition. McGraw-Hill.
- S. Tavernier. (2010). *Experimental Techniques in Nuclear and Particle Physics.* Springer.
- J. B. Topping. (1972). *Errors of Observations and Their Treatment*. 4th edition. Springer.

Course Title: **Environmental Physics**

Course Code: **PHYS4117**

Credit Hours: **3**

Objectives:

The main objectives of this course are;

- To become familiar with the essentials of environment and global climate.
- To learn to use spectroscopy for environments.

Course Outline:

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.

Recommended Books:

- E.t Booker & R. Van Grondelle, (2011). *Environmental Physics*, 3rd edition. John Wiley.
- G. Guyot. (1998). *Physics of Environment and Climate*. John Wiley.

Course Title: **Fluid Dynamics**

Course Code: **MATH 4136**

Credit Hours: **3**

Objectives:

The main objectives of this course are;

- To get physical understanding of fluid dynamics.
- To understand Phenomenological introduction to fluid dynamics

Course Outline:

Introduction: Kinematics and conservation laws, Ideal fluids, the Euler equations, ir-rotational 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:

- D. J. Acheson. (1990). *Elementary Fluid Dynamics.* Oxford University Press.
- P. K. Kundu and I.M. Cohen. (2010). *Fluid Mechanics*. 4th edition. Academic Press.
- D. J. Tritton. (1988). *Physical Fluid Dynamics*. 2nd edition. Clarendon.
- L. D. Landau & E. M. Lifschitz, (1987) *Fluid Mechanics*, 2nd edition. Butterworth- Heinemann.

Course Title: **Introduction to Material Sciences**

Course Code: **PHYS4126**

Credit Hours: **3**

Objectives:

The main objectives of this course are;

- To understand the important aspects of materials.
- To get knowledge of microstructures.

Course Outline:

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:

- W. D. Callister. (2006). *Materials Science and Engineering: An Introduction*, 7th edition. Wiley.
- W. D. Callister & D. G. Rethwisch. (2012). *Fundamentals of Materials Science and Engineering: An Integrated Approach*. 4th edition. Wiley.
- J. F. Shackelford. (2008). *Introduction to Materials Science for Engineers*. 7th edition. Prentice Hall.
- http://www.msm.cam.ac.uk/teaching/index.php,
- http://www.doitpoms.ac.uk/

Course Title: **Introduction to Nano Technologies**

Course Code: **PHYS4127**

Credit Hours: **3**

Objectives:

The aim of this course is

- To understand the concept of nano sciences
- To become familiar with the applications of nano sciences.

Course Outline:

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.

Recommended Books:

- S. Lindsay. (2009). *Introduction to Nanoscience*. Oxford University Press.
- C. Binns. (2010). *Introduction to Nanoscience and Nanotechnology (Wiley Survival Guides in Engineering and Science).* Wiley.

Course Title: **Introduction to Photonics**

Course Code: **PHYS4128**

Credit Hours: **3**

Objectives:

The main objective of this course is;

- To study the application of light, Studying the photonic devices including Detectors.

Course Outline:

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:

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