UNDERGRADUATE PROGRGAMME

SYLLABUSES

DEPARTMENT OF PHYSICS

SEMESTER SYSTEM BATCH: 2014 to 2017

First Year

Second Year

Third Year

Fourth Year

Department of Physics, NED University of Engineering &Technology, Karachi.

SCHEME OF STUDIES

BS APPLIED PHYSICS BATCH 2014 to 2017							
FIRST YEAR							
Fall Semester				**Spring Semester**			
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours		

Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
HS-105 OR HS-127	Pakistan Studies OR Pakistan Studies (For Foreigners)	2	0	2	HS-104	Functional English	3	0	3
CS-101	Introduction to Computer	2	1	3	MT-227	Differential Equations	3	0	3
MT-173	Calculus	3	0	3	EL-255	Programming Language	2	1	3
PH-101	Mechanics & Properties of Matter	3	0	3	PH-104	Waves & Oscillations	2	0	2
PH-102	Heat & Thermodynamics	2	0	2	PH-105	Electricity & Magnetism	3	0	3
CY-115	General Chemistry-I	2	1	3	PH-106	Physics Lab-II	0	1	1
PH-103	Physics Lab-I	0	1	1	CY-116	General Chemistry-II	2	1	3
	TOTAL CREDITS	14	3	**17**		**TOTAL CREDITS**	15	3	**18**

SECOND YEAR									
Fall Semester					**Spring Semester**				
Course Code	Course Title	Th	Pr	Total	Course Code	Course Title	Th	Pr	Total
HS-205 OR HS-206	Islamic Studies OR Ethical Behaviour	2	0	2	PH-205	Classical Mechanics	3	0	3
HS-201	Oral Communication	2	1	3	MT-272	Linear Algebra & Geometry	3	0	3
PH-201	Optics	2	0	2	MT-331	Probability & Statistics	3	0	3
PH-202	Modern Physics	3	0	3	MT-228	Complex Variables & Fourier Transforms	3	0	3
PH-203	Physics Lab-III	0	1	1	EL-238	Digital Electronics	3	1	4
PH-204	Introduction to Material Science	3	0	3	HS-301	Business & Organizational Communication	3	0	3
EL-232	Electronics	3	1	4					
	TOTAL CREDITS	15	3	**18**		**TOTAL CREDITS**	18	1	**19**

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Scheme of Studies 2014 to 2017

THIRD YEAR										
Fall Semester						**Spring Semester**				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours			
		Th	Pr	Total			Th	Pr	Total	
PH-301	Quantum Mechanics-I	3	0	3	PH-306	Statistical Mechanics	3	0	3	
PH-302	Laser Engineering	3	0	3	PH-307	Mathematical Physics –II	3	0	3	
PH-303	Mathematical Physics-I	3	0	3	PH-308	Quantum Mechanics-II	3	0	3	
PH-304	Electromagnetic Theory-I	3	0	3	PH-309	Electromagnetic Theory-II	3	0	3	
PH-305	Vacuum Science	3	0	3	PH-310	Solid State Physics-I	3	0	3	
	TOTAL CREDITS	15		**15**		**TOTAL CREDITS**	15		**15**	

FOURTH YEAR										
Fall Semester						**Spring Semester**				
Course Code	Course Title	Credit Hours			Course Code	Course Title	Credit Hours			
		Th	Pr	Total			Th	Pr	Total	
PH-401	Computational Physics	3	0	3	##-##	Elective-1	3	1	4	
PH-402	Atomic & Molecular Physics	3		3	##-##	Elective-2	3	1	4	
PH-403	Solid State Physics-II	3	0	3	##-##	Elective-3	3	1	4	
PH-404	Nuclear Physics	3	0	3	PH-407	Applied Physics Project	0	6	6	
PH-405	Introduction to Nanoscience and Nanotechnologies	2	0	2						
PH-406	Surface Science	3	1	4						
PH-407	*Applied Physics Project									
	TOTAL CREDITS	17	1	**18**		**TOTAL CREDITS**	9	9	**18**	
Total Credit Hours = 138										

Elective Courses (for Material Group)				
Course Code	Course Code	Credit Hours		
		Th	Pr	Total
MM-401	Material Characterization Techniques	3	1	4
MM-406	Electronic, Magnetic and Optical Materials	3	1	4
MM-408	High Temperature Materials and Superalloys	3	1	4
Total		**9**	**3**	**12**

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Course Code	Elective Courses (for Electronic Group)			
	Course Code	Credit Hours		
		Th	Pr	Total
EL-484	Optoelectronics and Microwave Systems	3	1	4
EL-304	Industrial Electronics	3	1	4
EL-433	Solid State Devices	3	1	4
Total		**9**	**3**	**12**

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First Year

PH-101 Mechanics and Properties of Matter

Units and Dimensions, SI Units, Changing Units, Scalars and Vectors, Adding Vectors: Graphical as well as Component Method, Multiplying Vectors: Dot and Cross Products, Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames, Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Gravitational Potential Energy, Escape Velocity, Kepler's Laws, Satellite Orbits & Energy, Work done by Constant and Variable Forces: Gravitational and Spring Forces, Power, Conservative and Nonconservative Forces, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy, Motion of a System of Particles and Extended Rigid Bodies, Centre of Mass and Newton's Laws for a System of Particles, Linear Momentum, Impulse, Momentum & Kinetic Energy in One and Two Dimensional Elastic and Inelastic Collisions, Rotation about a Fixed Axis, Angular Position, Angular Displacement, Angular Velocity and Angular Acceleration, Rotation under Constant Angular Acceleration, relationship between Linear and Angular Variables, Rotational Inertia, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Work and Rotational Kinetic Energy, Power, Rolling Motion, Angular Momentum for a single Particle and a System of Particles, Conservation of Angular Momentum, Precession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes i.e. for disc, bar and solid sphere, Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum, Elastic Properties of Matter, Physical basis of elasticity, Tension, Compression & shearing, Elastic Modulus, Elastic limit. Poisson's ratio, Relation between three types of elasticity, Fluid Statics, Variation of Pressure in fluid at rest and with height in the atmosphere, Surface Tension, Physical basis; role in formation of drops and bubbles, Viscosity, Physical basis, obtaining the Coefficient of viscosity, practical example of viscosity; fluid flow through a cylindrical pipe (Poiseulle's law).

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.

2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.

3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.

4. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

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PH-102 Heat & Thermodynamics

Thermodynamical systems, Surrounding and Boundaries, Type of systems, Macroscopic and microscopic description of system, Properties and state of the substance, Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium, Processes and Cycles, Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium, Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Internal energy of an ideal gas, Equipartition of Energy, Intermolecular forces, The Virial expansion, The Van der Waals equation of state, First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible processes, Second law of thermodynamics, Carnot theorem and Carnot engine, Heat engine, Refrigerators, Calculation of efficiency of heat engines. Thermodynamic temperature scale, Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and second law of thermodynamics, Entropy and Probability, Thermodynamic potentials, Maxwell's relations, TdS equations. Energy equations and their applications, Intrinsic and mutual stabilities of single component system, Conditions of stabilities, The Le Chatelier-Braun Principle, Phase transitions (latent heat), First order Phase transition, Discontinuities of Volume and Entropy, Second Order Phase Transition, Low Temperature Physics, Joule-Thomson effect and its equations, Thermocouple, Seebeck's effect, Peltier's effect, Thomson effect, Statistical distribution and mean values, Mean free path and microscopic calculations of mean free path. Distribution of Molecular Speeds, Distribution of Energies, Maxwell distribution, Maxwell Boltzmann energy distribution, Internal energy of an ideal gas, Brownian Motion and Langevin equation, Qualitative description.

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010.

2. M. W. Zemansky, "Heat and Thermodynamics", McGraw Hill, 7th ed. 1997.

3. M. Sprackling, "Thermal Physics" McMillan 1991.

4. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics, London 1995.

PH-103 Physics Lab-I

Experiments on Mechanics, Heat and Thermodynamics will be conducted. (See Appendix-A for list of experiments)

Recommended Books:

1. E. H. Barton, An Introduction to Practical Physics, General Books LLC, 2010

2. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind. 1995.

3. Nelkon and Ogborn, Advanced Level Practical Physics, Heimann Educational Books, 1978.

4.   D. H. Marrow, Selected Experiments in Physical Sciences, Longman. 1974.

PH-104 Waves and Oscillations

Mass-Spring System, Simple Harmonic Oscillator Equation, Complex Number Notation, LC Circuit, Simple Pendulum, Quality Factor, LCR Circuit, Steady-State Behaviour, Driven LCR Circuit, Transient Oscillator Response, Resonance, Two Spring-Coupled Masses, Two Coupled LC Circuits, Three Spring Coupled Masses, Normal Modes, Atomic and Lattice Vibrations, Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity, Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas, Standing Waves in a Finite Continuous Medium, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Transmission Lines, Reflection and Transmission at Boundaries, Fourier Series and Fourier Transforms, Bandwidth, Plane Waves, Three-Dimensional Wave Equation, Electromagnetic waves, Laws of Geometric Optics, Waveguides, Cylindrical Waves, Double-Slit Interference, Single-Slit Diffraction, Double-slit diffraction.

Recommended Books:

1.   J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed. 2005.

2.   A. P. French, "Vibrations and Waves", CBS Publishers (2003).

3.   A. Hirose, and K.E. Lonngren, "Introduction to Wave Phenomena", Krieger Publications, 2003.

PH-105 Electricity and Magnetism

Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to a Charge Distribution, Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry, Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and , Electric Potential, Energy, Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in an Electric Field, Dielectrics and Gauss' Law , Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, Semiconductors and Superconductors, Work, Energy, and EMF, Resistances in Series and Parallel, Single and Multiloop Circuits, Kirchhoff's Rules, RC Circuits, Charging and Discharging of a Capacitor, Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot-Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole, Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self-Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction, LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents,

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

Recommended Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.

2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.

3. R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.

4. F. J Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.

5. D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

PH-106 Physics Lab II

Experiments on Waves, Oscillation, Electricity and Magnetism will be conducted. (See Appendix-B for list of experiments)

Recommended Books:

1. E. H. Barton, An Introduction to Practical Physics, General Books LLC, 2010

2. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind. 1995.

3. Nelkon and Ogborn, Advanced Level Practical Physics, Heimann Educational Books, 1978.

4. D. H. Marrow, Selected Experiments in Physical Sciences, Longman. 1974.

HS-105 Pakistan Studies

Historical and ideological perspective of Pakistan Movement, Two Nation Theory, Definition: Claim of Muslims of being a separate nation from Hindus, based upon cultural diversity, Significance: Cultural diversity and interests led to the demand of Pakistan – Lahore resolution, Creation of Pakistan, Factors leading to the creation of Pakistan, Quaid-e-Azam and the demand of Pakistan, Land of Pakistan, Geo-physical conditions, Geo-political and strategic importance of Pakistan, Natural resource, viz: mineral, water and power, Constitutional Process, Early efforts to make a constitution (1947-1956) problems and issues, Salient features of the constitution of 1956

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and its abrogation., Salient features of the constitution of 1962 and its abrogation, Constitutional and political crisis of 1971, Salient features of the constitution of 1973, Constitutional developments since 1973 to date with special reference to the amendments to the constitutions, Contemporary issues in Pakistan, A brief survey of Pakistan Economy, An overview of current economic situation in Pakistan; problems, issues and future prospects, Social Issues, Pakistani Society and Culture-Broad features, Citizenship: national and international, Literacy and education in Pakistan: problems and issues, State of Science and Technology in Pakistan: A comparison with other countries with special reference to the Muslim world, Environmental Issues, Environmental pollution and its hazards: causes, and solutions, Environmental issues in Pakistan: government policies and measures and suggestions for improvement, Pakistan's role in the preservation of nature through international conventions / treaties, Pakistan's Foreign Policies, Evolution of Pakistan foreign policy-1947 to date, A brief survey of Relation with Neighbours, Super Powers & the Muslim World, Human Rights, Conceptual foundations of Human Rights, What are Human Rights? Definition, origins & significance, Comparative analysis of Islamic and Western Perspectives of Human rights, UN System for protection Human Rights, UN Charter, International Bill of Human Rights – an overview, Implementation mechanism, Other important international treaties and conventions, The convention on the elimination of all forms of discrimination against Women (CEDAW), International convention on the rights of child (CRC), Convention against torture (CAT), Other treaties and Convention, Pakistan's response to Human Rights at national and international levels, Constitutional Provisions, Pakistan's Obligations to international treaties and documents, Human Rights issues in Pakistan- a critical analysis, Pakistan's stand on violation of Human Rights in the international perspective.

Recommended Books:

1. Rafi Raza, Pakistan in Perspective 1947-1997

2. Sharif-ul-Mujahid, The Ideology of Pakistan

3. N. Sethi, The Environment of Pakistan

4. Ziring Lawrence, Pakistan in the Twentieth Century

5. Parvez Hoodbhoy, State and Education

6. Burke S. M. & Ziring Lawrence, Pakistan's Foreign Policy

7. Dr. Ishrat Hussain, Pakistan - The Economy of an Elitist State

8. Pakistan Almanac

HS-127 Pakistan Studies for Foreign Students (Alternate Course to Hs-105)

Land of Pakistan, Land & People, Strategic importance, Important beautiful sights, Natural resources, A brief Historical background, A brief Historical survey of Muslim community in the sub-continent, British rule & its impacts, Indian re-action, Two nation theory – Origin & development, Factors leading towards the demand of a separate Muslim state, Creation of Pakistan, Government & Politics in Pakistan, Constitution of Pakistan – A brief outline, Governmental

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structure – Federal & Provincial, Local Government Institutions, Political History – A brief account, Pakistan & the Muslim World, Relations with the Muslim countries, Language and Culture, Origins of Urdu Language, Influence of Arabic & Persian on Urdu Language & Literature, A short history of Urdu literature.

Recommended Books:

1. M. Ikram Rabbani, Pakistan Affairs, 8th Ed., 2005, Carvan Enterprises

2. Victoria Schofield, Old Roads - New Highways 50 years of Pakistan, 1997, Oxford University Press

CS-101 Introduction to Computers

Structure and organization of Computers and Computer Systems, Computer Peripherals, Introduction to Software development process, Modular decomposition, Introduction to common Software packages and their applications, Programming languages and their comparative study, High level and low-level languages, Introduction to data communication, LAN and WAN, Introduction to operating systems. The practical work will base on the above course.

CY-115 General Chemistry-I

Atomic and molecular structure, States of matter, Atomic theory, Periodic Table, Periodicity Electromagnetic spectrum and radiant energy, Quantum mechanics, Bohr Atomic model, Orbitals, electron spin and electronic configuration ,Lewis Structures, Octet Rules, Ionic, Covalent and Metallic Bonding, Valence Bond and Molecular Orbital Theory, Resonance Forms, Electronegativity, polarity and dipole moments, Types of reactions, Balancing, Types of solutes (ionic and molecular); electrolytes Solubility rules, Molecular and ionic equations, Conversion of and conservation of matter and energy, Empirical and molecular formulae, Reactant and product calculations, yields, Characteristics and properties of gases, Gas laws, Ideal vs. Real gases, Kinetic-molecular theory Dalton's laws of partial pressures, Diffusion, effusion and Graham's Law, Liquefaction of gases. Liquids and Solids: Kinetic-molecular description of liquids and solids, Intermolecular forces and their effects on liquid properties, Bulk properties of liquids and solids, Vapor pressures and phase changes, Phase diagrams. Energy and chemical changes/reactions, Enthalpy and heats of reaction Hess's Law, calorimetry. Redox reactions, Electrochemical Cells, Electrode potential, Emf of the Cell, Standard Electrode Potentials, Electrochemical Series, Fuel Cells, Electrolytic Cells, Faraday's Laws of Electrolysis, Corrosion of metals, Prevention of Corrosion.

Recommended Books:

1. Atkins, P.W. Physical Chemistry, 7thed.; Oxford University Press, Oxford, 2003.

2. Hill J.W. Petrucci R. H. General Chemistry, 8thed.; Prentice Hall: New jersey, 2002.

3. Shriver, D.F. Atkins, P.W. Langford, C.H. Inorganic Chemistry, Oxford University Press, Oxford, UK, 1990

CY-116 General Chemistry-II

Properties of simple mixtures/solutions, Concentration terms, The thermodynamic description of mixtures, Partial molar quantities, The chemical potential of liquids, Ideal solutions, Raoult's law, The properties of solutions: liquid mixtures, elevation of boiling point, depression of freezing point, solubility, Osmosis and Osmotic pressure, solvent and solute activity, Vant Hoff's theory of dilute solutions, Colloids, Spontaneous chemical reactions and equilibrium, Properties of equilibrium state, Le Chatelier's Principle, the reaction quotient, Relationship between K_c and K_p, Heterogeneous equilibria, The nature of solubility equilibria, Distribution law, Application of the distribution law to the selected systems like solvent extraction, Extraction of metals from their ore, Investigation of complex ions, Chromatography. Zeroth, first and second laws of thermodynamics, state functions, thermodynamic reversibility and irreversibility, Work done and the change of internal energy during isothermal expansion of an ideal gas, Change of internal energy due to heat transfer at constant volume and constant pressure. Heat capacities of a gas at constant volume and constant pressure, Arrhenius and Bronsted theories of acids and bases, Self-Ionization of water, pH scale, K_w, Strong and Weak Acids and Bases, K_a and K_b, Common Ion Effect in acid base Equilibria, Buffer Solutions, Solubility Equilibria, Lewis Acids and Bases, Hard and Soft Acids and Bases.The covalent bond, Hybridization, Stereoisomerism (optical/cis-trans isomerism), Alcohols (oxidation, esterification, ether formation), Aldehydes & ketones (oxidation, reduction, hemiacetal and acetal formation, aldol condensation), Carboxylic acids (reduction, ester formation, acid anhydride formation, salt formation, amide formation), Amines, Metallic, Polymers (natural and synthetic), Biomaterials (composite, metallic, ceramics, polymeric & biological).

Recommended Books:

1. Hill J.W.; Petrucci R. H. General Chemistry, 8thed.; Prentice Hall: New jersey, 2002.

2. Solomons, T.W.G. Organic Chemistry, 5th ed.; John Wiley and Sons Inc. New York,1992.

3. Morrison, R.T.; Boyd, R. N. Organic Chemistry, 6th ed.; Prentice-Hall of India Pvt. Ltd, New Delhi, 1992.

MT–173 Calculus

Vectors: Review of vectors, Vector derivatives. Line and surface Integrals. Gradient of a Scalar.

Complex Number: Argand diagram, De Moivre formula, roots of polynomial equations, curve and regions in the complex plane, standard functions, and their inverses (exponential, circular and hyperbolic functions).

Limits and Continuity: Bounds and bounded sets, Limit point of sets, Sequence, Convergence of sequences monotonic sequences, Function and their graph, limit of function and continuous functions.

Differential Calculus: Differentiation and Successive differentiation and its application; Leibnitz theorem, Taylor and Maclaurin theorems with remainders in Cauchy and Lagrange form, Taylor and Maclaurin series, L'Hopitals Rule, extreme values of a function of one variable using first and

second derivative test, asymptotes of a function, curvature and radius of curvature of a curve, partial differentiation, exact differential and its application in computing errors, Multivariate functions, Maxima and Minima for multivariate functions, Maxima Minima under certain conditions (Language Multiplier).

Integral Calculus: Indefinite integrals and their computational techniques, reduction formulae definite integrals and their convergence, Beta and Gamma functions and their identities, double and triple integration with applications. (Area, Volume, centroid, inertia, arc length).

Vector Algebra: Scalar and Vector quantities, physical and geometrical meanings, Algebra of vectors, Scalar and Vector triple products.

Recommended Books:

1. "Engineering Mathematics", Anthony Croft, Robert Davison and Martin Hargeaves, Pearson Education Limited, 3rd Edition, 2001.

2. "Calculus", Thomas & Finney, 3rd Edition, Addison Wesley Longman, 2006.

3. "Engineering Mathematics", K.A. Stroud and Dexter J. Booth, 6th Edition, Industrial Press, 2007.

4. "Calculus and Analytical Geometry", Howard Anton, John Wiley & Sons Inc, 5th Edition, 1998.

5. "Complex Analysis for Mathematics and Engineering", John H. Mathews, Jones and Bartlett Publishers Inc. 5th Edition, 2006.

MT-227 Differential Equations

1st Order Differential Equations: Basic concept; Formation of differential equations and solution of differential equations by direct integration and by separating the variables; Homogeneous equations and equations reducible to homogeneous from; Linear differential equations of the order and equations reducible to the linear form; Bernoulli's equations. Application in relevant Engineering: orthogonal trajectories: Numerical approximation to solutions; Solution in series. Euler method, Euler modified method, RungeKutta method of order 4

2nd and Higher Order Equations: Special types of 2nd order differential equations with constant coefficients and their solutions; The operator D; Inverse operator I/D; Solution of differential by operator D methods; Special cases, Cauchy's differential equations; Simultaneous differential equations; simple application of differential equations in relevant Engineering.

Partial Differential Equation: Basic concepts and formation of partial differential equations; Linear homogeneous partial differential equations and relations to ordinary differential equations; Solution of first order linear and special types of second and higher order differential equations; D' Alembert's solution of the wave equation and two-dimensional wave equations; Lagrange's solution: Various standard forms.

Laplace Integral& Transformation: Definition, Laplace transforms of some elementary functions, first translation or shifting theorem, second translation or shifting theorem, change of scale property, Laplace transform of the nth order derivative, initial and final value theorem Laplace transform of integrals. Laplace transform of functions tn F(t) and F(t)/ t, Laplace transform of periodic function, evaluation of integrals, definition of inverse Laplace transforms and inverse transforms, convolution theorem, solutions of ordinary differential using Laplace transform.

EL-255 Programming Language

Turbo C Programming environment, Setting up the Integrated Development Environment, File used in C program development, The basic structure of C program, the printf() function, C building blocks, Variables, input/output operators, comments, Loops, the for loop, the while loop, the do while loop, decisions, the if statement, the if-else statement, the else-if construct, The switch statement, the conditional, operator, Functions, simple functions, functions that return a value, using arguments to pass data to a function, using more than one functions, Pre-processor directives, Arrays and Strings, Arrays, Referring to individual elements of the array, String, String functions, Multidimensional, arrays, Pointers, Pointer overview, Returning data from functions, Pointers and array, Pointers and Strings, Structure, Unions and ROM BIOS, Graphics functions and files.

Second Year

PH-201 Optics

Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface, Thin Lenses, Newtonian Equation for a Thin Lens, Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points of an Optical System with examples, Optical Instruments including Simple Magnifiers, Telescopes and Microscopes, Chromatic and Monochromatic Aberrations, Spherical Aberrations, Coma, Distortion, Stops, Pupils, Windows, Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple-Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range, Linear, circular and elliptical polarization, Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction, Electro-optic and magneto-optic effects, Fraunhofer Diffraction from a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings, Zone Plates, Rectangular Apertures, Temporal Coherence, Spatial Coherence, Holography of a Point object and an Extended Objects, Stimulated Emission, Population Inversion, Resonators, Threshold and Gain, Multilayered Dielectric Films.

Recommended Books:

1. C. A. Bennett, "Principles of Physical Optics", John Wiley, 2008.

2. F. Pedrotti, L. S. Pedrotti and L. M. Pedrotti, "Introduction to Optics", Pearson Prentice Hall, 3rd ed. 2007.

3. E. Hecht and A. Ganesan, "Optics", Dorling Kindersley, 4th ed. 2008.

4. K. K Sharam, "Optics: Principles and Applications", Academic Press, 2006.

5. M. V. Klein and T. E. Furtak, "Optics", John Wiley, 2nd ed. 1986.

PH-202 Modern Physics

Black body radiation, Stefan Boltzmann, Wien's and Planck's law, consequences. The quantization of energy, Photoelectric and Compton effect, Line spectra, Explanation using quantum theory. Wave behaviour of particle (wave function etc.) its definition and relation to probability of particle, de 'Broglie hypothesis and its testing, Davisson Germer Experiment and J.P. Thomson Experiment, Wave packets and particles, localizing a wave in space and time, Bohr's theory (review), Frank-Hertz experiment, energy levels of electron, atomic spectrum, Angular momentum of electrons, Vector atom model, Orbital angular momentum. Spin quantization, Bohr's Magnetron. X-ray spectrum (continuous and discrete) Moseley's law, Pauli's exclusion principle and its use in developing the periodic table.

Recommended Books:

1. Paul A. Tipler and Ralph A. Llewellyn, "Modern Physics", W H Freeman and Company 6th ed. 2012.

2. R.A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", Brooks Cole, 3rded. 2004.

3. R. M. Eisberg and R. Resnick, "Quantum Physics of Atoms, molecules, Solids, Nuclei and Particles", John Wiley, 2nd ed. 2002.

4. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th ed. 2002.

PH-203 Physics Lab-III

Experiments on Optics and Modern Physics will be conducted. (See Appendix-C for list of experiments)

Recommended Books:

1. E. H. Barton, An Introduction to Practical Physics, General Books LLC, 2010.

2. Nolan and Bigliani, Experiments in Physics, Surjeet Pub Ind. 1995.

3. Nelkon and Ogborn, Advanced Level Practical Physics, Heimann Educational Books, 1978.

4. D. H. Marrow, Selected Experiments in Physical Sciences, Longman. 1974.

PH-204 Introduction to Material Science

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, Vacancies, impurities, dislocations, interfacial defects, bulk or volume defects, atomic vibrations, 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, 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, Polymer basics, polymer identification, polymer molecules, additional polymerization, step growth polymerization, measurement of molecular weight, thermosetting polymers and gels,

Department of Physics, NED University of Engineering &Technology, Karachi.

rubbers and rubber elasticity, configuration and conformation of polymers, the glassy state and glass transition, determination of T_g effect of temperature and time, mechanical properties of polymers, case studies in polymer selection and processing, Introduction to biomaterials, materials selection, biopolymers, structural polysaccharides, hard materials, biomedical materials.

Recommended Books:

1. W. D. Callister and D. G. Rethwisch "Fundamentals of Materials Science and Engineering: An Integrated Approach", Wiley, 4th ed. 2012.

2. J. F. Shackelford, "Introduction to Materials Science for Engineers", Prentice Hall, 7th ed. 2008.

3. W. D. Callister, "Materials Science and Engineering: An Introduction", Wiley, 7th ed. 2006.

PH-205 Classical Mechanics

Conservative Forces, Conservation of Energy, Motion near Equilibrium; the Harmonic Oscillator, Complex Representation, The Law of Conservation of Energy, The Damped Oscillator, Oscillator under Simple Periodic Force, General Periodic Force, Impulsive Forces, the Green's Function Method, Collision Problems, Energy, Conservative Forces, Projectiles, Moments, Angular Momentum, Central Forces; Conservation of Angular Momentum, Polar Co-ordinates, The Calculus of Variations, Hamilton's Principle; Lagrange's Equations, The Isotropic Harmonic Oscillator, The Conservation Laws, The Inverse Square Law, Orbits, Scattering Cross-sections, Mean Free Path, Rutherford Scattering, Angular Velocity, Rate of Change of a Vector, Particle in a Uniform Magnetic Field, Acceleration; Apparent Gravity, Coriolis Force, Larmor Effect, Angular Momentum and the Larmor Effect, Gravitational and Electrostatic Potentials, The Dipole and Quadrupole, Spherical Charge Distributions, Expansion of Potential at Large Distances, The Shape of the Earth, The Tides, The Field Equations, Centre-of-mass and Relative Co-ordinates, The Centre-of-mass Frame, Elastic Collisions, CM and Lab Cross-sections, Momentum, Centre-of-mass Motion, Angular Momentum; Central Internal Forces, The Earth–Moon System, Energy, Conservative Forces, Lagrange's Equations, Basic Principles, Rotation about an Axis, Perpendicular Components of Angular Momentum, Principal Axes of Inertia, Calculation of Moments of Inertia, Effect of a Small Force on the Axis, Instantaneous Angular Velocity, Rotation about a Principal Axis, Euler's Angles, Generalized Co-ordinates, Holonomic Systems, Lagrange's Equations, Precession of a Symmetric Top, Pendulum Constrained to Rotate about an Axis, Charged Particle in an Electromagnetic Field, The Stretched String, Small Oscillations and Normal Modes, Orthogonal Co-ordinates, Equations of Motion for Small Oscillations, Normal Modes, Coupled Oscillators, Oscillations of Particles on a String, Normal Modes of a Stretched String, Hamilton's Equations, Conservation of Energy, Ignorable Co-ordinates, General Motion of the Symmetric Top, Liouville's Theorem, Symmetries and Conservation Laws, Galilean Transformations.

Recommended Books:

1. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.

2. S.T. Thornton, J.B. Marion, "Classical Dynamics of Particles and Systems", Brooks Cole; 5th ed. 2003.

3. T. L. Chow, "Classical Mechanics", John Wiley, 1995

HS-201 Oral Communication

Foundations for Oral Communication: Introduction to communication, Model of Communication Competence, Perception, Language and Nonverbal communication, listening

Interpersonal Communication: Introducing IPC and its assumptions, Challenges, principles and ethics of IPC, Interpersonal relationships and skills, Conversation: process, management and problems, Interpersonal conflict, Pair discussion/ debate

Small Group Communication: Need and significance of small group communication. Challenges and coping strategies in small group competence, Decision making, leadership and managing relationships in small groups. Group discussion practice

Public Speaking & Technical Presentations: Introduction to public speaking, Realizing Speaking types [speaking to inform, explain or persuade], Understanding speech preparation (process and model, purpose, and thesis, gathering support materials, organizing, and outlining, and developing visual aids), Delivering speech effectively (eloquence, voice and articulation, nonverbal cues, and avoiding pitfalls), Practice in Speech and Technical Presentations

Interviewing: Types of interviews and process, Considerations & skills during interviews, preparing for effective Interviewing, Simulating Employment Interviewing

Recommended Books:

1. Human Communication (6thed) by Joseph A. Devito, Longman

2. Communicating in Business and Professional Settings (4thed) by Michael s. Hanna, McGraw Hill

3. The Perfect Presentation by Andrew Leigh and Michael Maynard, Random House.

4. Human Communication: Motivation, knowledge, and skills. By Sherwyn P. Morreale, Brian H. Spitzberg, & J Kevin Barge, Wadsworth, Thomson Learning USA

5. Process & product Approach to Business Communication by Mary Allen Guffy. Thomson Publishers

6. Business Communication Today (7th Edition) by Courtland L. Bovee& John V. Thill.Prentice Hall International Inc.

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HS-205 Islamic Studies

Quranic Verses, Tauheed: Al-Ambiya-22, Al-Baqarah - 163&164, Prophethood: Aal-e-Imran-79, Al-Hashr-7, Al-Maidah-3, Here-After: Al –Baqarah-48, and one Hadith, Basic Islamic Practices, Al-Mu' minun-1-11, and two Ahadith, Amer-Bil-Ma'Roof Wa-Nahi Anil Munkar, the concept of Good & Evil, Importance and necessity of Da'wat-e-Deen Aal-e-Imran-110, Method of Da'wat-e-Deen An-Nahl-125, Aal-e-Imran-104, and two Ahadith, Unity of the Ummah, Al-Imran-103, Al-Hujurat-10, Aal-e-Imran-64, Al-An' am –108, and two Ahadith, Kasb-e-Halal, Ta ha-81, Al-A'raf-32-33, Al-Baqarah-188, and two Ahadith, Haquq-ul-Ibad, Protection of life Al-Maidah-32, Right to Property Al-Nisa-29, Right to Respect & Dignity Al-Hujurat-11-12, Freedom of Expression: Al-Baqarah-256, Equality: Al-Hujurat-13, Economic Security: Al-Ma'arij-24-25, Employment Opportunity on Merit: An-Nisa-58, Access to Justice: An- Nisa-135, Women's Rights, An-Nahl-97, Al-Ahzab-35, An-Nisa-07, Relations with Non-Muslims, Al-Mumtahenah-8-9, Al-Anfa'al-61 and The last Sermon of Hajj of Holy Prophet (PBUH): Relevant extracts, Seerat (life) of the Holy Prophet (PBUH), Birth, life at Makkah, declaration of prophet hood, preaching & its difficulties, migration to Madina, brotherhood (Mawakhat) & Madina Charter, The Holy Wars of the Prophet (Ghazwat-e-Nabawi), Hujjat-ul-Wida, The last sermon of Khutbatulwida: Translation and important points, Islamic Civilization, In the sub-continent: pre-Islamic civilizations, The political, social & moral impacts of Islamic civilization, In the world: academic, intellectual, social & cultural impact of Islam on the world.

Recommended Books:

1. Dr. Saeedullah Qazi: Thematic study of Holy Quran & Hadith, NED University.

2. Dr. Mohsin Khan & Dr. Taqi uddin Hilali, The Nobel Quran (Quranic Translation)

3. Safi ur Rehman Mubarakpuri, The Sealed Nectar: A book on the biography of Holy Prophet (PBUH)

4. Israr ul Rehman Bukhari, Islam Kay Karhai Nomayan: A book on Islamic Civilization.

5. Tafseer Ibn-e-Kaseer (English Translation)

6. Tafseer Abdul Majid Darya Abadi (English)

7. Qazi Suleman Mansoor Puri, *Rehmat-ul-Lilalameen*

8. Arshad Bhatti, Mutaliah Tahzeeb- e- Islam

EL-232 Electronics

Conduction in Solids: Introduction, mechanics of conduction, mobility. Bohr's model for the elements, energy level diagrams for solids, conductors, intrinsic and extrinsic semiconductors, electron-hole pairs in an intrinsic semiconductor, distribution of electron and hole in conduction and valence bands, recombination, and lifetime.

Department of Physics, NED University of Engineering &Technology, Karachi.

Semiconductors and Diodes: Donor and acceptor impurities, zero biased, forward biased and reverse biased junction diodes, junction diode current equation, depletion barrier width and junction capacitance, diffusion capacitance, Zero and Avalanche break down, Hall effect, Fabrication of pn junction, diodes.

Electron Emission Devices: Types of electron emissions, thermionic diode, volt ampere characteristics, Child Langmuin Power Law, Gas filled diode, Thermionic triode, Parameters and characteristics, Tetrode, Pentode, and beam power tubes, Parameters, and characteristics.

Simple Diode Circuits and Applications: Mathematical and graphical analysis of diode circuits, The ideal and non ideal diodes, Piecewise linear models, Analysis of piecewise linear models of vacuum tube and junction diodes, The half wave rectifier. The inductance filter, the inductance capacitance filter circuits, Zener and gas diode, Voltage regulator circuits, Clamping and DC restorer circuits, Voltage doubler circuits, Clipping and limiting circuits.

Bipolar and Field Effect Transistors: Transistor biasing and thermal stabilization, The operating point, Bias stability, Collector to base bias, Fixed bias, Emitter feedback bias, Stabilization for the self biased circuits, Field effect transistors, Basic principles and theory, Types, FET characteristics, Different configurations-common gate, Common source and common drain, The FET, small signal model, Parameters, Biasing of the FET.

Amplifier Circuits: Introduction "h" parameters, Hybrid model for transistor, Elementary treatment, Low frequency transistor amplifier circuits, Stage cascaded LF.

EL-238 Digital Electronics

RTL and DTL circuit, Transistor-transistor logic, Integrated injection logic, MOS and CMOS, Fan in and fan out, Open collector TTL Gate, Tri state TTL gates, Schottky TTL and emitter coupled logic, non saturated logic, Combinational circuit design, A/D and D/A conversion. The practical work will be based on the above course.

MT-331 Probability& Statistics

Statistics: Introduction, Types of data & variables, presentation to data, object, classifications, Tabulation, Frequency distribution, Graphical representation, Simple & Multiple Bar diagrams, Sartorial & Pie-Diagram, Histogram, Frequency Polygon, Frequency Curves & their types.

Measures of Central Tendency and Dispersion: Statistics Averages, Median Mode, Quartiles, Range, Moments, Skew ness & Kurtosis, Quartile Deviation, Mean Deviation, Standard Deviation, Variance & its coefficient, Practical Significance in related problems.

Curve Fitting: Introduction, fitting of a first- and second-degree curve, fitting of exponential and logarithmic curves, related problems. Principle of least squares, Second order Statistics & Time series not in bit detail.

Simple Regression &Correlation: Introduction, Scatter diagrams, Correlation & its Coefficient, Regression lines, Rank Correlation & its Coefficient, Probable Error (P.E), Related problems.

Sampling and Sampling Distributions: Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors,

Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem with practical significance in related problems.

Statistical Inference and Testing of Hypothesis: Introduction, Estimation, Types of Estimates, Confidence interval, Tests of Hypothesis, Chi-square distribution/test, one tails & two tails tests. Application in related problems.

Probability: Basic concepts, Permutation & Combination, Definitions of probability, Laws of probability. Conditional probability, Baye'snile.Related problems in practical significance.

Random Variables: Introduction, Discrete & Continuous random variables, Random Sequences, and transformations. Probability distribution, Probability density function, Distribution function, Mathematical expectations, Moment Generating Function (M.G.F.), Markove random walks chain/ Related problems.

Probability Distributions: Introduction, Discrete probability distributions, Binomial Poisson, Hyper geometric & Negative binomial distributions. Continuous probability distribution, Uniform, Exponential & Normal distributions & their practical significance.

Recommended Books:

1. Advance Engineering Mathematics Erwin Kreyszig

2. Mathematical Statistics Hogg & Craig

3. Introduction to Statistics Walpole

4. Exploring Statistics Larry J. Kitchens

MT-272 Linear Algebra & Geometry

Linear Algebra: Linearity and linear dependence of vectors, basis, dimension of a vector space, field matrix and type of matrices (singular, non- singular, symmetric, non- symmetric, upper, lower, diagonal tri-diagonal matrix), Rank of a matrix using row operations and special method, echelon and reduced echelon forms of a matrix, determination of consistency of a system of linear equation using rank, transitions matrix.

Euclidean Spaces and Transformation: Geometric representation of vector, norm of vector, Euclidean inner product, projections and orthogonal projections, Euclidean n spaces n properties Cauchy-Schwarz inequality, Euclidean transformations, apply geometric transformations to plane figure, composition of transformations. Application of linear Algebra: Leontief Economic models, Electrical Networks, Scaling, translation, rotation, and projection etc.

Eigen values & Eigen Spaces : Interpret eigenvectors and eigenvalues of a matrix in terms of transformation it represents, convert a transformation into a matrix eigen value problem, find the eigenvalues and eigenvectors of order not more than 3×3 matrices algebraically, determine the modal matrix for a given matrix, reduce a matrix to diagonal (form and Jordan form, state the Cayley-Hamilton theorem and use it to find powers and the inverse of a matrix, understand a simple numerical method for finding the eigenvectors of a matrix, use appropriate software to

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compute the eigenvalues and eigenvectors of a matrix, Define quadratic form and determine its nature using eigenvalues.

Solid Geometry: Coordinate Systems in three dimensions. Direction cosines and ratios, vector equation of a straight line, plane and sphere, curve tracing of a function of two and three variables, Surfaces of revolutions. Transformations (Cartesian to polar &cylindrical).

Recommended Books

1.   Elementary Linear Algebra Howard Anton Seventh Edition

2.   Calculus & Analytical Geometry Howard Anton Fifth Edition

3.   Elementary Linear Algebra Bernald Kolman Seventh Edition

MT-228 Complex Variables Fourier Transforms

Infinite Series: Application of convergence tests such as comparison, Root, Ratio, Raabe's and Gauss tests on the behaviour of series.

Complex Variable Limit, continuity, zeros, and poles of a complex function. Cauchy-Reimann equations, conformal transformation, contour integration.

Fourier series Introduction to Fourier series. Euler Fourier formulae, even and odd functions, application of Fourier series. Fourier transform and fast Fourier transform and properties with applications.

Series Solutions of Differential Equation Series Solution, General Method, Forms of Series Solutions, Bessel's equation, Expansions for J_o and J_1, value of $J_{i/2}$, Generating function for $Jn(x)$, Orthogonality of Bessel function, Fourier-Bessel expansion of f(x).

Recommended Books

1. Advance Engineering Mathematics Erwin Kreyszig Seven Edition

2. Differential Equation G. Zill

3. Complex Analysis for Mathematics and Engineering John H. Mathews 2001

4. Calculus & Analysis Geometry Howard Anton Fifth

5. Mathematical Physics Bruce Kusse and Erik 2006

HS- 301 Business & Organizational Communication

Business Communication Foundations: Definition of business, organization and communication, Goals, patterns, principles, channels, tools, levels, Qualities (7 C's) and process of communication, Forms and functions of organizational communication, Communication

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barriers, Feedback and its types, Listening & Understanding Nonverbal Communication, International and cross-cultural communication,

Communication Technologies and Techniques: Tools for digital communication, Etiquettes and ethics of using communication technologies

Communicating in Teams: Improving your performance in Teams (team communication, group dynamics, Etiquette in team settings), Making your meetings more productive (preparing for meetings, leading and participating in meetings, Meeting Notice, Agenda and minutes, Meeting simulation

Business Writing: Planning Audience Cantered Business Messages & Applying the three step Writing Process, Letter and Memos (Structure and elements) Practice in writing letters and memos, Three Types of Business Messages, and situations: Routine/Neutral/Positive/Good news and Goodwill messages, Negative/Bad News messages, Persuasive messages.

Employment Communication: Resume/CV, Job application (solicited and unsolicited) Writing Proposals and Reports: Finding and Communicating Information, Communicating Information Through Visuals, Writing effective Proposals, Short Reports (analytical and informational reports, memo, and letter reports), Formal Reports (structure and organization)

Recommended Books:

1.   Business Communication Today (8th Edition) by Courtland L. Bovee& John V. Thill. Prentice Hall International Inc.

2.   Process & product Approach to Business Communication by Mary Allen Guffy. Thomson Publishers

3.   Business & Administrative Communication by Kitty O Locker, Irwin McGraw-Hill.

4.   Basic Business Communication, Skills for Empowering the Internet Generation, 9th Edition, LesikarFlatley, McGraw-Hill Irwin.

5.   Business Communication 4th Edition, AC Buddy Krizan, Patricia Merrier, Carol Larson Jones, Jules Harcourt, International Thomson Publishing.

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Third Year

PH-301 Quantum Mechanics-I

Electromagnetic waves and photon, material particles and matter waves, quantum description of a particle, wave packets, particle in a time-independent scalar potential, order of magnitude of the wavelength associated with material particles, constraints imposed by uncertainty relations, one-dimensional Gaussian wave packet, Spreading of the wave packet, stationary states of a particle in one-dimensional square potential, behavior of a wave packet at a potential step, One-particle wave function space, state space, Dirac notation, representations in the state space, observable, representations, review of some useful properties of linear operators, unitary operators, study of the and representations, some general properties of two observable, Q and P, whose commutator is equal to $i\hbar$, the two-dimensional infinite well, Statement of the postulates and their physical interpretation, the physical implications of the Schrodinger equation, the superposition principle, particle in an infinite potential well, study of the probability current in some special case, root-mean-square deviations of two conjugate observables, the density and evolution operators, Schrodinger and Heisenberg pictures, Gauge invariance, bound states of a particle in a potential well of arbitrary shape, unbound states of a particle in the presence of a potential well or barrier of arbitrary shape, quantum properties of a particle in a one-dimensional periodic structure, Spin ½ particles, quantization of the angular momentum, illustration of the postulates in the case of a spin ½, general study of two level systems, Pauli matrices, diagonalization of a 2×2 Hermitian matrix, System of two spin ½ particles, Spin ½ density matrix, Spin ½ particle in a static magnetic field and a rotating field, Magnetic resonance, Importance of the harmonic oscillator in physics, eigen values and eigen states of the Hamiltonian, mean value and root-mean-square deviations of X and P in state $|$, Some examples of harmonic oscillators, study of the stationary states in the representation, Hermite polynomials, solving the Eigenvalues of the harmonic oscillators by the polynomial method, study of the stationary states in the representation, isotropic three-dimensional harmonic oscillator, charged harmonic oscillator placed in a uniform electric field, coherent states, Normal vibrational modes of coupled harmonic oscillators, vibrational modes of an infinite linear chain of coupled harmonic oscillators, phonons, one-dimensional harmonic oscillator in thermodynamics equilibrium at a temperature T, General Properties of Angular Momentum in Quantum Mechanics, Particle in a Central Potential.

Recommended Books:

1. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

2. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.

3. R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4 ed. 2002.

PH-302 Laser Engineering

Brief history of laser development, principle components of laser, types of lasers, properties of laser beam, an overview of laser technology, energy states in atom, transition between energy

states (absorption, spontaneous and stimulated emission), principles of laser, power and energy, special features of laser beam (directionality, diffraction, intensity, monochromaticity, coherency, line-width), Thermal equilibrium, Einstein coefficients, condition for large stimulated emissions, condition for light amplification, population inversion, energy state, metastable state, three level laser, four level laser, line broadening, laser rate equations (two, three, and four level systems), generic laser, gain medium, pumping source, resonant cavity, Amplification and gain, optical resonator, laser action, gain of active medium (mathematical treatment), threshold condition, gain calculation, conditions for steady state oscillation, cavity resonance frequencies, laser modes (longitudinal and transverse), single mode operation, Resonator (cavity) configuration, Fabry Perot resonator or plane parallel cavity, confocal resonator, hemispherical cavity or combination of plane and spherical resonator, long radius cavity, stability criterion, examples (stable and unstable resonator), What is pumping, pumping methods, optical pumping, electric pumping (direct discharge), electric pumping for semiconductor laser, chemical pumping, flash lamps, optical pumping configuration, optical pumping assembly, active mediums (atoms, molecules, liquids, dielectric solids, semiconductor material), Introduction to control of laser output beam, frequency selection, generation of high power pulses, Q-factor, Q-switching and giant pulses, methods of Q-switching, active Q-switching (mechanical Q-switching, acousto-optic Q-switching, electro-optic Q-switching), passive Q-switching (saturable absorber, cavity dumping), introduction to mode-locking, mode-locking techniques (active mode-locking, passive mode-locking), Q-switched Nd:YAG laser system, Industrial applications, material processing (laser drilling, laser cutting, laser welding), LIDAR (laser imaging detection and ranging), photolithography, medical applications (LASIK surgery, laser seizer), isotope separation using laser, Nuclear fusion, brief overview of major laser facility (NIF facility), laser holography, military applications.

Recommended Books:

1. K. Thyagarajan, "Lasers: Fundamentals and Applications", Springer, 2nd ed. 2010.

2. O. Svelto, "Principles of Lasers", Springer, 5th ed. 2009.

3. K. R. Nambiar, "LASERS: Principles, Types and Applications", New Age, 2009.

4. W. Koecher, "Solid-State Laser Engineering", Springer, 2009.

5. W. T. Silfvast, "Laser Fundamentals", Cambridge, 2nd ed. 2008.

6. R. F. Walter, "Gas Lasers (Optical Science and Engineering)", CRC Press, 2006

PH-303 Mathematical Physics-I

Bessel Functions, Neumann Functions, Hankel Functions, Spherical Bessel Functions, Legendre Functions, Associated Legendre Functions, Spherical Harmonics, Hermite Polynomials. Introduction to important PDEs in Physics (wave equation, diffusion equation, Poisson's equation, Schrodinger's equation), general form of solution, general and particular solutions (first order, inhomogeneous, second order), characteristics and existence of solutions, uniqueness of solutions, separation of variables in Cartesian coordinates, superposition of separated solutions, separation

of variables in curvilinear coordinates, special functions, integral transform methods, Green's functions, Review (polar form of complex numbers and de Moivre's theorem, complex logarithms and powers), functions of a complex variable, Cauchy-Riemann conditions, power series in a complex variable and analytic continuation with examples, multi-valued functions and branch cuts, singularities and zeroes of complex functions, complex integration, Cauchy's theorem, Cauchy's integral formula, Laurent series and residues, residue integration theorem, definite integrals using contour integration.

Recommended Books:

1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012.

2. K. F. Riley, M. P. Hobson, S. J. Bence, "Mathematical Methods for Physicists", Cambridge University Press, 2006.

3. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.

PH-304 Electromagnetic Theory-I

Review of Vector Calculus, The Dirac Delta Function: Review of vector calculus using example of Dirac Delta function, Electrostatics, Laplace's equation: introduction, Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems, The classic image problem, induced surface charge, force and energy, other image problems, Approximate potential at large, the monopole and dipole terms, origin of coordinates in multipole, expansions, the electric field of a dipole, dielectrics, induced dipoles, alignment of polar molecules, polarization. The field of a polarized object bound charges, physical interpretation of bound charges, and the field inside a dielectric. The electric displacement, Gauss's law in the presence of dielectrics, a deceptive parallel, boundary conditions. Linear Dielectrics, susceptibility, permittivity, dielectric constant, boundary value problems with linear dielectrics, energy in dielectric systems, forces on dielectrics, The Lorentz Force law, magnetic fields, magnetic forces, currents. The Biot-Savart Law, steady currents, the magnetic field of a steady current. The divergence and curl of B, straight-line currents, the divergence and curl of B, applications of Ampere's law, comparison of magnetostatics and electrostatics, the vector potential, summary, magnetic boundary conditions, multipole expansion of the vector potential, Magnetization, diamagnets, paramagnets, ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization, field of a magnetized object, bound currents, physical interpretation of bound currents, and the magnetic field inside matter. The auxiliary field H, Ampere's law in magnetized materials, a deceptive parallel, boundary conditions. Linear and nonlinear media, magnetic susceptibility and permeability, ferromagnetism.

Recommended Books:

1. Hearld J and W. Muller-Kristen, "Electrodynamics", World Scientific Publishing, 2nd ed. 2011.

2. M. N. O. Sadiku," Elements of Electromagnetics", Oxford University Press, 5th ed.2009.

3. F. Melia, "Electrodynamics", University of Chicago Press, 2001.

4. D. J. Griffiths, "Introduction to Electrodynamics", Prentice Hall, 3rd ed. 1999.

PH-305 Vacuum Science

Basic concepts, Importance of vacuum, Range of vacuum, Gas mixture and partial pressure, Vapors and vapor pressure, Kinetic Molecular Theory of a gas, The Maxwell-Boltzmann Distribution of Molecular Speed, Molecular Collisions and Mean Free Path, Heat Conduction in Gases, Thermal Transpiration, Viscosity in Gases, The Scattering of Molecules by a Surface, Adsorption and Desorption, Outgassing, Molecular Drag, Sputtering, Throughput and Pumping Speed, Conductance, Continuum Flow, Molecular Flow, Pumping Process, Pump-Down Time and Ultimate Pressure, Rotary Oil Pumps, Sorption Pumps Diffusion Pumps, (High Vacuum). Production of Ultrahigh Vacuum, Guttering Pumps, Ion Pumps, Cryogenic Pumps, Turbo Molecular Pumps, Manometers, Perini gauges, The McLoad gauges, Mass Spectrometer for Partial Measurement of Pressure, Surface to Volume ratio, Pump Choice, Pumping System Design, Vacuum Valves, Vacuum Flanges, Liquid Nitrogen Trap, Mechanical Feed throughs & Electrical Feed throughs, Basic Consideration in leak detection, Leak Detection Equipment, Special Techniques and Problems

Recommended Books:

1. A. Chambers, Modern Vacuum Physics, Chapman& Hall, 2004.

2. Modern Vacuum Practice, McGraw Hill, 1989.

3. J. Yarwood, High Vacuum Techniques, Chapman & Hall, 1967.

PH-307 Mathematical Physics-II

Fourier Series and Integral Transforms, Fourier Series of Various Physical Functions, Uses and Applications of Fourier Series, Fourier Transforms, Convolution Theorems, Laplace transforms and applications, Vector calculus (differentiation, integration, space curves, multi-variable vectors, surfaces, scalar and vector fields, gradient, divergence and curl, cylindrical and spherical coordinates, general curvilinear coordinates), change of basis, Cartesian tensor as a geometrical object, order/rank of a tensor, tensor algebra, quotient law, pseudo tensors, Kronecker delta and Levi-cevita, dual tensors, physical applications, integral theorems for tensors, non-Cartesian tensors, general coordinate transformations and tensors, Transformations, groups – definitions and examples, subgroups and Cayley's theorem, cosets and Lagrange's theorem, conjugate classes, invariant subgroups, factor groups, homomorphism, direct products, mappings, linear operators,

matrix representations, similarity transformation and equivalent matrix representations, group representations, equivalent representations and characters, construction of representations and addition of representations, invariance of functions and operators, unitary spaces and Hermitian matrices, operators: adjoint, self-adjoint, unitary, Hilbert space, reducibility of representations, Schur's lemmas, orthogonality relations, group algebra, expansion of functions in basis of irreducible representations, Kronecker product, symmetrized and anti-symmetrized representations, adjoint and complex-conjugate representations, real representations.

Recommended Books:

1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012.

2. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.

3. M. Hamermesh, "Group Theory and its Applications to Physical Problems", Dover Publications 1989.

PH- 308 Quantum Mechanics-II

Total angular momentum in classical mechanics, total angular momentum in quantum mechanics, addition of two spin ½ angular momenta, addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, addition of spherical harmonics, vector operators, Wigner-Eckart theorem, electric Multipole moments, Evolution of two angular momenta $J1$ and $J2$ coupled by an interaction a $J1. J2.$, Description of the method, perturbation of a non-degenerate level, perturbation of a degenerate level, one-dimensional harmonic oscillator subjected to a perturbing potential, interaction between the magnetic dipoles of two spin ½ particles, Van dar wals forces, volume effect and The influence of the spatial extension of the nucleus on the atomic levels, variational method, energy bands of electrons in solids, a simple example of the chemical bond: The ion, fine and hyperfine structure of atomic levels in hydrogen, Calculation of the mean values of the spin-orbit coupling in the 1s, 2s and 2p levels, hyperfine structure And the Zeeman effect for muonium and positronium, Stark effect, approximate solution of the Schrodinger equation, An important special case: Sinusoidal or constant perturbation, Interaction of an atom with electromagnetic waves, linear and non-linear response of a two-level system subjected to a sinusoidal perturbation, oscillations of a system between two discrete states under the effect of a resonant perturbation, Rabi flopping, decay of discrete state resonantly coupled to a continuum of final states, Fermi's golden rule, Identical particles, Permutation operators, The symmetrisation postulate, difference between bosons and fermions, Pauli's exclusion principle, many-electrons atom and their electronic configurations, energy levels of the helium atom, configurations, terms, multiples, spin isomers of hydrogen (ortho and parahydrogen), Importance of collision phenomena, Stationary scattering states, scattering cross section, scattering by a central potential, method of partial waves, phenomenological description of collisions with absorption.

Recommended Books:

1. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

2. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.

3. R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4th ed. 2002.

PH-309 Electromagnetic Theory-II

Electromotive force, Ohm's law, motional emf, electromagnetic induction, Faraday's law, the induced electric field, inductance, energy in magnetic fields, Maxwell's equations: electrodynamics before Maxwell, how Maxwell fixed Ampere's law, Maxwell's equations, magnetic charges, Maxwell's equations in matter, boundary conditions, Charge and energy: the continuity equation, Poynting's theorem, momentum: Newton's third law in electrodynamics, Maxwell's stress tensor, conservation of momentum, angular momentum, Waves in one dimension: the wave equation, sinusoidal waves, boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum, the wave equation for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter: propagation in linear media, reflection and transmission at normal incidence, reflection and transmission at oblique incidence, absorption and dispersion, electromagnetic waves in conductors, reflection at a conducting surface, the frequency dependence of permittivity, guided waves: wave guides, the waves in a rectangular wave guide, the coaxial transmission line, Potentials and Fields, Radiation, Dipole Radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, point charges, power radiated by a point charge, radiation reaction, the physical basis of the radiation reaction, The special theory of relativity, Einstein's postulates, the geometry of relativity, the Lorentz transformations, the structure of space-time, relativistic mechanics, proper time and proper velocity, relativistic energy and momentum, relativistic kinematics, relativistic dynamics, relativistic electrodynamics, magnetism as a relativistic phenomenon, how the field transform, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Recommended Books:

1. Hearld J and W. Muller-Kristen, "Electrodynamics", World Scientific Publishing, 2nd ed. 2011.

2. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 5th ed. ed. 2009.

3. F. Melia, "Electrodynamics", University of Chicago Press, 1st ed. 2001.

4. D. J. Griffiths, "Introduction to Electrodynamics", ed. Prentice Hall, 3rd ed. 1999.

PH- 310 Solid State Physics- I

Lattices and basis, Symmetry operations, Fundamental Types of Lattice, Position and Orientation of Planes in Crystals, Simple crystal structures, Diffraction of X-rays, Neutrons and electrons from crystals; Bragg's law; Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis

of the Basis, Quantization of Lattice Vibrations, Phonon momentum, inelastic scattering by phonons, Lattice Vibrations for Mono-atomic and diatomic basis, Optical Properties in the Infrared Region, Lattice heat Capacity, Classical model, Einstein Model, Enumeration of normal modes, Density of state in one, two or three dimensions, Debye model of heat capacity, Comparison with experimental results, thermal conductivity and resistivity, Umklapp processes, 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.

Recommended Books:

1. C. Kittle, "Introduction to Solid State Physics", John Wiley, 8th ed. 2005.

2. M. A. Omar, "Elementary and Solid-State Physics", Pearson Education, 2000.

3. M. A. Wahab, "Solid State Physics", Narosa Publishing House, 1999.

4. S. R. Elliott, "The Physics and Chemistry of Solids", John Wiley, 1998

5. H. M. Rosenberg, "The Solid State", Oxford Science Publication, 3rd ed. 1988.

PH-306 Statistical Mechanics

Review of Classical Thermodynamics, Thermodynamic processes (engines, refrigerators), Maxwell relations, phase equilibria. Foundations of Statistical Mechanics, Phase Space, Trajectories in Phase Space, Conserved Quantities and Accessible Phase Space, Macroscopic Measurements and Time Averages, Ensembles and Averages over Phase Space, Liouville's Theorem, The Ergodic Hypothesis, Equal a priori Probabilities. Specification of the state of a system, concept of ensembles, Statistical Ensembles Microcanonical ensemble, canonical ensemble and examples (e.g., paramagnet), calculation of mean values, calculation of partition function and its relation with thermodynamic quantities, the grand canonical ensemble and examples (e.g. adsorption), calculation of partition function and thermodynamic quantities Simple Applications of Ensemble Theory Monoatomic ideal gas in classical and quantum limit, Gibb's paradox and quantum mechanical enumeration of states, equipartition theorem and examples (ideal gas, harmonic oscillator), specific heat of solids, quantum mechanical calculation of Para magnetism, Quantum Statistics Indistinguishability and symmetry requirements, polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE), Systems of Interacting Particles: Lattice vibrations in solids, van der Waals gas, mean field calculation, ferromagnets in mean field approximation.

Recommended Books:

1. F. Reif, "Fundamentals of Statistical and Thermal Physics", Waveland PrInc, 2008.

2. W. Brewer, F. Schwabl, "Statistical Mechanics", Springer, 2nd ed. 2006.

Department of Physics, NED University of Engineering &Technology, Karachi.

3.   T. L. Hill, "Statistical Mechanics", World Scientific Publishing Company, 2004.

4.   K. Huang, "Statistical Mechanics", John Wiley, 2nd ed. 1987.

5.   A.J. Pointon, "Introduction to Statistical Physics", Longman 1967.

Department of Physics, NED University of Engineering &Technology, Karachi.

Fourth Year

PH-401 Computational Physics

A brief introduction of the computer languages like Basic, C. Pascal etc and known software packages of computation, Numerical Solutions of equations, Regression and interpolation, Numerical integration, and differentiation. Error analysis and technique for elimination of systematic and random errors, Conceptual models, the mathematical models, Random numbers and random walk, Doing Physics with random numbers, Computer simulation, Relationship of modeling and simulation. Some systems of interest for physicists such as Motion of Falling objects, Kepler's problems, Oscillatory motion, Many particle systems, Dynamic systems, Wave phenomena, Field of static charges and current, Diffusion, Populations genetics etc.

Recommended Books:

1. H. Gould, J. Tobochnik and W. Christian, "An Introduction to Computer Simulation Methods", Addison Wesley, 3rd ed. 2006.

2. M. L. De Jong," Introduction to Computational Physics", Addison Wesley, 1991.

3. S. C. Chapra and R. P. Chanle," Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill,1990.

4. S. T. Koonini, "Computational Physics", The Benjamin-Cummings, 1985.

PH-402 Atomic and Molecular Physics

One Electron System, Fermi Golden rule, Quantum numbers, Atoms in radiation field, Radiative transitions, Einstein coefficients, Selection rules, normal Zeeman effect, Stark effect, Hyperfine structure. Many body Systems, Periodic system of the elements, Stern Gerlach experiment, Spin orbit coupling, Central field approximation, Hartree Fock methods and self-consistent field, Thomas Fermi potential, LS coupling, jj coupling and other type of coupling, X-ray spectra. Interaction with field, Many electron atoms in an electromagnetic field, Anomalous Zeeman effect, Paschen back effect, Stark effect. Molecules, Ionic and covalent bonding, Diatomic molecules-rotational, vibrational, and electronic spectra; Born Oppenhimer approximation, Transition probabilities of diatomic molecules, electron spin and Hund's cases, Polyatomic molecules (brief introduction), Raman effect, Hydrogen Molecular ion (LCAO approximation), Hydrogen molecule (Heitler London and molecular orbital theories)

Recommended Books:

1. W. Demtroder, "Atoms, Molecules and Photons", y, Springer, 2nd ed. 2010.

2. B. H. Bransden and C. J. Joachain, "Physics of Atoms and Molecules", Pearson Education, 2nd ed. 2008.

3. C. J. Foot, "Atomic Physics", Oxford University Press, 2005.
   4. J. M. Hollas, "Basic Atomic & Molecular Spectroscopy", John Wiley, 2002.

Department of Physics, NED University of Engineering &Technology, Karachi.

PH- 403 Solid State Physics – II

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, 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, Interaction of light with solids, Optical Properties of Metals and Non-Metals, Kramers-Kronnig Relation, Excitons, Raman Effect in crystals, optical spectroscopy of solids, Magnetic dipole moment and susceptibility, different kinds of magnetic materials, Langevin diamagnetic equation, Paramagnetic equation and Curie law, Classical and quantum approaches to paramagnetic materials. Ferro-magnetic and anti – ferromagnetic order, Curie point and exchange integral, Effect of temperature on different kinds of magnetic materials and applications, Introduction to superconductivity, Zero-Resistance and Meissner Effect, Type I and Type II superconductors, Thermodynamic fields, Tow fluid model, London equations, BCS and Ginzburg – Landau Theory, Vortex Behavior, Critical Current Density, Josephson effect and applications.

Recommended Books:

1. M. Fox, "Optical Properties of Solids", Oxford University Press, 2nd ed. 2010.

2. N. A. Spaldin, "Magnetic Materials: Fundamentals and Device Applications", Cambridge University Press, 2nd ed. 2010.

3. C. Kittle, "Introduction to Solid State Physics", John Wiley, 8th ed. 2005.

4. G. Burns, "High Temperature Superconductivity - An Introduction", Academic Press, 1992.

PH-417 Nuclear Physics

Properties of Nucleus, Nuclear size, nuclear mass, Binding energy, Magnetic dipole and electric quadrupole moment, Parity and statistics, nuclear forces, nuclear spin, Charge independence and spin dependence of nuclear force, MRI (Magnetic resonance imaging) Principle and working. Nuclear Models, Liquid drop model, Shell model, Collective model, Fermi gas Model. Nuclear Decay, Nuclear decay, nuclear equilibrium, Transient equilibrium, Permanent equilibrium, Alpha decay, Beta decay, Neutrino hypothesis. Nuclear reactions, Q values and threshold energy of nuclear reaction, Cross sections for nuclear reactions, Direct reaction, Resonance reaction. Radiation Detectors, Scintillators, Geiger Muller counter, Bubble chamber, Cloud chamber.

Recommended Books:

1. B. Povh, K. Rith, C. Scholtz, F. Zetsche, "Particle and Nuclei", 1999.

2. Green, "Nuclear Physics", McGraw Hill, 1995.

3. K. S. Krane, "Introducing Nuclear Physics", John Wiley, 3rd ed. 1988.

Department of Physics, NED University of Engineering &Technology, Karachi.

4. Kaplan, "Nuclear Physics", Addison-Wisely, 1980.

5. E. Segre, "Nuclei and Particles", Bejamin-Cummings, 2nd ed. 1977.

PH-405 Introduction to Nano Science and Nanotechnologies

Introduction, Feynman talks on small structures, Nano scale dimension, Course goals and **Objectives**
Quantum Effects, Quantum Dots, Moore's law, tunnelling Surfaces and Interfaces, Interfaces, Surface chemistry and physics, Surface modification and characterization, Thin Films, Sputtering, Self-assembled films Material Properties, Subatomic physics to chemical systems, types of chemical bonds, Fabricating Nano Structures, Sol gel, Lithography (photo and electron beam), MBE, Self-assembly, FIB, Stamp technology, Nano junctions Electrons in Nano Structures: Single electron transistor, Resonant tunnelling, Molecular Electronics, Lewis structures, Approach to calculate Molecular orbitals, Donor Acceptor properties, Electron transfer between molecules, Charge transport in weakly interacting molecular solids, Single molecule electronics Nano Materials, Quantum dots, nano wires, nano photonics, magnetic nano structures, nano thermal devices, Nano fluidic devices, biomimetic materials Nano Biotechnology, DNA micro-arrays, Protein and DNA Assembly, Digital cells, genetic circuits, DNA computing, Characterization Techniques: Electron Microscopy (STM, AFM, SEM and TEM), Fluorescence methods, Synchrotron Radiation, XRD, Nanotechnology the Road Ahead: Nanostructure innovation, Quantum Informatics, Energy solutions.

Recommended Books:

1. C. Binns, "Introduction to Nanoscience and Nanotechnology (Wiley Survival Guides in Engineering and Science)", Wiley, 2010.

2. S. Lindsay, "Introduction to Nanoscience", Oxford University Press, 2009.

PH-406 Surface Sciences

Basics of Surface Science, Surface reactions, Heterogeneous catalysis, Semiconductor technology, Corrosion, Nanotechnology, Surface Structure and Reconstruction, Screening, Work Function, Surface States, Electron Affinity, Ionization Potential, Surface Chirality, Thermodynamics of Surfaces, Equilibrium Crystal Shape Quantum confinement of Electrons at Surfaces: Mechanical Quantum Wells, Quantum Wires, Chemist's Approach, Bonds to Bands. Surface Dynamics, Nucleation and growth of nanostructures and films, Surface Magnetism and magnetic imaging, Kerr microscopy (MOKE), Spin Polarized Photoemission (SP-PEEM), Magnetic Force Microscopy (MFM) Surface Study Techniques: Surface Sensitivity and specificity, Explanation and comparison of Low-Energy Electron Diffraction (LEED) and Reflection High-Energy Electron Diffraction (RHEED), Explanation of Near-Edge X-ray Absorption Fine Structure (NEXAFS), High-Resolution Electron Energy Loss Spectroscopy (HREELS), Introduction to Desorption Techniques, Thermal Desorption Spectroscopy (TDS), Electron Stimulated Desorption (ESD), Electron Stimulated Desorption Ion Angular Distribution (ESDIAD), Photon Stimulated Desorption (PSD), Electron Spectroscopy, Theory: Mean free path, Koopman's Theorem, Spin orbit coupling effects, chemical shifts, binding energy, Auger Electron Spectroscopy (AES), X-Ray Photo-electron Spectroscopy, Electron Analyzer, Electron optics, Scanning Tunnelling Microscopy (STM), History, Theory,

Electronics and applications, Silicon Surfaces Geometric and Electronic Structure, Molecular Adsorption on Semiconductor Surfaces, Adsorption Properties of CO on Metal Single-Crystal Surfaces, Molecular or dissociative adsorption, Chemical bonding and Orientation, Adsorption Site as a function of coverage, Over layer long-range order, Ammonia Synthesis, Oxide Surfaces, Photovoltaic and Organic Electronics: Prototypes (OLEDs etc), intra-molecular bonding,, Field effect Transistors, basics of excitonic solar cells.

Recommended Books:

1.   I. Harald, Physics of Surfaces and Interfaces, Springer Verlag, 2006.

2.   R. I. Masel, "Principles of Adsorption and Reaction on Solid Surfaces", Wiley-Interscience, 1996.

3.   J. B. Hudson, "Surface Science, an Introduction", Wiley-Interscience, 1998.

4.   M. Prutton, "Introduction to Surface Physics", Oxford University Press, 1994.

5.   D. Briggs and M. P. Seah, "Practical Surface Analysis", Vol-I, John Wiley, 2nd ed. 1990.

PH-407 Applied Physics Project

The project will include the study and characterization of indigenous materials for their developments in high efficiency photovoltaic cell, Laser Induced Spectroscopy, Solar Energy and Wind Energy.

Electives:

MM-401 Materials Characterization Techniques

Wet analysis, microscopic characterization, Optical microscopy, interference contrast, quantitative analysis. Image analysis, SEM and TEM principles and configuration, elastic and inelastic scattering, SE, BSE, imaging, WDS and EDS microanalysis, BSCP, TEM BF and DF contrast, diffraction patterns, STEM. Defect analysis, sample preparation, EPMA, field ion microscopy (AP-FIM) and concentration profiling. Scanning tunnelling, acoustic and atomic force microscopy, DTA, DSC and dilatometry, AES and SIMS, molecular spectroscopy, Electron micro probe analysis, Gas analysis by mass spectrometry.

MM-406 Electronics, Magnetic and Optical Materials

Survey and classification of materials according to electronic, magnetic, and optical properties. Classification of materials according to magnetic properties, origin of magnetic moment of atoms, theories of all types of magnetism. Magnetization curves, hysteresis, magnetic domains, domain walls, methods of observations of domains, soft magnetic materials, hard magnetic materials, powder magnets. Materials for semiconductor devices and VLSI. Thin film technology, metallization, packaging, opto-electronic devices, and solar cells.

MM-408 High Temperature Materials and Superalloys

Overview of Elevated-Temperature characteristic of engineering materials, Mechanical properties and corrosion, Industrial application of heat resistant materials, Properties of superalloys, Metallurgy, processing and properties of superalloys, Elevated temperature corrosion of materials, Microstructure instabilities, Protective coatings properties of nonferrous heat resistant materials, Refractory metal and alloys, Structural intermetallic ceramics carbon-carbon composites, Analysis and design assessment of creep rupture data, Thermomechanical fatigue of structural materials, Elevated temperature crack growth, Creep-Fatigue interaction. Material design for elevated temperature applications, Design for oxidation resistance, Creep, thermal fatigue, oxidation, high temperature corrosion, erosion, Ageing, Structural changes, Material damage, Crack propagation, Damage mechanics, Life time analysis, Creep resistant steels, Superalloys, Ceramics and polymers for high temperature applications, Intermetallic, usage of high strength steels, Spring materials, Fatigue, Evaluation of property data extrapolation, Plastics and composites materials for high temperature applications.

EL-433 Solid State Devices

Quantum Mechanics: Probability and uncertainty principle, The Schrödinger wave equation, Quantum mechanical tunneling.

Semiconductor Materials and Crystal Properties: Energy bands and charge carriers in Semiconductors, Carrier statistics, Drift, Excess carriers, and diffusion. The PN Junction and Junction Diodes: Equilibrium conditions, Forward and reverse biased junction, Reverse breakdown, Metal semiconductor junctions, Transient response, Hetero junctions, Switching diodes, Tunnel diode and photodiode. Bipolar Junction

Transistor: Charge transport in bipolar junction transistor, Minority carrier distribution and terminal currents, The coupled diode model.

Field Effect Transistors: JFET Pinch-off, Gate control and I/V characteristics the GaAs MESFET, MOS capacitor, Threshold voltage, Volt-Ampere relationship of MOSFET.

The practical work will be based on the above course.

EL-484 Optoelectronics and Microwave Systems

Light: Historical background, The nature of light, Basic laws of light, Polarization, Interference, Diffraction, Units of Light.

Optical Fiber: Propagation of light in dielectric, Propagation of light in planar dielectric waveguide, Optical fiber waveguide, Wave propagation in optical fiber, Types of optical fiber, Optical fiber bandwidth calculation, Attenuation in optical fiber, Fiber material and fabrication.

Semiconductor Light Sources: Light emission in Semiconductor, Light emitting diodes and Types of Light Emitting Diodes (LEDs), Spectral characteristics, Modulation capabilities and conversion efficiency, LED drive circuit, Stimulation emission in semiconductors, Lasing

Conditions in semiconductors, Semiconductors Laser Diodes (SLDs), Types of Semiconductor Laser Diodes, Spectral and output characteristics, Semiconductors Laser Diodes drive circuits.

Laser: Emission and absorption of radiation, The Einstein relation, Absorption of radiation, Population inversion, Optical feedback, Threshold condition, LASER losses, Population inversion and pumping threshold conditions, LASER modes, Classes of LASER, Single mode operation.

Optical Transmitter: Photo detection in semiconductors, Semiconductor photodiodes, Responsivity of photodiodes, PIN photodiodes, Avalanche photodiodes (APDs), Photodiode noise considerations, Optical receivers and receiver design, Measurement, and prediction of receiver sensitivity.

Microwave Devices: Transistors, Varactors, Step recovery diodes, Multipliers, Parametric amplifiers, Tunnel diodes, Negative resistance amplifier, Gunn effect, Avalanche effect diode and other microwave diodes, Klystron and Magnetron and traveling wave tube.

EL-304 Industrial Electronics

Introduction: Industrial world, measurement and accuracy, control system concept, preventive maintenance, safety fundamentals.

Signal Conditioning and Data Communication: Voltage to current conversion and current to voltage conversions, filtering, Industrial Communication standards and practices.

Process Control Systems: On-off control system, proportional control system, proportional and integral control system, PID control system.

Programmable Logic Controllers (PLC): Basic controller operation, hardware components, CPUs, addressing, memory organization, PLC programming.

Microcontrollers: Internal Architecture, addressing modes, data movement instructions, control instructions, microcontroller programming, hardware interfacing.

Motor Control Systems: Braking dc motors, speed control of dc motor, stepper motor, braking ac motor, speed control of ac motor.

Introduction To Robotics: Introductory aspects of robotics, homogeneous transforms, robot arm kinematics, robot configurations, inverse kinematics, robot arm dynamics, robot control, trajectory planning, work-space consideration, obstacle avoidance.

Overview of SCADA and DCS: Definitions, Architecture, Hardware specifications, working principles, communication medium for a telemetry system.

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