DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY, HYDERABAD

M. Sc. (Physics) and M.Sc. (Appl. Electronics) Courses under CBCS (with effect from the academic year 2016 –2017)

Semester –I

Sl.No	Sub.Code	Paper No.	Subject	Instruc-tions. Hrs/Week	Credits	Max. Marks
THEORY						
01	PAE 101 T	I	Mathematical Physics	4	4	100*
02	PAE 102 T	II	Classical Mechanics	4	4	100*
03	PAE 103 T	III	Quantum mechanics - I	4	4	100*
04	PAE 104 T	IV	Solid State Physics	4	4	100*
PRACTICALS						
05	PAE 151 P	V	C - Programming Lab	4	2	100
06	PAE 152 P	VI	Electronics Lab	4	2	100
07	PAE 153 P	VII	Heat & Acoustics Lab	4	2	100
08	PAE 154 P	VIII	Optics Lab	4	2	100
			Total:		24	800

*** Out of 100 Marks for each theory paper 20 Marks are allotted for internals and 80 for University exam. There shall be no internal assessment examinations for practicals.Practical Examinations will be conducted at the end of each semester.**

Pattern of Question Paper: The question paper consists of two parts, each covering all the **four units**.Part –A consists of EIGHT short notes questions, carrying 4 marks each. The student has to answer all the questions. Part –B consists of FOUR essay type questions with an internal choice. Each question carries 12 marks.

DEPARTMENT OF PHYSICS, OSMANIA UNIVERSITY

M.Sc. (Physics) and M.Sc. (Applied Electronics)

(w. e. f 2016 -2017 Under **CBCS)**

Semester - I Syllabus

PAE 101 TPaper –I :: Mathematical Physics

UNIT –I: (13 Hrs**)**

Legendre's Differentialequation: ThePowerseriesequation**:**Solution–Legendre Functions of thefirst and second kind –Generating Function- Rodrigues'– OrthogonalFormulaProperties – Recurrence Relations. Beta and Gamma function – Properties –Relations between them.

Bessel's Differential Equation:Powerseries Solutionequation–BesselFunctions of First andSecond kind- Generating Function –Orthogonal Properties –Recurrence Relations.

UNIT –II: (13 Hrs**)**

Hermite Differential Equation : Power series Solution–Hermite polynomials - GeneratingFunction-Orthogonality –Recurrence relations -Rodrigues formula –Hyper geometric equation-solution-Laplace equation-Solution Wave equation and its applications to rectangular membrane.

UNIT –III : (13 Hrs**)**

Fourier Transform : Infinite Fourier Sine and Cosine transforms–Properties of Fouriertransforms-Derivative of Fourier transform –Fourier transform of a derivative-Fourier Sine and Cosine transform of derivatives-Finite Fourier transforms – Applications of Fourier Transforms.

Laplace Transform: Propertiesof Laplace transforms **–**Derivative of Laplace transform– Laplace transform of a derivative –Laplace transform of periodic functions- Inverse Laplace transform and its properties –Inverse Laplace theorem –Convolution theorem-Evaluation of inverse Laplace Transforms by Convolution theorem.

Unit –IV : (13 Hrs**)**

Matrices–Addition, subtraction and multiplication of matrices –Inverse of matrices-Characteristic equation of a matrix- eigen values- eigen vectors- Types of matrices-square, diagonal, unit symmetric and skew symmetricandHermitian matrices.

Tensors –Order and rank of the tensors –transformation laws Covariant and contra-variant tensors - Addition, subtraction and multiplication of tensors-Christoffel symbols of first and second rank and their transformation law.

Recommended Books:

1. Applied Mathematics for Engineers and Physicists –Lious A Pipes and Lawrance R. Rarvill.
2. Mathematical Physics –AK Ghatak, IC Goyal and SL Chua-Macmillan India Ltd.
3. Vector and Tensor Analysis –Scham Series.
4. Mathematical Physics –SatyaPrakash

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Semester - I Syllabus

PAE 102 TPaper –II :: CLASSICAL MECHANICS

UNIT –I : (13 Hrs**)**

Newtonian formalism : Inertial frames and Galilean transforms-Non-inertial frames-pseudo forces, rotational frames, rotational transforms and conservation theorems.Description of rotations in terms of Eulerangles-Euler's equations of motion for a rigid body. Minkowski space, space-time diagrams, world point and world line-relativistic motion and Lorentz transforms as rotations in four-space, four velocity, energy-momentum vectors with few examples.

UNIT –II : (13 Hrs**)**

Lagrangian formalism : Constraints, generalized coordinates. Principle Lagrange's equations from-ApplicationsD'Alembert'sof principle, Lagrangian (plane and spherical pendulums, L-C circuit), velocity dependent potential-Lagrangian for a charged particle in electromagnetic field, Eul Hamilton's-Lagrangepicipleequation's from Hamilton's pr

UNIT –III : (13 Hrs**)**

Hamiltonian formalism : Principle of Least Action–ApplicationsandHamilton'sof Hamiltonian equationof(motion of a particle in a central force field, projectile motion of a body). Cyclic coordinates and conservation theories, Canonical coordinates and canonical transforms, Conditions for a transformation to be canonical, generating functions, Lagrange and Poisson brackets. Hamilton equations in Poisson bracket from, Hamilton-Jacobi theory.

UNIT –IV : (13 Hrs**)**

Mechanics of continuous systems : Analysis of the free vibrations of a linear triatomic molecule, Eigen value equation- Principal axis transformation-Frequencies and normal coordinates Lagrangian formulation for continuous systems, Hamiltonian formulation.

Reference Books :

1. Classical Mechanics : By Goldstein, Poole &Safko (Pearson 2002)
2. Classical Mechanics :By JC Upadhyaya (Himalaya Publishing House)
3. Introduction to Classical Mechanics : Takwale&Puranik (TMH)
4. Classical Mechanics :Rana&Joag (TMH)
5. Classical Mechanics of Particles and Rigid Bodies :Kiran C Gupta. (New Age International Publishers)
6. Lagrangian and Hamiltonian Mechanics: Calkin (Allied Publishers 2000)
7. Lagrangian Dynamics : Dave Wells (schaum series 19

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Semester - I Syllabus

PAE 103 TPaper –III :: Quantum Mechanics- I

UNIT –I (13 hrs) :

Basics of Quantum Mechanics : Linear Vector space, Dirac's Ket and Bra notation.Eigenvalue equation, Eigenkets and Eigenvalues – Degenerate and non-degenerate states - completeness relation, Wave functions in position and momentum space. Normalization and Orthogonality of wave functions, change of basis. Observables - Operators, Hermitian operators and their properties-Commuting and non-commuting operators, Physical significance. Matrix representations of vectors and operators – Observable and expectation value of an observable - Parity operator, Projection operator and significance. Basic commutation relations.Uncertainty principle between any two non-commuting Operators.

UNIT –II (13 hrs) :

Exactly Solvable problems : The Schrodinger, Heisenberg picture and interaction pictures.Linear harmonic oscillator-Solution to Schrodinger equation, Eigen values and Eigen functions, properties of stationary states. Linear harmonic oscillator- Solution by operators method. Raising and Lowering operators, the number operator.Hydrogen atom, solution of the radial part of the Schrodinger equations.

UNIT –III (13 hrs) :

Symmetries in Quantum Mechanics : Space and time displacements –unitary operators of space and time displacements and equations of motion.Generators of infinitesimal rotations.Space inversion and unitary inversion operator - intrinsic parity. Time reversal operator –anti-linear operator- time reversal operator for spin zero and non- zero spin particles.

UNIT –IV (13 hrs) :

Angular Momentum : Orbital Angular Momentum, Commutation Relations involving : L^2, L_x, L_y, L_z –Eigenvalues and Eigen functions of L^2 –Generalized angular momentum, J – commutation relationsbetween J^2 and components of J. J_+ and J_- Eigen values of J^2 and J_z. Matrix representation for J^2 and J_z. Spin angular momentum-Pauli spin matrices and their properties. Addition of angular momenta - Clebsch-Gordon coefficients- Recursion relations-C-G coefficients for $J_1 = ½$, $J_2 = ½$, and $J_1 = ½$, $J_2 = 1$, as examples.

Reference Books :

1. Quantum Mechanics by LI Schiff
2. A Text book Quantum Mechanics : PM Mathews and K Venkateshan (TMH)
3. Quantum Mechanics by Ghatak and Lokanathan (Macmillian)
4. Quantum Mechanics by E Merzbacher (John Wiley)
5. Quantum Mechanics by Aruldhas (New Age International
6. Modern Quantum Mechanics by Sakurai (Addison Wesley

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Semester - I Syllabus

PAE 204 T Paper – IV : Solid State Physics

UNIT – I : (13 Hrs**)**

Crystalline State & Structural Studies : Crystal translational vectors, unit cell, Bravais lattices, Crystal system, Miller indices, Symmetry operations, Point groups, Space groups and their notation. Crystal structures of fcc, bcc, hcp, CsCl, NaCl, ZnS and Diamond. Bragg's law, Atomic structure factor, Geometrical structure factor and Debye Wallar factor, Concept of reciprocal lattice, Concept of Brillouin zones, Experimental methods of X-ray diffraction of crystals – Laue and Powder methods, Determination of unit cell parameters of a cubic crystal, Elements of neutron and electron diffraction.

UNIT – II : (13 Hrs**)**

Lattice Vibrations and Thermal Properties : Elastic waves in one dimensional array of identical atoms, Vibrational modes of a diatomic linear lattice and dispersion relations, Acoustic and Optical modes, Infrared absorption in ionic crystals, Phonons and verification of dispersion relation in crystal lattices. Lattice heat capacity- Einstein and Debye theories, Lattice thermal conductivity –Phonon mean free path, Origin of thermal expansion and Grunceisen relation.

UNIT – III : (13 Hrs**)**

Band Theory and Semiconductor Physics : Failure of Free electron theory of metals, Bloch theorem, Behavior of electron in periodic potentials, Kronig- Penny model, E vs K relation, Density of states in a band, Effective mass of electron, Negative effective mass and concept of hole. Distinction between metals, Semiconductors and Insulators, Intrinsic semiconductors, Fermi level, Expressions for electron and hole concentrations in intrinsic and extrinsic semiconductors, Hall effect in semiconductors.

UNIT – IV : (13 Hrs**)**

Crystal Growth and Imperfections : Crystal growth from solution and melt, growth from vapour phase, Experimental techniques of growth from melt. Classification of imperfections, Schottky and Frenkel defects, expression for their equilibrium concentrations in metals and ionic crystals, Colour centers and their models, Diffucion mechanisms, Fick's laws of diffucion, Kirkendal effect, Ionic conductivity, Dislocations- Edge and Screw dislocations, Dislocation multiplication, Grain boundaries.

Reference Books. :

1. Crystallography and Solid State Physics – A.R. Verma and O.N. Srivastava
2. Solid State Physics – A.J. Deckker, Macmillian Indian Ltd, 2003.
3. Introduction to Solid State Physics – C. Kittel, Johan Wiley Sons Inc, New York
4. Solid State Physics- RL Singhal, KedarNath&Ramnath& Co, 2006
5. Elements of Solid State Physics – J.P. Srivastava, Prentice Hall India, 2006.
6. Elements of Solid State Physics -- Ali Omar, Pearson Education Inc, 2002.

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Semester –II

Sl.No	Sub.Code	Paper No.	Subject	Instruc-tions.	Credits	Max. Marks
THEORY						
01	PAE 201 T	I	Electromagnetic Theory	4	4	100*
02	PAE 202 T	II	Statistical Mechanics	4	4	100*
03	PAE 203 T	III	Quantum Mechanics - II	4	4	100*
04	PAE 204 T	IV	Electronics	4	4	100*
PRACTICALS						
05	PAE 251 P	V	C- Programming Lab	4	2	100
06	PAE 252 P	VI	ElectronicsLab	4	2	100
07	PAE 253 P	VII	Heat & Acoustics Lab	4	2	100
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Semester - IISyllabus

PAE 201 T Paper – I :: Electromagnetic Theory

UNIT – I : (13 Hrs**)**

Electro-Static Potentials and Maxwell's Field Equations : Special techniques for calculating electrostatic potential : Poisson's and Laplace's equations- Solutions of Laplace's equations for electrostatic potential in Cartesian, spherical and cylindrical coordinates-Multipole expansion of the energy of a system of charges in an electrostatic field-The scalar and vector magnetic potentials. Derivation of Maxwell's equations-General wave equation-Gauge transformations-Lorentz and Coulomb gauges-Momentum, angular momentum and free energies of electromagnetic field-Poynting Theorem (work energy theorem in electrodynamics).

UNIT – II: (13 Hrs**)**

Propagation of Plane Electromagnetic Waves: Electromagnetic (EM) waves in unbounded media-EM wave equation for a homogeneous isotropic dielectric medium-Propagation of plan EM waves in free space-Propagation of EM waves in homogeneous isotropic dielectric medium- Energy transmitted by a plane EM wave-Propagation of EM wave in conducing medium- Attenuation and Skin effect-Energy transmitted –Polarization of EM wave.

UNIT – III: (13 Hrs**)**

Interaction of Electromagnetic Waves with Matter : Propagation of EM waves in bounded media-Boundary conditions for EDB and H – Reflection and Refraction of plane EM waves at plane interface between two dielectrics- Laws of reflection and refraction-Fresnel's relations- Reflection (R) and Transmission(T) coefficients -Brewester's angle-Total internal reflection-Reflection and Refraction of plane EM waves at plane interface between non-conducing and conducting medium-Metallic reflection and its applications – Dispersion in non-conductors –Normal and anomalous dispersion.

UNIT – IV: (13 Hrs**)**

Electromagnetic Fields and Radiating Systems: Electromagnetic radiation: Inhomogeneous wave equation for potentials-Retarded potentials-Multi-pole expansion of EM radiation for harmonically oscillating source-Long wavelength approximation-Oscillating electric dipole radiation-Oscillating magnetic dipole radiation-Radiation from centerfed linear antenna.**Radiation from accelerated charges** : LienardWiechert potentials-Electromagnetic field of a charge in arbitrary motion.

Reference Books:

1. Classical Electrodynamics by SP Puri, Tata McGraw-Hill Publishing Co., Ltd (2000).
2. Introduction to Electrodynamics by DJ Griffiths, Prentice- Hall of India (1998).
3. Electricity and Magnetism by MH Nayfeh and MK Brussel, John Wiley and Sons (1985).
4. Classical Electrodynamics by JD Jackson, John Wiley and Sons (1999).
5. Foundations of Electromagnetic Theory by JR Rietz, FJ Milford and Christy, Narosa Publishing house (1986)
6. Engineering Electromagnetics by WH Hayt and JA Buck Tata Mc-Graw Hill (2001)
7. Electromagnetic waves and Radiating systems by EC Jordan and KG Balmain, Prentic Hall (1968)

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Semester - IISyllabus

PAE 202 T Paper – II :: Statistical Mechanics

UNIT – I : (13 Hrs**)**

Relation between thermodynamics and statistical mechanics- Micro stages and macro states of a system – Phase space- Ensembles – Mean values and ensemble average – Density distribution in phase space- Liouville's theorem. Apriori probability postulate – Micro canonical, canonical and grand canonical ensembles –Quantization of phase space. Entropy and Probability –Equilibrium conditions: Thermal, mechanical and concentration equilibrium.Entropy of a perfect gas using micro canonical ensemble-Gibbs paradox-Sackur.-Tetrode equation.

UNIT – II : (13 Hrs**)**

Maxwell –Boltzmann statistics-Distribution law- Maxwell velocity distribution-Equi-partition theorem. Canonical ensemble- Partition function-Ideal gas, Grand canonical ensemble-Partition function-Ideal gas .Quantum Statistical Mechanics-Postulates-Indistinguishability-Bose-Einstein and Fermi-Dirac statistics and distribution laws.

Partition function and thermodynamic quantities-Translational, rotational and vibrational partition functions - Specific heat of diatomic molecules.

UNIT – III : (13 Hrs**)**

Ideal Bose-Einstein gas-Energy and pressure of the gas. Bose-Einstein condensation-Liquid Helium-Two Fluid model-Phonons, protons, super fluidity. Ideal Fermi-Dirac gas Energy and pressure of the gas –Electronic specific heat, thermionic emission, white dwarfs.

UNIT – IV : (13 Hrs**)**

Fluctuation-mean square deviation-Fluctuations in energy, volume and concentration Brownian motion-Classification of phase transition-Phase transitions of first and second kind: using model, Bragg-Williams approximation-One dimensional using model a application to Ferro magnetic systems-Order-Disorder transition.

Reference Books. :

1. Statistical Mechanics by SatyaPrakash and JP Agarwal (Pragati Prakahan-2002)
2. Statistical Mechanics by Gupta and Kumar (PragathiPrakahan -2002)
3. Statistical Mechanics by BK Agarwal and M Eisner (New Age Internaional)
4. Statistical Mechanics by RK Srivatava and J Ashok (Prentice Hall, India)
5. Introduction to phase transitions and critical Phenomena HE Stanley (Clrendon Press, Oxford).
6. Heat and Thermodynamics by Zemansky (TMH).

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Semester - IISyllabus

PAE 203 T Paper – III :: Quantum Mechanics – II

UNIT – I (13 hrs) :

Scattering Theory : Kinematics of Scattering Process: differential and total cross-section -Asymptotic from of scattering wave function. Scattering amplitude by Green's method. Born approximation method and screened potential and square well potential as examples - Partial wave analysis and phase shift-Optical Theorem- Relationship between phase shift and Potential. Scattering by Hard sphere.

UNIT – II (13 hrs) :

Time Independent Perturbation Theory : Approximation Methods. Non-degenerate case, First-and Second- order cases - Examples of harmonic and an-harmonic Oscillators. Degenerate case- Stark effect for H-atom for n=2 level. Variation Method - Helium atom ground state. WKB approximation method - connection formulae - application to Alpha Decay.

UNIT – III (13 hrs) :

Time Dependent Perturbation Theory : Time development of state, variation of constants (coefficients), Transition probability- Selection rules for transition. Constant perturbation. Transition probability to closely spaced leaves- Fermi's golden rule. Harmonic perturbation- Transition probability rate. Interaction of an atom with electromagnetic radiation. Electric dipole approximation. The Einstein Coefficients.

UNIT – IV (13 hrs) :

Relativistic Quantum Mechanics : Klein –Gordon Equation, Plane wave solution and Equation of continuity, Probability density- Dirac Equation, alpha, beta- matrices, Plane wave solution, significance of negative energy states. Spin of Dirac particle Relativistic particle in central potential –Total Angular Moment, Particle in a magnetic field – Spin Magnetic moment, properties of gamma matrices- Dirac's equation in covariant form.

Reference Books:

1. Quantum Mechanics by LI Schiff
2. A Text book Quantum Mechanics by PM Mathews and K Venkateshan (TMH)
3. Quantum Mechanics by Ghatak and Lokanathan (Macmillian)
4. Quantum Mechanics by E Merzbacher (John Wiley)
5. Quantum Mechanics by Aruldhas (New Age International
6. Modern Quantum Mechanics by Sakurai (Addison Wesley)

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Semester - IISyllabus

PAE 104 T **Paper – IV :: Electronics**

UNIT – I : (13 Hrs**)**

Regulated Power Supply : basic Principle of Zener regulator and its working, Transistorized Series regulator, Regulated power supplies using IC 723,78XX and Switch Mode Power Supply

Amplifiers :, Single Stage and two stage RC coupled amplifiers and their frequency response, hybrid π- model. High frequency response using hybrid π-model.

Feed back : The concept of feed back, Positive and Negative feed back. Advantages of Negative feedback in amplifiers, Emitter follower and Darlington pair.

Sinusoidal Oscillators (Using BJT's) : Barkhausen Criterion, Phase shift Oscillator, Wein Bridge Oscillator, Hartley and Collpitts Oscillators, Crystal Oscillator.

Multi-vibrators : Collector coupled Astable, Mono-stable, Bi-stable multi-vibrators, Schmitt trigger and its applications.

UNIT – II : (13 Hrs**)**

Operational Amplifiers : Characteristics of Ideal operational Amplifier, Block diagram of an IC operational Amplifier, Emitter coupled differential amplifier and its transfer characteristics. Analysis of inverting amplifier, Non-inverting amplifier, Integrator, Differentiator, summing amplifier, Difference amplifier, Comparator, Logarithmic amplifier and exponential amplifier, Analog computation, Square wave, Rectangular wave, Triangular wave and Sine wave generators. **Timer IC 555:** Working of IC 555, Astable and Mono-stableMulti-vibrator with IC 555.

D/A Converters: R-2R ladder type, 4 bit Binary Converter, D/A Accuracy and Resolution.

A/D Converters : Counter method, Successive approximation Conversion, Dual slope A/D conversion, A/ D Accuracy and Resolution.

.**UNIT – III : (**13 Hrs**)**

Logic Circuits: Min terms and Max terms, Karnaugh Maps (upto 4 variables), Half adder and Full adder, Decoder/ De-multiplexer, Data selector/ Multiplexer, Encoder.

Flip –Flops: RS, D JK and M/S JK flip flops with their truth tables, timing diagrams.

Shift Registers: Types of Registers, Serial in Serial out, Serial in Parallel out, Parallel in Serial out and Parallel in Parallel out Registers, IC 7496, Ring Counter.

Counters: Ripple (Asynchronous) Counters, Divide by N Counter, Synchronous Counters, Decade Counter using Flip-Flops and IC's 7490, 7493.

UNIT – IV: (13 Hrs**)**

Microprocessor: Introduction to Microprocessors –Architecture of 8085 microprocessor, Instruction set : Data transfer instructions, Arithmetic Logic and Branch operations, Interrupts, Simple Assembly language programming : 8-bit addition, 8-bit subtraction, 8-bit multiplication, Ascending and descending arrangement of given numbers.

Reference Books. :

1. Integrated Electronics –Milman Halkies.
2. Microelectronics –Milliman&Grabel.
3. Digital principles and applications- Malvino and Leech
4. Operational amplifier –Gawkward
5. Principles of Digital Electronics –Gothman
6. Digital Principles and Applications Computer Electronics –Malvino.
7. Microprocessors Architecture, Programing and Application with the 8085 / 8080 – Goankar
8. Pulse Digital & Switching Waveforms by Millman and Taub, TMH 2001.
9. Fundamentals of electronics by JD Ryder, Wiely.