w.e.f. 2008 - 09

DEPARTMENT OF PHYSICS
KAKATIYA UNIVERSITY
WARANGAL

M.Sc. Physics - Semester system- Courses with effect from academic year 2008-09.

Theory:		**Practicals:**	
I-Semester	Marks: 400	Marks: 200	Marks: 600
	I-1: Mathematical Physics	I-5 : General Physics - I	
	I-2: Classical Mechanics	I.6 : Electronics - I	
	I-3: Solid State Physics		
	I-4: Electronic Devices and Circuits		
II-Semester	Marks: 400	Marks: 200	Marks: 600
	II – 1 : Statistical Mechanics	II-5 : General Physics - I	
	II – 2 : Quantum Mechanics - I	II-6 : Electronics - I	
	II – 3 : Digital Principles and Integrated Circuits		
	II – 4 : Computer Programming and Numerical Methods		
III-Semester	Marks: 400	Marks: 200	Marks: 600
	III-1 : Quantum Mechanics – II	III-5 : General Physics - II	
	III-2 : Nuclear Physics (Spl)	III-6 (i) : Solid State Physics	
	III-3A: Solid State Physics – Special I	III-6(ii) : Electronics (Spl)	
	III-4A: Solid State Physics – Special II		
	III-3B : Electronics – Special I.		
	III-4B: Electronics – Special II.		
IV-Semester	Marks: 400	Marks: 200	Marks: 600
	IV-1 : Electromagnetic Theory and Optics	IV-5 : General Physics - II	
	IV-2 : Molecular and Resonance Spectroscopy (Spl)	IV-6 (i) : Solid State Physics	
	IV-3A: Solid State Physics – Special III	IV-6(ii) : Electronics (Spl)	
	IV-4A: Solid State Physics – Special IV		
	IV-3B: Electronics – Special III		
	IV-4B: Electronics – Special IV		

Grand Total Marks: 2400

Note:

1. For each theory paper, the maximum marks for end – semester examination is 80 marks and internal assessment 20 marks. Details are enclosed.
2. The Practical examinations will be conducted at the end of each semester.

M.Sc. I Semester (Paper I –1)

MATHEMATICAL PHYSICS

Unit I:
Solution of second order differential equation with constant coefficients, power series solutions – Frobenius method. Generating function for Hermite polynomials. Hermite differential equation and polynomials, Integral formula for Hermite polynomial, recurrence formula, Rodrigues formula, orthogonality of Hermite polynomials.

Unit II:
Laguerre differential equations and polynomials, Generating function for Laguerre polynomials, recurrence relation, Rodrigues formula for Laguerre polynomials, orthogonality property.

Beta and gamma functions: symmetry property, evaluation and transformation of Beta function, evaluation of gamma function, transformation of gamma function, relation between beta and gamma functions. Evaluation of integrals using Beta & gamma functions.

Unit III:
Hypergeometric equation, Hypergeometric function: Differentiation of hypergeometric function and its integral representation , Linear transformations, Representation of various functions in terms of hypergeometric functions, confluent hypergeometric functions, representation of various functions in terms of hypergeometric functions.

Unit IV:
Integral transforms, Fourier transforms and their properties, convolution theorem for Fourier transforms, Parseval's theorem, simple applications of Fourier transforms. Evaluation of integrals, solution of boundary value problems.
Laplace transforms and their properties, Laplace transform of derivatives and integrals. Laplace transform of periodic functions, initial and final value theorem, Laplace transform of some special functions, inverse Laplace transforms, Convolution theorem

Text and reference books:

1. Mathematical methods for Physicists – **Geroge B. Arfken & H.J. Weber** *(Academic Press)*
2. Mathematical methods in Physics and Engineering - **L.A. Pipes**.
3. Mathematical Physics - **B.D. Gupta** *(Vikas Publishing House Pvt. Ltd.)*
4. Mathematical Physics – **Satyaprakash** *(Pragati Prakasham)*

M.Sc. I Semester (Paper I –2)

CLASSICAL MECHANICS

Unit I:
The Lagrangian formalism: Mechanics of a system of particles, constraints of motion, generalized coordinate, Hamilton's variational principle, and Lagrange equations, Lagrangian of a free practicle and a system of particles with interaction, Lagranges equations from D' Alembert's principle, velocity dependent forces, dissipative function, Generalised momentum, conservation of momentum, cyclic coordinates and conservation of energy

Unit II:
Hamiltonian formalism:Hamiltonian and its physical significance, Hamilton's equations, Hamilton's equations in different coordinate systems. Examples: Harmonic oscillator, motion of a particle in central force field, charged particle in an electromagnetic field. Compound pendulum, Routh's procedure ,the Routhian, Poisson brackets, angular momentum and Poisson brackets, a modified variational principle, canonical tranformations, Poissons brackets and canonical transformations.

Unit III:
Rigid body dynamics: Fixed and moving coordinate systems of a rigid body, The Eulerian angles, Cayley – Klein parameters, angular momentum and kinetic energy of rigid body, equations of motion of a rigid body, Euler's equations, free rotation and precession of a symmetrical top, motion of a charged rotating particle in a uniform magnetic field.

Unit IV:
Hamilton-Jacobi theory: The Hamilton-Jacobi equation for Hamilton's principle function, the harmonic oscillator problem, Hamilton-Jacobi equation from Hamilton's characteristic function, Seperation of variables in the Hamilton – Jacobi equation, Action-angle variables in a system of one degree of freedom, action-angle variables for completely separable systems, The Kepler problem in action-angle variables, Hamilton-Jacobi theory – application to geometrical optics and wave mechanics.

Text and reference books:

1. Classical Mechanics of Particles and Rigid Bodies – **Kiran C. Gupta** *(New Age International Publishers)*
2. Classical Mechanics – **Goldstein** *(Narosa Publishing House)*
3. Classical Mechanics – **JC Upadhyaya** *(Himalaya Publishers)*

M.Sc. I Semester (Paper I –3)

SOLID STATE PHYSICS

Unit I – Crystallography

Introduction to crystal structures - Atomic packing in solids – s.c., b.c.c., f.c.c. and hcp. Reciprocal lattice, X-ray diffraction Laue equations from X-ray diffraction, Bragg's law, equivalance of Laue and Bragg's equations, diffraction in reciprocal space, Ewald sphere, limiting sphere. Electron and neutron diffraction (qualitative)

Nanomaterials: Introduction – nanoparticles – metal nanoclusters – semiconductor nanoparticles, nanostructures – carbon clusters, carbon nanotubes, quantum nanostructures. Applications of nanomaterials.

Unit II – Lattice vibrations

Elastic vibrations of continuous media, group velocity and phase velocity. Vibrations of monoatomic and diatomic linear lattices; concept of phonon – experimental determination of dispersion relations, inelastic scattering of neutrons by phonons. Infrared absorption by ionic crystals. Thermal expansion and thermal conductivity - Normal and Umklapp processes.

Unit III – Band theory of solids

Bloch theorem, Kronig Penny model, effective mass . Distinction between metals, insulators and semiconductors; concept of a hole. Motion of electrons in a three dimensional lattice, constant energy surface and Brillouin zones. Concentration of electrons and holes in an intrinsic semiconductor, model for an impurity semiconductor.

Unit IV – Magnetism

Laugeuin's theory of Diamagnetism . Quantum theory of paramagnetism, the rare earth ions, iron group ions; quenching of orbital angular momentum.

Ferromagnetism – characteristic behaviour of ferromagnetic materials, spontaneous magnetization, Curie – Weiss law and hysteresis, interpretation in terms of the exchange integral, temperature dependence of spontaneous magnetization. Saturation magnetization at absolute zero. Ferromagnetic domains, anisotropy energy, transition between domains. Origin of domains, coercive force and hysteresis, concept of magnons.

Text and reference books:

1. Introduction to Solid State Physics – **C. Kittel.** *(John Wiely & Sons)*
2. Solid State Physics – **A. J. Dekker** *(Machmillan student Editions)*
3. Solid State and Semiconductor Physics – **J. P. Mc kelvy** *(Krieger Publications)*
4. Principles of Solid State Physics – **R. A. Levy** *(Academic Press)*
5. Elements of Solid State Physics - **J.P. Srivastava** *(Prentice-Hall of India)*

M.Sc. I Semester (Paper - I.4)

ELECTRONIC DEVICES & CIRCUITS

Unit I

Special purpose, electronic devices: LED, photo diode, Laser diode, varactordiode, BJT as a switch, solar cell – characteristics - opto coupler, photo transistor.
FET – construction – V.I. characteristics – FET as Voltage Varaiable Resistor (VVR) - Automatic gain control (AGC).
SCR – construction - V.I. characteristics – controlled power rectification.
UJT – construction - V.I. characteristics, UJT as a relaxation oscillator.

Unit II

Power supplies: Full wave rectifiers – ripple factor – conversion efficiency. Filters : capacitor input and inductor input filters – LC and RC-Π type filters. Zener diode voltage regulator, Transistor series voltage regulator, switch mode power supply. IC voltage regulators: LM78XX, LM79XX and LM317 series.

Unit III

Fundamentals of amplifiers: Feed back topologies classification. Analysis of RC coupled C.E amplifier: low, mid and high frequency – response – Bode plot –Emitter follower – frequency response. Darlington pair, cascode connection. Large signal amplifiers: classification – class A, class B – pushpull amplifier -harmonic distortion – class AB amplifier – class C - tuned amplifier.

Unit IV

Oscillators: Barkhausen criterion – RC oscillators: Phase shift oscillator and Wein bridge oscillator, LC oscillators: Hartley oscillator, Colpitts oscillator and crystal oscillator. Multivibrators: astable, monostable and bistable.

Text and reference books:

1. Integrated Electronics – **Millman & Halkias** *(Tata McGraw Hill)*
2. Electronic Principles – **Malvino & Bates** *(Tata McGraw Hill 7th edition)*
3. A first course in electronics – **Anwar Khan & Kanchan Dey** *(Prentice-Hall of India, 2006)*
4. Electronic Devices and Circuit theory – **Robert L . Boylestad & Louis Nashelsky** *(Prentice-Hall of India 8th edition)*
5. Electronic Devices and Circuits - **Bogart** *(Pearson education)*
6. Electronic Devices and Circuits - **David A. Bell** *(Prentice-Hall of India)*

M.Sc. Physics I – Semester (Practicals)
List of Experiments

General Physics Laboratory (Paper: I-5)

1. Viscosity of liquid by oscillating disc method.
2. Specific heat of a solid (cylindrical graphite sample).
3. Determination of elastic constants (y,n,k) by Newton's rings (uniform bending).
4. Determination of Cauchy's constants for a) glass b) quartz c) calcite.
5. Biprism - Determination of wave-length of monochromatic light (sodium light).
6. Diffraction grating - Determination of wavelength of laser beam.
7. Michelson interferometer – Determination of λ.
8. Hallow prism – Refractive index of liquids.

Electronics Laboratory (Paper: I-6)

1. Verification of Maximum Power Transfer theorem, Thevinin's theorem and Norton's theorem.
2. V-I characteristics of FET-Determination of parameters.
3. V-I characteristics of UJT and UJT as relaxation oscillator.
4. VI characteristics of SCR - Phase controlled rectification.
5. RC-coupled common source amplifier – study of gain frequency response.
6. Collector coupled astable multivibrator.
7. Hartley oscillator-study of variation of frequency with capacitance in the tank circuit.
8. Colpitt's oscillator.
9. IC Voltage Regulators (78XX and 79XX).

Text and reference books:

1. Advanced Practical Physics - **Wornsop & Flint**.
2. Advanced Practical Physics vol.1 - **SP Singh** *(Pragatiprakashan).*
3. A Text Lab manual in Electronics - **ZBAR** *(Tata McGraw Hill*)
4. Linear Integrated Circuits – **Shail B. Jain & B. Roy Choudhury** (*New Age International Publishers, 2nd edition).*
5. Linear Integrated Circuits - **Shalivahanan & VS Bhaaskaran** *(Tata McGraw Hill,2008)*

M.Sc. II Semester (Paper II -1)

STATISTICAL MECHANICS

Unit – I : **Fundamentals of statistical mechanics**

Microstates and Macrostates of a system - principle of equal apriori probability - phase space - quantization of phase space - concept of ensemble- ensemble average - density distribution function in phase space- Liouville's theorem - Maxwell-Boltzman(MB), Fermi-Dirac(FD), Bose-Einstein(BE) distributions – classical limit – entropy and probability – entropy of a two level system.

Unit – II : **Ensembles**

Microcanonical ensemble(MCE) – Thermodynamics in MCE- Entropy of an ideal gas in MCE- Gibbs Paradox – Sackur-Tetrode equation – Canonical ensemble(CE) – Thermodynamics in CE – Ideal gas in CE – Maxwell's velocity distribution – Equipartition energy theorem – Grand Canonical Ensembel(GCE) – Thermodynamics in GCE – Ideal gas in GCE - Fermi-Dirac and Bose-Einstein distribution functions from grand canonical partition function.

Unit – III : **Bose systems:**

Equation of state for ideal BE and FD gases – Photons - Planks distribution law – Phonons – Specific heat of solids – Einstein and Debye's theories – Bose Einstein condensation - Liquid He – Two Fluid model – Phonons – Rotons – Superfluidity.

Unit – IV: **Fermi systems:**

Ideal Fermi gas – Free electron model – electronic specific heat – thermionic emission – Pauli paramagnetism – Landau diamagnetism – white dwarfs – Boltzman transport equation – Electrical conductivity –Thermal conductivity – Wiedermann-Franz law – Non-equlibirium semiconductors – Electron-hole recombination – Classical Hall effect – Quantum Hall effect.

Text and reference books :

1) Statistical Mechanics - **Agarwal & Melvin Eisner** *(New age international).*
2) Statistical Mechanics - **Kerson Huang** *(John Wiley & Sons).*
3) Statistical Mechanics - **R.K. Srivastava & J. Ashok** *(Prentice-Hall of India).*
4) Statistical Physics - **L.D. Landau & E.M. Lifshitz** *(Pergamon).*
5) Statistical Mechanics - **D.A. McQuarrie** *(Harper & Row).*

M.Sc. II Semester (Paper II –2)

QUANTUM MECHANICS - I

Unit – I : Bra and Ket notation:

Principles of superposition. Bra and Ket vectors, linear operators. Hermitian conjugate. Eigen values and eigen vectors of Hermitian operators. Complete set of states. Complete set of commuting operators. Continuous spectrum of eigen values. Orthogonality.

Unit – II : Representations:

Properties of Dirac – Delta function. Orthogonal basis. Representation for ket, bra and operator. Wave function as a representation of ket, position and momentum representations. Poissons brackets, Quantum conditions. Equation of motion, Schroedinger Heisenberg and Interaction pictures. Ehrenfest theorem. Harmonic oscillator problem in terms of creation and annihilation operators.

Unit – III : Exactly solvable problems:

Spherically symmetric potentials in 3 dimensions, orbital angular momentum operator. Commutation relations, Eigen vectors and eigen values of L^2 and L_z . Pauli spin operators . The hydrogen atom problem, Vibrating rotator, rigid rotator.

Unit – IV : **Approximate methods:**

i) Time independent perturbation theory: Non-degenerate levels. Application to normal He atom. Degenerate levels-application to first order stark effect in hydrogen atom with n = 2 and to normal Zeeman effect.

ii) Time dependent perturbation theory: Transition amplitude in first and second order, first order transition constant perturbation, Fermi golden rule, harmonic perturbation. Emission and absorption probabilities. Einstein A and B coefficients.

iii) Variation method, application to normal helium, atom.

Text and reference books :

1. Quantum Mechanics – **Ajoy Ghatak & S. Loknathan** *(Macmillan India Ltd)*.
2. The Principles of Quantum Mechanics – **P.A.M. Dirac** *(Oxford University Press).*
3. Quantum Mechanics – **L.I. Schiff** *(McGrawhill)*
4. A Text Book of Quantum mechanics – **P. M. Mathews & K. Venkatesan** *(Tata McGraw Hill)*

M.Sc. II Smester (Paper II - 3)

DIGITAL PRINCIPLES AND INTEGRATED CIRCUITS

Unit I

Logic gates, Positive and Negative logic, Boolean laws, logic simplification using Boolean Algebra and Karnaughmap method.

4 bit Binary Adder, Encoders & Decoders, parity generator and checker Multiplexer and DeMultiplexer. RS,D,JK & MS-JK flipflops, their operating principles and truth tables, shift registers and their operations, counters: Asynchronous 4 bit binary counter and with feedback for different modulo - Synchronous counters – Ring counter.

Unit II

Logic families and Memory Devices: Logic families and their performance characteristics – RTL, DTL, I^2R Logic, TTL, ECL, PMOS, NMOS & CMOS logic, Tristate logic (TSL)

Semiconductor memories: Diode ROM, EPROM, E^2PROM, Memory organization and expansion – Memory devices: 8155 RAM, 2716 EPROM – 8355 ROM with I/O ports.

Unit III

Operational Amplifiers characteristics and Applications: OP-AMP Basic structure – Difference amplifier circuits using BJTs only. OP-AMP-dc and ac performance characteristics – open and closed loop configurations, virtual ground concept; Inverting and Non inverting Amplifiers – voltage follower – Adder, Subtractor, Differentiator, Integrator & difference amplifier, Analog computation – solution of second order differential equation – Log and antilog amplifiers.

Waveforms generators: sinewave, squarewave, triangular and sawtooth wave voltage comparators.

Unit IV:

Active filters & Timer circuits: comparision between passive and active filters, first order low pass, high pass active filters, band pass, band reject and all pass filters.

555 timer – description of functional diagram – Astable and monostable operations, VCO, Schmitt trigger. Phase locked loop (IC565): Basic Principles - frequency multiplication/division, analog phase detector.

Text and reference books :

1. Modern Digital Electronics – **RP Jain** *(Tata McGraw Hill 3rd edition)*
2. Fundamentals of digital circuits – **A. Anand Kumar** *(Prentice-Hall of India)*
3. Linear Integrated circuits – **Shail B. Jain & Roy choudhury** *(New Age International Publishers 2nd edition).*
4. Operational Amplifiers – **Ramakanth A Gaykwad** *(Prentice-Hall of India)*
5. Linear Integrated circuits - **S.Salivahanan & V.S. Bhaaskaran** *(Tata McGraw Hill,2008)*
6. Microprocessor Architecture, Programming and Applications with 8085 – **Ramesh S Goankar** *(Wiley Eastern Edition*)
7. Digital Principles and Applications – **Malvino & Leach** *(Tata McGraw Hill)*

M.Sc. II Semester (Paper II –4)

COMPUTER PROGRAMMING AND NUMERICAL METHODS

Unit – I: C – 1.

Character set, Identifiers and key words, data types, constant, variables, and arrays, declarations, expressions, statements, symbolic constant, arithmetic operators, Unary operator, relational and logical operators, assignment operators, conditional operator, library functions, getchar, putchar, scanf, printf, gets , puts functions. Control statements – while, do-while, for statements, nested loops, if-else, switch, break, continue statements, comma operator, go to statement.

Unit II: C – 2.

Functions – defining and accessing a function – passing arguments to a function, specifying argument data types, function prototypes. Storage classes, automatic variables, external variables, static variables, multi file programs. Arrays – defining an array, processing an array passing arrays to functions, multi dimensional arrays, arrays to a function, pointers – pointer declarations, passing pointers on pointers, pointers and multi dimensional arrays, arrays of pointers, passing functions to other functions, structures and unions – defining a structure, processing a structure, user defined data types, structures and pointers, passing structure to a function, self-referential structures – unions.

Unit- III: Numerical Methods - I

Finding the roots of a transcendental equations – Bisection method, Newton – Raphson method - solving of problems – writing programs in C-language for these methods.

Rate of convergence – methods for multiple roots. Finding the roots of polynomial equations – Berge viata, Baristow and Graffee root squaring methods – Solving of problems. Writing programs in C-language for these methods.

Unit – IV: Numerical Methods - II

Solution of simultaneous equations – Cramer's rule, Gauss elimination method, triangularization method. Jacobi, Gauss–siedel and successive over relaxation methods. Problems: Writing of programs in C-language for these methods.

Text and reference books :

1. Numerical Mathematical Analysis – **J.B. Scarborough** *(OXFORD & IBH Publishing Co. PVt. Ltd.)*
2. Numerical Methods for Scientific and Engineering Computation – **M.K.Jain, S. R. K. Iyengar & R.K. Jain** *(New Age International Pvt. Ltd.)*
3. Programming with C – **Byron S. Gottfried** *(Tata McGraw Hill Edition)*
4. Let us C - **Kanitkar** *(BPB Publications)*
5. Computer Oriented Numerical Methods – **V. Rajaraman** *(Prentice – Hall of India Pvt. Ltd.)*

M.Sc. Physics II-Semester (Practicals)
List of Experiments

General Physics Laboratory (Paper: II-5)

1. Determination of Stefan's constant.
2. Velocity of ultrasonic waves in organic liquids - using Interferometer.
3. Thermal expansion by Fizeau's method (Coefficient of linear expansion of brass).
4. Diffraction due to single slit – Determination of λ.
5. Diffraction of laser light due to single slit – study of intensity distribution.
6. Lloyd's mirror - Determination of wavelength of monochromatic light.
7. Michelson interferometer – Determination of λ.
8. Determination of Rydberg's constant
9. Computer Programming

Electronics Laboratory (Paper: II-6)

1. Operational Amplifiers – Measurement of
   a) bias current and offset voltage b) CMRR
2. Operational Amplifiers – Measurement of
   a) slew rate b) output impedance
3. (a) Inverting Op-amplifier – study of gain frequency response.
   (b) Non-inverting Op-amplifier – study of gain frequency response.
4. (a) Op-amp as differentiator.
   (b) Op-amp as Integrator.
5. Phase shift oscillator using IC741.
6. IC555 timer - Monostable multivibrator.
7. IC555 timer - Schmitt trigger.
8. IC555 timer - voltage controlled oscillator.
9. Digital experiments: a) Verification of DeMorgans Theorems
   b) Construction and verification of half and full adder circuits.

Text and reference books:

1. Advanced Practical Physics - **Wornsop & Flint**.
2. Advanced Practical Physics vol.1 - **SP Singh** *(Pragatiprakashan).*
3. A Text Lab manual in Electronics - **ZBAR** *(Tata McGraw Hill)*
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