CMJ UNIVERSITY, SHILLONG

REGULATION FOR MSC PHYSICS

Duration – Two Years

Eligibility - B.Sc. with relevant subject or its equivalent

Scheme of Distribution of Marks

Sr. No.	First Year	Internal Assessment Marks	Term End Examination	Total Marks	Passing Marks
1	Mathematical Physics And Numerical Methods	30	70	100	40
2	Wave And Quantum Mechanics	30	70	100	40
3	Condensed Matter Physics	30	70	100	40
4	Basic Electronics	30	70	100	40
Sr. No.	**Second Year**	**Internal Assessment Marks**	**Term End Examination**	**Total Marks**	**Passing Marks**
1	Modulation Techniques And Optical Communication	30	70	100	40
2	Introduction To Spectroscopy And Nuclear Physics	30	70	100	40
3	Electro Magnetic Theory	30	70	100	40
4	Semiconductor Memories And Microcontroller	30	70	100	40

M.Sc PHYSICS SYLLABUS - First Year

MATHEMATICAL PHYSICS AND NUMERICAL METHODS

MSP - 101

UNIT I

VECTOR SPACE AND TENSORS

Vector Space - Definitions - Linear independence of Vector - Bilinear and quadratic forms - change of basis - Schmidt's orthogonalisation processes - Swartz inequality - Application of vectors to hydrodynamics the equation of flow in solids Tensors-N-dimensional space – superscripts - subscripts - coordinate transformations Kronecker delta symbol - properties of Kronecker delta - generalized Kronecker delta Tensors of higher ranks - Algebraic operation of Tensors - symmetric and asymmetric Tensors - Application of Tensors - Dynamics of a particle – Elasticity - Rigid bodies.

UNIT II

Fourier's and Laplace's integral transforms

Fourier transform-properties of Fourier's transform-Fourier transform of a derivatives - Fourier's sine and cosine transform of a derivative - Finite Fourier transforms - Simple application of fourier transforms - Laplace transforms - properties of Laplace transform - Laplace transforms of a derivative of a function - Laplace transforms of integral - Inverse Laplace transform-properties of inverse Laplace transform-convolution theorem - Application of Laplace transform.

UNIT III

Complex variable

Function of complex variable – limit - continuity – Differentiability - Analytic function – Cauchy - Rieman condition - Differential equation - Cauchy Integral theorem- Cauchy Integral formula - Morera's theorem - Liouville's theorem - Taylor's series – Laurent's series - singularities of an analytical function – Residues - Cauchy Residue theorem – Evaluation of definite integrals - contour integration.

UNIT IV

Special function and differential equations

Gamma and Beta function - Liouville problem - solution for Bessel - Legendre-Lagurre and Hermite differential equation - properties - Generating functions – Rodrigue's formula - Orthogonal properties - recurrence relation.

UNIT V

Dirac delta function and greens function

Dirac - Delta function - Three dimensional delta function – Green's function - for one dimensional case - Symmetry properties of green function – Green's function for poisson equation - Quantum mechanical scattering problem.

WAVE AND QUANTUM MECHANICS

MSP - 102

UNIT – I

Wave Mechanical Concepts and Formalism of Quantum Mechanics

Inadequacy of Classical Mechanics-.Shortcomings of Old Quantum Theory- Introduction -The de Broglie Wavelength- Experimental Study of matter waves - (Thomson's Experiment) - Heisenberg's Uncertainty Principle- Basic postulates of Wave Mechanics- Ehrenfest's Theorem- Derivation of Time-dependent form of Schrodinger Equation- Properties of the Wave Function

UNIT – II

One Dimensional Problems

The particle in a box- Particle in a Box Infinite Square Well Potential-The Barrier Penetration Problem- Linear Harmonic Oscillator- Rectangular Potential Well

UNIT – III

Three Dimensional Problems

The Hydrogen Atom- The Normal (Ground) State of Hydrogen Atom- Hydrogen-like Wave-Functions and their Discussion-The Rigid Rotator

UNIT – IV

Statistical Mechanics

Introduction - Phase Space- Maxwell-Boltzmann Distribution Law- Molecular Energies in an Ideal Gas- Maxwell-Boltzmann Velocity Distribution Law- Bose-Einstein Distribution Law- Fermi-Dirac Distribution Law- Comparison of the three Distribution Laws- Planck Radiation Formula- Macroscopic and Microscopic Descriptions-Quantum Statistics- Electron Gas

UNIT – V

Relativity Thoery

Introduction- Frame of Reference - Special Theory of Relativity- The Lorentz Transformation Equations- Length Contraction- Time Dilation- Addition of Velocities- Variation of Mass with Velocity- Mas Energy Equivalence- The general Theory of Relativity

CONDENSED MATTER PHYSICS

MSP - 103

UNIT I

Lattice Vibrations-Group velocity and Phase velocity -Derivation of force constant from experimental dispersion relation- Brillouin zones-Lattice with two atoms per primitive cell- PHONONS- Momentum of phonons-Einstein's theory of specific heat-Debye's Theory of specific heat -Thermal conductivity-Thermal Expansion-Umklapp processes- Imperfections in crystals-Colour Centres -The Edge Dislocation - The Screw Dislocation -Grain Boundaires

UNIT II

Drude theory of metals- The Hall effect- Free electron gas in three dimensions- Transport properties- Boltzmann transport equation- Electrical conductivity- Thermal conductivity- De Haas-Van Alphen effect- Periodic potential and Bloch theorem- Electron in a periodic potential – Kronig and Penny model-Brillouin zones - Wave functions in periodic lattice and near zone boundary- Fermi surface- Density of states-Band gap-Equation of motion-Holes- Effective mass- Carrier concentration in semiconductor- Impurity conduction.

UNIT III

Fermi surfaces-Construction of fermi surfaces-Experimental methods for Fermi surface studies-Quantisation of orbits in a magnetic field- Carrier concentration-Mobility - Variation of Fermi level with temperature and concentration of donor atoms- Direct and indirect bandgap –semiconductors-Conductivity of extrinsic semiconductor- Drift current (or) conduction current in Semiconductors-Diffusion current in semiconductors- Einstein equation- Generation and recombination of minority charge carriers in semiconductors -Equation of continuity

UNIT IV

Ferro magnetism- General properties of ferroelectric materials-Ferroelectric domains-Thermodynamics of ferroelectric transitions- Weiss theory of ferromagnetism- Temperature dependence of spontaneous magnetisation - Heisenberg's theory of Ferromagnetism between the two spins.- Ferromagnetic domains- Bloch Wall-Spin waves –Magnons- Ferrites-Thermodynamics of the superconductivity transition- London equations-BCS theory of superconductivity- Flux quantization- Persistent currents- Josephson tunneling-Josephson effect

UNIT V

Crystal growth phenomena-Introduction- Nucleation-Crystal growth techniques- Growth from the melt- The bridgman technique- The crystal pulling technique- Liquid encapsulated -Czhochralski technique- Zone melting technique-Preparation of quantum nanostructures-Fermi gas and density of states

BASIC ELECTRONICS

MSP - 104

Unit I

Working and Characteristics of Junction diode ,Zener diode and tunnel diode. Working of IMPATT diode, PIN diode . Construction and V-I characteristics of thermistors, Gunn effect diode, Varactor diode, Photoconductive devices - Photoconductive cells, photo diodes, LED, Solar Cells - MEMS and Nano Technology

Unit II

Construction – operation and Characteristics of a Bipolar transistor- biasing of a transistor – base bias, collector to base bias and self bias-. Causes of shift of Quiescent operating point. Stability factor- Hybrid parameters- Construction , operation and Characteristics of SCR, UJT, JFET and MOSFET - Biasing of JFET- Multivibrators.

Unit III

IC Fabrication: classification –fundamentals of monolithic IC technology – basic planer processes: Silicon wafer preparation – Epitaxial growth – Oxidation – photolithography – Diffusion – Isolation – Metallization – monolithic transistors – monolithic diodes – integrated resistors – integrated capacitors – thin and thick film technology

Unit IV

Digital IC's: Basic terms related to digital IC's – RTL and DTL circuits – Integrated Injection logic - TTL – Open collector output – Totem pole output – Schottky TTL gate – ECL – MOS – CMOS.

Unit V

Designing of OPAMP circuits: OPAMP as Comparator – OPAMP as zero crossing detector – Constant current source – current to voltage converter – thermocouple – temperature monitor – strain gages –force measurement

M.Sc (PHYSICS) - Second Year

MODULATION TECHNIQUES AND OPTICAL COMMUNICATION

MSP - 201

UNIT I

PULSE MODULATION SYSTEM:

Introduction to pulse modulation – types – Sampling theorem – Pulse – Width Modulation – Generation and demodulation of (PWM) – Pulse Position Modulation (PPM). Pulse code Modulation – Principles – Effects of noise – Companding – Advantages and applications of PCM – Differential PCM – Delta Modulation.

UNIT II

DIGITAL MODULATION TECHNIQUES:

Digital carrier systems – Amplitude shift keying – Frequency shift keying - Phase shift keying (PSK) – Binary Phase Shift Keying (BPSK) – Carrier Recovery circuits – Differential phase shift keying (DPSK) – Hard and soft Decision Decoders.

UNIT III

FIBER OPTIC CABLES:

Optical fiber cables – Fiber strength and durability – Stability of the fiber transmission characteristics: - Micro bending – Hydrogen absorption – Nuclear radiation exposure – Cable design; Fiber buffering – Cable structured and strength members – Cable sheath and water barrier – Example of fiber cables.

UNIT IV

LIGHT SOURCES AND LIGHT DETECTORS:

Light sources: LED structure – Planar LED, Dome LED, Surface emitter LEDs – Edge emitter LEDs – Super luminescent LEDs – LEDs Reliability. Light detectors: Mid – Infrared photodiodes – phototransistors – Photoconductive detectors.

UNIT V

FIBER OPTICAL COMMUNICATION COMPONENTS AND SYSTEMS

Components: Coupling Components for optical fibers - Modulation methods and Modulators-Switches – Transmitters – Receivers – Optical amplifiers (Semiconductor Laser Amplifiers). Systems: Transmitter and Receiver design – Link design – Link codes for Optical fiber links.

INTRODUCTION TO SPECTROSCOPY AND NUCLEAR PHYSICS

MSP - 202

UNIT-I

Vibrational Spectroscopy: Symmetry of polyatomic molecules and molecular vibrations-Group theory and selection rules for Raman and IR vibrational modes-Calculation of normal modes of Raman and IR activity toC_{2V} and C_{3V} point groups-Representations fro molecular vibrations-Internal and symmetry coordinates-Calculation of F-G matrix-Normal coordinate analysis for XY_2 bent asymmetrical type molecule.

IR-Spectroscopy: Principle and theory of infrared spectroscopy-Far IR and Near IR absorption spectroscopy-Mid IR. FT-IR spectroscopy- Vibrational frequencies and qualitative analysis-sampling methods-Instrumentation- Applications.

Raman Spectroscopy:FT-Raman spectroscopy-Degree of polarization-structure determination using IR and Raman spectroscopy- Resonance Raman spectroscopy- Coherent anti – Stokes Raman spectroscopy.

UNIT-II

NMR and ESR Spectroscopy: Basic principles of interaction of spin and applied magnetic field-concept of NMR spectroscopy-High resolution continuous wave NMR spectrometer-advantage of FT-NMR-Chemical shift-simple application to structural determination – first order and second order spectrum-double resonance and spin tickling.Origin of electron spin resonance- design of ESR spectrometer-hyperfine structure study-ESR study of anisotropic systems- Triplet states study of ESR-application of ESR to crystal defects and biological studies.

UNIT-III

NQR and Mossbauer Spectroscopy: Principles of NQR- Energy levels of quadrupole transitions for half integral spins- design of NQR spectrometer-application of NQR to chemical bonding and molecular structures.Principle of Mossbauer effect- Schematic arrangements of Mossbauer spectrometer- isomer shift-quadrupole interaction-magnetic hyperfine interactions- applications to molecular and electronic structures.

UNIT-IV

Nuclear Reactions and Scattering Process: Bohr Wheeler's theory of nuclear fission- Fission reactors-Power and breeder type reactor-Nuclear fusion-Basic fusion process-Solar fusion-cold fusion-Controlled thermonuclear reactions Energetic of reactions-Q equation-level widths in nuclear reaction- Nuclear reaction cross section. The scattering cross section-scattering amplitude-

Expression in terms of Green's function-Born approximation and its validity- Screened coulomb potential- Alpha particles scattering- Rutherford formula.

UNIT-V

Elementary particles: Four types of interactions and classifications of elementary particles- Isospin- Isospin quantum numbers- Strangeness and Hyper charge- Hadrons Baryons- Leptons- Invariance principles and symmetries- Invariance under charge- parity (CP), Time(T), and CPT-CPT violation in neutral K meson decay- Quark model SU(3) symmetry- Gellmann- Nishijama formula- Gauge theory of weak and strong interactions- charm, bottom and top quarks.

ELECTRO MAGNETIC THEORY

MSP - 203

UNIT 1

Electrostatics-Coulomb's law-electric field-Gauss's law-surface distributions of charges and dipoles-Poisson's equation-Laplace equation-Green's theorem-Solution of boundary value with green function-Electrostatic potential energy and capacitance

UNIT –II

Boundary value problems in electrostatics-surface charge density-point charge in the presence of a charged, insulated, conducting sphere-point charge near a conducting sphere at -fixed potential-point charge in the presence of a charged, insulated, conducting sphere-point charge near a conducting sphere at fixed potential-conducting sphere in a uniform electric field by method of images-solution of Laplace equation in spherical co-ordinates-multipole expansion-boundary value problems with dielectrics-molecular polarizability and electric susceptibility-electrostatic energy in dielectric media

UNIT-III

Magnetostatics-biot-savart law-differential equation of magnetostatics and ampere's law-momentum-magnetic fields of a localized current distribution & magnetic -force, torque and energy of a localized current distribution in an external magnetic induction-macroscopic equations and boundary conditions of b and h-macroscopic equations on b & h- boundary conditions-methods of solving boundary – value problems in magnetostatics-uniformly magnetised sphere

UNIT-IV

Electromagnetics-Faraday's law of induction-Maxwell's equation-gauge-transformation, lorentz gauge transformation, coulomb teansfor-poynting's theorem and conservation of energy and momentum-plane electromagnetic waves in non conducting medium-electro magnetic theory linear and circular polarization-snell's law-cylindrical cavities and waveguides

UNIT-V

Applications of E.M waves in plasma-Pinch effect-instabilities in plasma kink –instability-Alfen wave

SEMICONDUCTOR MEMORIES AND MICROCONTROLLER

MSP - 204

UNIT-I

Memories : Introduction**,** Static shift register memory – Dynamic MOS shift register memory – CMOS shift register memory – Charge Coupled Device (CCD) – Practical CCD Memory – Content Addressable Memory (CAM)

UNIT-II

Magnetic recording technique – magnetic tape – magnetic bubble memory – magnetic disk storage – floppy disk – Winchester disk – compact disk (CD) – digital audio CD – laser CD.

UNIT-III

Measuring Instruments :Q meter – Dual trace oscilloscope – sampling oscilloscope – analog recorders – XY recorders – Digital recorders – Digital displays – wave analyzers and spectrum analyzer – Digital voltmeter and multimeters – Electronic counters.

UNIT-IV

Architecture of Microcontroller 8051: Introduction – comparison between microcontroller and microprocessors – architecture of 8051 – key features of 8051 – Memory organization – data memory and program memory – internal RAM organization – special function registers – control registers – I/O ports – counters and timers – interrupt structure.

UNIT-V

Programming the Microcontroller 8051: Instructions set of 8051 – arithmetic, logical, data move, jump and call instructions - addressing modes – immediate, register, direct and indirect addressing modes – assembly language programming – simple programs to illustrate arithmetic and logical operations (sum of numbers, biggest and smallest in an array) – software time delay