M.Sc. (Physics) II - Semester Syllabus under CBCS pattern
(For 2021-22 academic year onwards)

II-Semester (w.e.f. 2021-2022 academic year)

Paper code	Comp. code	Title of the paper	Internal Exam Marks	End Exam		Total Max. Marks	Total Min. Marks	No. of credits
				Max. Marks	Min. Marks			
Theory								
2.1	201	Statistical Mechanics	20	80	32	100	40	04
2.2	202	Quantum Mechanics-1	20	80	32	100	40	04
2.3	203	Integrated circuits & Analog modulation	20	80	32	100	40	04
2.4	204	MATLAB and Applications	20	80	32	100	40	04
Practical								
2.5	205	General Physics – II	--	100	40	100	40	04
2.6	206	Electronics - II	--	100	40	100	40	04
Seminar			--	25	10	25	10	01
Total						**625**		**25**

G. Padmaja
22/12/2021
Chairperson, BoS in Physics, KU, Wgl

2.1: STATISTICAL MECHANICS

Unit I: ENSEMBLES **(13 Hrs)**

Concept of ensembles, Ensemble average, 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 ensemble (GCE) – Thermodynamics in GCE – Ideal gas in GCE – Fermi-Dirac and Bose-Einstein distribution functions from grand canonical partition function.

UNIT II: BOSE SYSTEMS **(10 Hrs)**

Equation of state for Ideal BE and FD gases – Photons – Planks distribution Law – Photons –Specific heat of solids – Einstein and Debye's theories – Bose Einstein Condensation – Liquid He – Two fluid model – Photons – Rotons – Super fluidity.

UNIT III : FERMI SYSTEMS **(11 Hrs)**

Ideal Fermi gas – Free electron model – electronic specific heat –thermionic emission – Pauli Paramagnetism – Landau diamagnetism – Boltzsman transport equation – Electrical conductivity – Thermal conductivity – Weiderman – Franzlaw – Non-equilibrium semiconductors – Electron-hole recombination- Classical Hall effect and Quantum Hall effect.

UNIT IV: FLUCTUATIONS AND PHASE TRANSITIONS **(14 Hrs)**

Fluctuations, Mean square deviation, fluctuations in ensembles, concentration fluctuations on quantum states, Classification of phase transitions, Vander Waal's equation of state, Maxwell's construction, Law of corresponding states, Clausius–Clapeyran equation, Critical exponents, Inequalities scaling hypothesis. Ising model, equivalence of Ising model to other models, solution to 1-D Ising model.

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. Lifshits (Pergamom)**
5. Statistical Mechanics –**D. A. McQuarrie (Harper & Row).**
6. Equilibrium statistical physics –**M. Plischke and B. Bergesen**
1. Modern theory of critical phenomena –**S. K. Ma**

G. Padmaja
22/12/2021

Chairperson, BoS in Physics, KU, Wgl

2.2: QUANTUM MECHANICS-1

UNIT I: BRA AND KET NOTATION **(10 Hrs)**

Principle of superposition. Bra and Ket vectors, linear operators. Hermitian operators. 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 **(12 Hrs)**

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

UNIT III: EXACTLY SOLVABLE PROBLEMS **(12Hrs)**

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. Hydrogen atom problem, vibrating rotator, rigid rotator and 1D harmonic oscillator.

UNIT IV: APPROXIMATE METHODS **(14Hrs)**

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

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.

Variation method, application to normal Helium atom.

Recommended 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. L. Schiff (McGraw Hill)**
4. A Text Book of Quantum Mechanics – **P. M. Mathews & K. Venkatesam (Tata McGraw Hill)**

G. Padmaja
22/12/2021

Chairperson, BoS in Physics, KU, Wgl

2.3: INTEGRATED CIRCUITS & ANALOG MODULATION

UNIT I : OPERATIONAL AMPLIFIERS (IC741) AND APPLICATIONS (12 Hrs)

Difference amplifiers using BJT and types - Block diagram of typical Op-Amp - IC741 Op-Amp: Features, PIN out, Performance electrical parameters and ideal characteristics - Open and closed loop configurations - Inverting and Non-inverting amplifier. Applications of Op-Amps: Voltage follower – Adder, Subtractor, Differentiator and Integrator, Logarithmic and antilog amplifiers – Wien-bridge sine-wave generator – Square-wave and Triangle-wave generators.
Active Filters: Introduction – Low-pass, High-pass, Band-pass, Band-reject and All-pass first-order filters and their design

UNIT II: SPECIALIZED ICS:(IC555, IC565 & VOLTAGE REGULATORS) (12 Hrs)

IC555 timer - Description of functional diagram – Astable and monostable operations, Voltage-controlled oscillator, Schmitt trigger. Phase-locked loops – Operating principles - IC565 monolithic phase-locked loops – 565 PLL Applications: Frequency multiplier – Frequency shift keying demodulator.
IC Voltage regulators: Basics of voltage regulator – IC Regulators (78xx, 79xx, LM317, LM337, 723)

UNIT III: 8085 MICROPROCESSOR (12 Hrs)

Evolution of Microprocessors - Intel 8085 Microprocessor – Architecture of 8085 microprocessor – Instruction cycle, Fetch Cycle, Execute cycle (Timing diagram), Machine cycle and clock states. Interrupts – Hardware and Software, Address space partitioning – Memory mapped I/O & I/O mapped I/O. Instruction set of 8085 microprocessor and its classification - Types of addressing modes - Programming of 8085 microprocessor: Addition (8 and 16 bit), 8 bit subtraction, multiplication and division - Finding the largest and smallest number in data array.

G. Padmaja
22/12/2021

Chairperson, BoS in Physics, KU, Wgl

UNIT IV: BASICS OF ANALOG MODULATION **(12 Hrs)**

Need for modulation - Types of modulation - **Amplitude Modulation:** Analysis of Amplitude modulation, Frequency spectrum of AM, modulation index, AM generation: Collector modulator, Balanced modulator, Detection of AM – Square-law diode detector. **Frequency Modulation:** Analysis of FM, Frequency spectrum of FM wave, Average power of FM wave, Working of simple frequency modulator, Varactor diode FM modulator, detection of FM waves: Balanced slope FM discriminator, **Phase modulation (PM):** Analysis and characteristics, Advantages of frequency modulation, AM and FM transmitters and radio receivers **(Block diagram approach)**.

Recommended Books:

1. Op amps and linear Integrated Circuits – **Ramakanth A GayKwad** (PHI).
2. Linear Integrated Circuits - **Coughlin and Driscoll** (PHI, 2014).
3. Linear Integrated circuits – **Shail B. Jain & Roy Choudhury** (New Age International Publishers 2nd edition).
4. Linear Integrated circuits – **S.Salivahanan & V.S. Bhaaskaran** (Tata McGraw Hill).
5. Electronic Communication Systems-**G. Kennedy & Bernard Davis** (Tata McGraw Hill).
6. Principles of Electronic Communication Systems - **Louis E Freznel**, TMH.
7. Microprocessors: Architecture and Programming and Applications with 8085 - **Ramesh S. Gaonkar**, Penram Intl' Publishing.
8. Microprocessors and Microcomputers – **B. Ram**, TMH.
9. Introduction to Microprocessor – **Aditya P.Mathur** – TMH.

G. Padmaja
22-12-2021

Chairperson, BoS in Physics, KU, Wgl

2.4: MATLAB AND APPLICATIONS

UNIT I: INTRODUCTION TO MATLAB **(10 Hrs)**

MATLAB Windows, On-line help, functions, MATLAB as a calculator, MATLAB operations: arithmetic operations rational operations, logical operations, variables, ,display formats, complex numbers, , Interactive Computations: : Matrices and Vectors, Creating vectors, Matrix manipulation, creating vectors, Matrix and array operations, Elementary math functions, Matrix functions, Vectorization, character strings.

UNIT II: PROGRAMMING IN MATLAB **(12 Hrs)**

Functions: command line functions, using Built – in functions, files, Loops, Branches and Control flow :IF-END,IF –ELSE-END,ELSE-IF,SWITCH CASE,FOR LOOPS,WHILE LOOPS, ,: saving and loading data.

Script files: M files, creating ,saving and executing, general structural of files, scope of variables, recursive functions, files In-put/Out-put, opening and closing files, writing formatted output files, reading formatted data from files, writing and reading binary files.

UNIT III: MATLAB - NUMERICAL METHODS **(14 Hrs)**

Linear Algebra, finding the solutions of linear systems: Gaussian elimination, finding eigen values and eigen vectors of Matrix, matrix factorization, Jacobi, Gauss-siedal method, Successive over relaxation methods, curve fitting: Polynomial curve fitting on the fly, Linear curve fitting, least squai- curve fitting, transcendental equations : Bisection ...ethod, Newton Raphson method, , Numerical integration by Trapezoidal rule, Simpson's 1/3 rule and Gauss's quadrature. Basic principles, Formulae –Algorithms.

UNIT IV: GRAPHICS USING MATLAB **(12 Hrs)**

Line styles, markers and colors, important plotting commands (line, lables, legend and tile commands), axis control, zoom in and zoom out , modifying plots with the plot editor , obtaining numerical values from graphs, 2-D plots and 3-D plots, Handle Graphics: object handles, objective properties and modifying the existing plot, saving plotting graphs.

Books Recommended:

1. MATLAB programming by **Rudrapratap.**
2. Programming in MATLAB by **Marc E. Hermitter (Thomson Brooks)**
3. Numerical Mathematical Analysis **–U. B. Scarborough (OXFORD & IBH publishing Co. Pvt. Ltd)**
4. Numerical Methods for Scientific and Engineering Computation **–M. K. Jain**
5. Computer Oriented Numerical Methods **– V. Rajaraman (PHI Pvt. Ltd)**
6. Numerical Methods, **E. Balaguruswamy (Tata McGraw Hill)**

G. Padmaja
22/12/2021

Chairperson, BoS in Physics, KU, Wgl

GENERAL PHYSICS – II LABORATORY

1. Michelson interferometer – Determination of wavelength, λ
2. Velocity of Ultrasonic waves in liquids using Interferometer.
3. Thermal expansion by Fizeau's method (Coefficient of linear expansion of Brass).
4. Study the elastic constants of glass by Cornu's interference method –elliptical and hyperbolic fringes.
5. Determination of Numerical aperture and loses in optical fiber.
6. Study the characteristics of Solar Cell.
7. MATLAB Programmes
   a) Fitting data straight-line.
   b) Solving a system of linear equations using Bisection and Gauss elimination Methods.
   c) Finding the eigen values and eigen vectors of a matrix.
   d) Evaluating the Integrals using Trapezoidal rule and Simpson's rule.

ELECTRONICS – II LABORATORY

PART-I: INTEGRATED CIRCUITS:

1. Operational Amplifiers (IC741) – Determination of CMRR, Slew-rate and output impedance.
2. Op-Amp (IC741): Frequency response of inverting and non-inverting amplifier.
3. Op-amp (IC741): Differentiator and Integrator – Observation of input and output waveforms and study the frequency response.
4. IC Voltage Regulators (78XX and 79XX) – To study the line and load regulation characteristics
5. IC555 timer – Monostable multivibrator: To construct and determination of pulse width.
6. IC555 timer – Voltage controlled oscillator: To construct and study the variation of frequency of the oscillation with applied voltage.
7. Amplitude Modulation
8. Frequency Modulation

PART-II: MICROPROCESSOR EXPERIMENTS:

1. Programs for data transfer, arithmetic and logical operations.
2. Programs for array operations – finding out the longest and smallest in a data array.

G. Padmaja
22/12/2021

Chairperson, BoS in Physics, KU, Wgl

3. Programs for arranging Hex. numbers in ascending and descending order.
4. Programs to find the square root, finding the sum of 'n' natural numbers and finding the sum of squares of the 'n' natural numbers.

Recommended Books:

1. Advanced practical Physics – **Wornsop & Flint**
2. Advanced Practical Physics,Vol.1 – **S P Singh** (Pragati prakashan).
3. A Text Lab manual in Electronics – **Zbar** (Tata McGraw Hill).
4. Lab manual for Electronic Devices and Circuits – **David A Bell**, (4th Edition – PHI)
5. Linear Integrated Circuits – **Shail B.Jain & B.Ray Choudhury** (New Age International Publishers, 2nd Edition).
6. Linear Integrated Circuits – **Shalivahanan & V S Bhaaskaran** (Tata McGraw Hill, 2008).
7. MATLAB programming by **Rudrapratap.**
8. Programming in MATLAB by **Marc E. Hermitter** (Thomson Brooks)

G. Padmaja
22/12/2021

Chairperson, BoS in Physics, KU, Wgl