APPENDIX-12(R)
UNIVERSITY OF MADRAS

M.Sc. DEGREE COURSE IN PHYSICS
Choice Based Credit System

I. That in the Regulations relating to M.Sc. Physics Degree Course under the Scheme of Examinations and Elective papers be modified to read as follows :

FIRST SEMESTER

S. NO	COURSE COMPONENTS	NAME OF COURSE	SEMESTER	INST. HOURS	CREDITS	HRS	MAX MARKS	
							CIA	EXTERNAL
4	CORE	PAPER 4 – INTEGRATED CIRCUTES AND MICROPROCESSOR 8085	I	6 HRS	3	3	25	75

Each Elective paper will carry three (3) credits instead of 4

Following elective paper be added in the existing elective list.

Elective – I Paper 9

Any one-out of the following:-

3. COMMUNICATION ELECTRONICS
4. ENERGY PHYSICS
5. ASTROPHYSICS

Elective II & III – Papers 18 & 19

Any two – out of the following:-
4. MICROPROCESSOR 8086 AND MICROCONTROLLER 8051
5. CRYSTAL GROWTH
6. QUANTUM FIELD THEORY

II. The above amendment to the Regulations to take effect from the academic year 2013-14 onwards.

A.C.S.'13

APPENDIX-12(S)
UNIVERSITY OF MADRAS

M.Sc. DEGREE COURSE IN PHYSICS
CHOICE SYSTEM BASED CREDIT
REVISED SYLLABUS
(w.e.f.2013-14)

PAPER – 4 : INTEGRATED CIRCUITS AND MICROPROCESSOR 8085

UNIT – I Linear ICs and Applications

Operational Amplifier : Solution of simultaneous equations and differential equations – Instrumentation amplifier – Log and Antilog amplifiers – Analog multiplication and division.

Generation of square, triangular and sine waves – pulse generation – Schmitt trigger – Active filters (Second order Butterworth design).

Timer 555 : Internal architecture and working – Schmitt trigger – Astable and monostable multivibrators – Phase Locked Loop.

UNIT – II Data Counters

Binary weighted and R/2R ladder DAC – Accuracy and resolution – Dual slope DAC- ADC – Simultaneous conversion – Counter method – Successive approximation.

UNIT – III Combinational and Sequential Logic Circuits

4-bit binary adder and subtracter- Encoder and Decoder – Multiplexer and Demultiplexer.

Flip – Flops : RS, D-type, JK and M/S JK Flip-Flops, Counters – Asynchronous , Synchronous and Modulus counters – BCD counter – Shift registers – Ring counter – Johnson counter.

UNIT – IV 8085 Programming, Peripheral Devices and their Interfacing

Instruction set -Addressing modes – Programming techniques – Memory mapped I/O scheme – I/O mapped I/O scheme – Memory and I/O interfacing – Data transfer schemes – Interrupts of 8085 – Programmable pheripheral interface (PPI) – Control group and control word – Programmable DMA controller – Programmable interrupt controller – Programmable communication interface – Programmable counter/interval timer.

UNIT – V 8085 Interfacing Applications

Seven segment display interface – Interfacing of Digital to Analog converter and Analog to Digital converter – Stepper motor interface – Measurement of electrical quantities (voltage and current) – Measurement of physical quantities (temperature and strain).

BOOKS FOR STUDY :

1. **Millman** and **Halkias**, *Integrated Electronics*.
2. **R. A. Gaekward**, 1994, *OpAmps and Integrated Circuits*, EEE.
3. **Taub** and **Shilling**, 1983, *Digital Integrated Electronics*, Mc Graw Hill, New Delhi.
4. **Malvino and Leech**, *Digital Electronics*
5. **J. Millman**, 1979, *Digital and Analog Circuits and Systems*, Mc Graw Hill, London.
6. **R. S. Gaonkar**, 1997, *Microprocessor Architecture, Programming and Application with the 8085*, 3rd Edition, Penram International Publishing, Mumbai**.**
7. **B. Ram,** *Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, New Delhi.*
8. **V. Vijayendran**, 2002, *Fundamentals of Microprocessor 8085 – Architecture, Programming and Interfacing*, Chennai.

BOOKS FOR REFERENCE :

1. **S. M. Sze**, 1985, *Semiconductor Devices – Physics and Technology*, Wiley, New York.
2. **R. F. Coughlin** and **F.F. Driscol**, 1996 *OpAmp and linear integrated circuits*, Printice Hall of India, New Delhi.
3. **M.S. Tyagi**, *Introduction to Semiconductor Devices*, Wiley, New York.
4. **P.Bhattacharya**, 2002, *Semiconductor Optoelectronics Devices*, 2nd Edition. Printice Hall of India, New Delhi.
5. **B. Somanath Nair**, 2002, *Digital Electronics And Logic Design*, Printice Hall of India, New Delhi.
6. **R.L. Boylestad** and **L.Nashelsky**, *Electronic Devices and Circuit Theory*, 8th Edition, Pearson Education.

PRACTICALS

Paper 5 : PRACTICAL – I (CORE COURSE, FIRST YEAR FIRST SEMESTER) – 4 CREDITS

<u>Part – 1A : Electronics and Microprocessor 8085</u> (Any TEN Experiments)

1. FET CS amplifier – Design, Frequency response, input impedance, output impedance
2. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
3. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
4. Design of a Schmitt trigger circuit using IC 741 f or a given hysteresis – application of squarer.
5. Design of a square wave oscillator using IC 741 – Triangular wave oscillator.
6. Construction of pulse generator using the IC 741 – application as frequency divider.
7. OP-Amp. – 4 bit Digital to Analog converter [R / 2R ladder network].
8. Study of R-S, clocked R-S and D-flip flops using NAND / NOR gates.
9. Study of J-K, D and T flip flops using IC 7476 / 7473.
10. Arithmatic operations using IC 7483 – 4 bit binary addition and subtraction.
11. IC 7490 as a scalar and display using IC 7447.

Microprocessor 8085

12. 8 –bit addition and subtraction, multiplication and division.
13. Sum of a set of N data (8 – bit numbers), Picking up the smallest and largest number in an array. Sorting in ascending and descending order.
14. Code conversion (8 – bit numbers) : (a) Binary to BCD and (b) BCD to Binary.
15. Addition of multibyte numbers, Factorial.

Part – 1B : General (Any FIVE Experiments)

1. Cornu's Method – Young's modulus and Poisson's ratio by Elliptic fringes.
2. Stefan's constant.
3. Bang gap energy – Thermistor / Semiconductor.
4. Hydrogen spectrum – Rydberg's constant.
5. Thickness of the enamel coating on a wire – by diffraction.
6. Coefficient of linear expansion – Air wedge method.
7. Permittivity of a liquid using an RFO.
8. L-G plate.
9. Lasers : Study of laser beam parameters.
10. Arc spectrum : Copper.

Paper 8 : PRACTICAL – II (CORE COURSE, FIRST YEAR SECOND SEMESTER) – 4 CREDITS

Part – 2A : Electronics and Microprocessor 8085 (Any TEN Experiments)

1. Design of UJT relaxation oscillator for a frequency – Generation of positive and negative triggering pulses.
2. Solving simultaneous equations - IC 741 / IC LM324.
3. Op-Amp. – Active filters : Low pass, High pass and Band pass filters (Second Order).
4. Construction of square wave generator using IC 555 – study of VCO.
5. Design of Schmitt trigger circuit using IC 555 for a given hysteresis – Application as squarer.
6. Construction of pulse generator using the IC 555 – Application as frequency divider.
7. IC 7476 / IC 7473 – Study of binary up / down counters
8. IC 7476 – Shift register, ring counter and Johnson counter (twisted ring counter).

Microprocessor 8085

9. Clock program – 12 / 24 hours.
10. LED interface – single LED on / off, binary, BCD, ring and Johnson counters.
11. Interfacing of seven segment display.
12. Interfacing R / 2R ladder DAC (IC 741) – Wave form generation.
13. DAC 0800 interface and wave form generation.

Part – 2B : General **(Any FIVE Experiments)**

1. Cornu's Method – Young's modulus and Poisson's ratio by Hyperbolic fringes.
2. Determination of strain hardening coefficient.
3. Viscosity of liquid – Meyer's disc.
4. F. P. Etalon using spectrometer.
5. Solar constant.
6. Solar spectrum – Hartmann's formula.
7. Arc spectrum – Iron.
8. Edser and Butler fringes – Thickness of air film.
9. B-H loop using Anchor ring.
10. Specific charge of an electron – Thomson's method.

Note : **Practical Examination 1 – Questions from both Part 1A and Part 2A**

Practical Examination 2 – Questions from both Part 1B and Part 2B

Paper 14 : PRACTICAL – III
(CORE COURSE, SECOND YEAR THIRD SEMESTER) – 4 CREDITS

Part – 3A : Advanced Microprocessor 8085 and Computational Methods
(Any TEN Experiments)

Advanced Microprocessor 8085

1. ADC 0809 interface.
2. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action.
3. Interfacing of Temperature Controller and Measurement
4. Water level detector

Computational Methods

5. Lagrange interpolation with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.
6. Newton forward interpolation with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.
7. Newton backward with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.
8. Curve-fitting : Least squares fitting with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.
9. Numerical integration by the trapezoidal rule with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.

10. Numerical integration by Simpson's rule with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.
11. Numerical solution of ordinary first-order differential equations by the Euler method with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.
12. Numerical solution of ordinary first-order differential equations by the Runge-Kutta method with Algorithm, Flow chart, FORTRAN / C PROGRAM, and output.

Part – 3B : General (Any FIVE Experiments)

1. GM counter – Characteristics, inverse square law, absorption coefficient.
2. GM counter – Feather's analysis : Range of Beta rays.
3. Hall effect.
4. Susceptibility by Quincke's method.
5. B-H curve using CRO.
6. Thermal diffusivity of brass.
7. Thermal relaxation of bulb.
8. Conductivity measurement using four probe method.
9. Laser Experiments : (i) Diffraction at straight edge, (ii) Interference of laser beams – Llyods single mirror method, (iii) Interference using an optically plane glass plate, (iv) Diffraction at a straight wire and (v) Diffraction at a circular aperture.
10. Experiments on optical fibres.
11. FFT and DFT of certain signals.

Paper 17 : PRACTICAL – IV
(CORE COURSE, SECOND YEAR FOURTH SEMESTER) – 4 CREDITS

Part – 4A : Microprocessor 8086 (MASM) and Microcontroller 8051
(Any TEN Experiments)

Microprocessor 8086 Programs using MASM

1. Addition, Subtraction, Multiplication and Division (8 bit numbers)
2. Multibyte addition and subtraction (64 and 128 bit numbers)
3. Square and square root of 8 bit number
4. Sum of a set of N data (8 – bit numbers), average of N numbers.
5. Sorting in ascending and descending order. Picking up the smallest and largest number in an array.
6. Generation of Fibonacci series.

Micro controller 8051

7. Addition, subtraction, multiplication and division of two 8-bit numbers.
8. Sum of a series of 8-bit numbers, average of N numbers.
9. Factorial of number, Fibonacci series of N terms.
10. Sorting in ascending and descending order – Picking up smallest and largest number.

11. LED interface – Binary up/down counter, BCD up/down counter, Ring and twisted ring counter.
12. Interfacing seven segment display.
13. DAC 0800 / 1408 interface and wave form generation.
14. ADC interfacing.
15. Stepper motor interfacing.

Part – 4B : General (Any FIVE Experiments)

1. Michelson Interferometer – Wavelength, separation of wavelengths.
2. Michelson Interferometer – Thickness of mica sheet.
3. Susceptibility by Guoy's method.
4. Ultrasonics – Compressibility of a liquid.
5. Miscibility measurements using ultrasonic diffraction method.
6. Dielectric measurements in Microwave test bench.
7. Iodine absorption spectra
8. Molecular spectra – AlO band
9. Molecular spectra – CN bands
10. UV-visible spectroscopy – Verification of Beer-Lambert's law and identification of wave-length maxima – Extinction coefficient.

Note : Practical Examination 3 – Questions from both Part 3A and Part 4A

Practical Examination 4 – Questions from both Part 3B and Part 4B

ELECTIVE – I Paper – 9

3. COMMUNICATION ELECTRONICS

UNIT – 1 Antennas and Wave Propagation

Radiation field and Radiation resistance of a short dipole antenna – Grounded $\frac{\lambda}{4}$ Antenna – Ungrounded $\frac{\lambda}{2}$ Antenna – Antenna Arrays – Broadside and End side Arrays – Antenna Gain – Directional high Frequency Antennas – Sky Wave Propagation – Ionosphere – Ecles and Larmor Theory – Magento Ionic Theory – Ground Wave Propagation.

UNIT – II Microwaves

Microwave Generation – Multicavity klystron – Reflex klystron – Magnetron – Travelling Wave Tubes (TWT) and other Microwave tubes – MASER – Gunn Diode – Wave guides – Rectangular Wave guides – Standing Wave indicator and Standing Wave ratio (SWR).

UNIT – III Radar and Television

Elements of a Radar System – Radar Equation – Radar Performance Factors – Radar Transmitting Systems – Radar Antennas – Duplexers – Radar Receivers and Indicators – Pulsed Systems – Other Radar Systems - Colour TV Transmission and Reception – Colour mixing principle – Colour Picture Tubes – Delta Gun picture tube – PIL colour picture tube - Cable TV, CCTV and Theatre TV.

UNIT IV Optical Fibres

Propagation of Light in an Optical Fibre – Acceptance Angle – Numerical Aperture – Step and Graded Index Fibres – Optical Fibre as a Cylindrical Wave Guide – Wave guide Equations – Wave Equations in Step Index Fibres – Fibre Losses and Dispersion – Applications.

UNIT V Satellite Communication

Orbital Satellites - Geostationary Satellites - Orbital Patterns - Satellite system link models – Satellite system parameters – Satellite system link equation – Link budget – INSAT communication satellites.

BOOKS FOR STUDY and REFERENCE:

1. Handbook of Electronics by Gupta and Kumar – 2008 Edition.
2. Electronic Communication System – George Kennedy and Davis – Tata McGraw Hill 4th Edition 1988.
3. Taub and Schilling, “Principles of Communication Systems”, Second edition, Tata McGraw Hill (1991).
4. Electronic Communications – Dennis Roddy and Coolen, Prentice Hall of India, IV Edition., (1995).
5. Wayne Tomasi, “Advanced electronics communication Systems”, fourth edition, Prentice Hall, Inc., (1998).
6. M. Kulakarni, “Microwave and Radar Engineering”, Umesh Publications, 1998.
7. Monochrome and Colour TV – R.R. Gulati

4. **ENERGY PHYSICS**

UNIT – I

Introduction to energy sources - Energy sources and their availability – prospects of renewable energy sources – Energy from other sources – chemical energy – Nuclear energy – Energy storage and distribution.

UNIT – II

Energy from the oceans – Energy utilization – Energy from tides – Basic principle of tidal power – utilization of tidal energy.

UNIT – III

Basic principles of wind energy conversion – power in the wind – forces in the Blades – Wind energy conversion – Advantages and disadvantages of wind energy conversion systems (WECS) Energy storage – Applications of wind energy.

UNIT – IV

Energy from Biomass: Biomass conversion Technologies – wet and dry process – Photosynthesis.

Biogas Generation: Introduction – basic process and energetic – Advantages of anaerobic digestion – factors affecting bio digestion and generation of gas - biogas from waste fuel – properties of biogas- utilization of biogas.

UNIT – V

Solar radiation and its measurements – solar, cells : Solar cells for direct conversion of solar energy to electric powers – solar cell parameter – solar cell electrical characteristics – Efficiency – solar water Heater – solar distillation – solar cooking – solar green house.

BOOKS FOR REFERENCE:

1. Non-conventional sources of energy by G.D. Rai, 4th edition, Khanna Publishers, New Delhi (1996)

2. Energy Technology by S. Rao and Dr. Paru lekar.

3. John Twidell and Tony weir, Renewable energy resources, Taylor and Francis group, London and Newyork.

4. M.P. Agarwal, Solar energy, S. Chand and Co.,

5. A.B. Meinel and A.P. Meinal, Applied solar energy.

6. Solar energy, principles of thermal collection and storage by S.P. Sukhatme 2nd edition,

Tata McGraw-Hill publishing co. Ltd., New Delhi (1997).

5. ASTROPHYSICS

Unit-I Observational Astronomy

The electromagnetic spectrum; geometrical optics (ray diagrams, focal length, magnification etc); diffraction (resolving power, Airy disc, diffraction limit etc); telescopes (reflecting, refracting, multi-wavelength).

Unit-II Properties of stars

Brightnesses (luminosities, fluxes and magnitudes); colours (blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman & Balmer series etc, Doppler effect); Hertzprung-Russell diagram; the main sequence (stellar masses, binary systems, Kepler's laws, mass-luminosity relations); distances to stars (parallax, standard candles, P-L relationships, m-s fitting etc); positions of stars (celestial sphere, coordinate systems, proper motions, sidereal and universal time).

Unit-III The life and death of stars

Energy source (nuclear fusion, p-p chain, triple-alpha, CNO cycle, lifetime of the Sun); solar neutrinos; basic stellar structure (hydrostatic equilibrium, equation of state); evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants (white dwarfs, neutron stars, black holes, degeneracy pressure, Swarszchild radius, escape velocities).

Unit-IV Galaxies

Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter; active galaxies and quasars.

Unit-V Cosmology

Galaxies and the expanding Universe; Hubble's Law; the age of the Universe; the Big Bang; cosmic microwave background (blackbody radiation); big bang nucleosynthesis (cosmic abundances, binding energies, matter & radiation); introductory cosmology (the cosmological principle, homogeneity and isotropy, Olber's paradox); cosmological models (critical density, geometry of space, the fate of the Universe); dark energy and the accelerating Universe.

Recommended texts:

1. Zeilik & Gregory, *Introductory Astronomy & Astrophysics*, 4th ed (Saunders College Publishing)
2. Morison, I., *Introduction to Astronomy and Cosmology* (Wiley)
3. Kutner, M.L., *Astronomy: A Physical Perspective* (Cambridge University Press)
4. Green, S.F. & Jones, M.H., *An Introduction to the Sun and Stars* (Cambridge University Press)
5. Jones, M.H. & Lambourne, R.J.A., *An Introduction to Galaxies & Cosmology* (Cambridge University Press)
6. Carroll, B.W. & Ostlie, D.A., *An Introduction to Modern Astrophysics* (Pearson)
7. Shu, F.H., *The Physical Universe, An Introduction to Astronomy*, (University Science Books)
8. Motz, L. & Duveen, A., *The Essentials of Astronomy*, (Colombia University Press)

Elective II and III - Paper 18 and 19

Any two out of the following:

4. MICROPROCESSOR 8086 AND MICROCONTROLLER 8051

UNIT - I 8086 Architecture and Programming

8086 Architecture – Min.Mode, Max.Mode – Software Model – Segmentation- Segmentation of address – Pipe line Processing.

Addressing Modes – Instruction Set- Constructing Machine Code – Instruction Templates for MOV Instruction– Data Transfer Instructions– Arithmetic, Logic, Shift, rotate instructions- Flag Control instructions- Compare, Jump Instructions– Loop and String instructions -Assembly programs- Block move, Sorting, Averaging, Factorial – Code Conversion : Binary to BCD , BCD to Binary.

UNIT - II 8051 Microcontroller Hardware

Introduction – Features of 8051 – 8051 Microcontroller Hardware : Pin-out of 8051, Central Processing Unit (CPU), Internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input / Output pins, Ports and Circuits – External data memory and Program memory : External program memory, External data memory.

UNIT - III 8051 Instruction Set And Assembly Language Programming

Addressing modes – Data moving (Data transfer) instructions : Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions : byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions : Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions : Jump and Call program range, Jump, CALL and subroutines – Programming.

UNIT - III Interrupt Programmig

8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts, Software triggering of interrupt.

UNIT - IV Interfacing To External World

Interfacing keyboard : Simple keyboard interface, Matrix keyboard interface – Interfacing displays : Interfacing seven segment LED displays, Interfacing LCD display – Interfacing DAC to 8051– Interfacing ADC to 8051 – Interfacing sensors – Interfacing stepper motor.

BOOKS FOR STUDY

1. A. P. Godse and D. A. Godse, "Microprocessors & its Applications", Technical Publications, Pune,
2. Kenneth Ayala, "The 8051 Microcontroller", Third Edition, Delmar Cengage Learning, 2005.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, "The 8051 Microcontroller and Embedded Systems", Second Edition, Pearson Education 2008.
4. W.A. Triebel and Avatar Singh, *The 8086 /8088 Microprocessors- Programming, Software, Hardware and application,* Prentice Hall of India, New Delhi. (Unit 2)

BOOKS FOR REFERENCE

1. Douglas V. Hall : - Microprocessors and Interfacing programming and Hardware (Tata Mc Graw Hill) (Unit 1)
2. B. Brey, 1995, *Intel Microprocessors 8086/8088, 80186,80286,80486,80486,* Architecture, Programming and Interfacing
3. Yu – Cheng and Glenn A. Gibson, *The 8086 / 8088 family Architecture, Programming and Design*, Prentice-Hall of India.
4. Muhammed Ali Mazidi and Janice Gillespie Mazidi, 2004, *The 8051 Microcontroller and Embedded Systems*, Fourth Indian Reprint, Pearson Education.
5. V. Vijayendran, 2002, *Fundamentals of Microprocessor –8086- Architecture, Programming (MASM) and interfacing*, Viswanathan, Chennai.

5.CRYSTAL GROWTH

UNIT – I NUCLEATION (12 Hours)

Nucleation concept – Kinds of nucleation – Classical theory of nucleation - Spherical nucleus – Induction period – Measurement - Heterogeneous nucleation – Equilibrium concentration of embryos – Energy of formation of a critical nucleus - Free energy of formation of a critical heterogeneous cap shaped and disc shaped nuclei –Nucleation rate.

UNIT – II CRYSTAL GROWTH THEORIES (12 Hours)

Surface energy theory – Diffusion theory – Adsorption layer theory – Volmer theory – Bravais theory – Kossel theory – Two dimensional nucleation theory – Free energy of formation of a two dimensional nucleus – Possible shapes – Rate of nucleation

UNIT – III CRYSTAL GROWTH FROM SOLUTION (12 Hours)

Low temperature solution growth – Solution and Solubility – Preparation of solution - Principle of low temperature solution growth - Mier's solubility diagram – Measurement of solubity – Measurement of Ostwald-Mier's metastable zone width – Achievement of supersaturation.

Crystal Growth methods – Slow cooling method – Holden's rotary crystallizer - Mason Jar method – Slow evaporation method – Johnson's rotating crystal method - Temperature gradient method – Kruger and Fink U tube method.

UNIT – IV MELT GROWTH AND VAPOUR GROWTH (12 Hours)

Growth of crystal from melt – Bridgman method – Czochralski method – LEC growth of III – V materials – Verneuil method – Phase diagram principle of zone refining - Zone melting method.

Physical vapour deposition – Chemical vapour deposition – Open and closed systems – Physical and thermo - chemical factors affecting growth process.

UNIT – V GEL GROWTH AND FLUX GROWTH (12 Hours)

Gel growth – Different gel medium – Specific gravity – Silica gel – Agar gel – Basic growth procedure – Single diffusion technique – Double diffusion technique – Reaction method – Chemical reduction method.

High temperature solution growth (Flux growth) – Principle of flux growth – Slow cooling method – Slow evaporation method – Top seeded solution growth.

BOOKS FOR STUDY

1. M. Ohora and R. C. Reid, "Modeling of Crystal Growth Rates from Solution"
2. J. C. Brice, " Crystal Growth Processes"
3. J. C. Brice, "The Growth of Crystals from Melt"
4. D. Elwell and H. J. Scheel, "Crystal Growth from High Temperature Solution"
5. Heinz K. Henish, "Crystal Growth in Gels", Cambridge University Press, 1973.

BOOK FOR REFERENCE

1. P. Ramasamy and F. D. Gnanam, "UGC Summer School Notes", 1983.
2. P. SanthanaRaghavan and P. Ramasamy, "Crystal Growth Processes", KRU Publications.

6. QUANTUM FIELD THEORY

Unit-I Symmetry Principles

Relativistic kinematics, relativistic waves, Klein-Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: its Lagrangian and Hamiltonian, Noether's theorem and derivation of energy-momentum and angular momentum tensors as consequence of Poincaré symmetry, internal symmetry and the associated conserved current.

Unit-II Quantization of Klein-Gordan Field

Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, definition of the vacuum and N-particle eigenstates of the Hamiltonian, vacuum expectation values, propagators, spin and statistics of the KG quantum.

Unit-III Quantization of Dirac Field

Review of Dirac equation and its quantization, use of anti-commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, energy, momentum and angular momentum, spin and statistics of Dirac quanta.

Unit-VI Quantization of Electromagnetic Fields

Review of free Maxwell's equations, Lagrangian, gauge transformation and gauge fixing, Hamiltonian, quantization in terms of transverse delta functions, expansion in terms of creation operators, spin, statistics and propagator of the photon.

Unit-V Perturbative Interaction at Tree Level

Introduction to interacting quantum fields, Wick's Theorem, Feynman Diagram, Examples from quantum electrodynamics at the tree level: positron-electron and electron-electron scattering.

References:

1. **C. Itzykson and J.B. Zuber,** *Quantum Field Theory.*
2. **J.D. Bjorken and S.D. Drell,** *Relativistic Quantum Fields.*
3. **L. Ryder,** *Quantum Field Theory.*
4. **V.B. Berestetskii, E.M. Lifshitz and L.P. Pitaevskii,** *Quantum Electrodynamics.*
5. **M.E. Peskin and D.V. Schroeder,** *An Introduction to Quantum Field Theory.*

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