Starex University, Gurugram

Choice Based Credit System(CBCS)

M.Sc. (Physics)

(2018-20)

Ordinance, Scheme & Syllabus

M.Sc. (Physics)

(W.E.F. 2018-20)

Ordinance, Scheme of Examination and Syllabi

M.Sc (Physics)

Saved as provided in the First Ordinance of the University, this Ordinance shall contain the following;

1. **Title and Commencement**

   This Ordinance shall be called the Ordinance of Starex University and shall be effective from the Academic Session 2018-19.

2. **Duration of the Course**

   The duration of M.Sc. (Physics) course shall be of two academic years. Each year shall be divided in two semesters i.e. semester-1, semester-2. Accordingly, the two years shall consist of four semesters. However, a student is required to pass out the said course within a maximum period of 4 years from the date of admission to 1st semester where after he/she shall stand unfit for the course.

3. **Eligibility**

   B.Sc.(Hons.)/ B.Sc. with Physics with 45% marks or any other equivalent degree from any recognized University.

4. **Admission Schedule, Submission of Examination Forms and Fee**

   The admission schedule along with the last date for submission of admission form and fee shall be fixed by the Vice-Chancellor from time to time and displayed by the University.

   Date of examinations and fee shall be fixed by the Vice-Chancellor from time to time and notified by the Controller of Examinations.

5. Change of Branch/ Discipline

A student will be entitled to change/switch over Branch/Discipline within 15 days after the commencement of academic session where after no change will be allowed. Such a student must be eligible for admission to the Branch/Discipline intended to be admitted to.

6. **Promotion to Higher Semester(s)**

   The student shall be promoted to 2nd and 4th semester automatically without any condition of passing minimum number of papers. For promotion from 2nd to 3rd semester, the student shall have to clear at least 50% paper of 1st and 2nd semester taken together.

7. Reappear Examinations

Re-appear examinations for odd semesters will be held along with the regular semester examinations of these semesters in December and those of even semesters along with the regular examinations of these semesters in May. However, the re-appear examination of 4th semester may be held in December along with the odd semester examinations.

8. Medium of Instruction and Examination

The medium of instructions and writing question papers shall be English only.

9. Type of Examinations

Wherever not otherwise provided in any course Ordinance there will be two types of examinations.

(a) **End term:** End term examination shall be held at the end of each semester and will cover the entire syllabus for that semester. 1st and 3rd semester examinations shall ordinarily be held in the month of December and 2nd and 4th semester examinations in the month of May.

(b) **Internal Test:** There may be one/two Internal Assessment test(s) in each semester. Each Internal Assessment test will cover the syllabus taught up to the date of test.

10. Scheme of Examinations

25% marks of the total marks of the concerned subject shall be earmarked for Internal Assessment.

a) **Distribution of Marks**

i)	Theory	75
ii)	Internal Assessment	25

b) **Pass Percentage**

Theory:

i) 40% marks in written paper.
ii) 40% marks in written paper and Internal Assessment taken together

Practical: (Wherever provided)

i) 40 % marks in Practical.
ii) 40 % marks in Practical and Internal Assessment taken together.

Viva-Voce: (Wherever provided)

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i) 40% marks in Viva-Voce separately.

Note:

i) In case, a student fails to secure 25% marks in Internal Assessment in Theory of a particular subject, he/she shall be detained from appearing in the Theory paper examination of that subject and so for practical exams (wherever provided).

ii) A list of detained students and the students detained due to shortage of attendance shall be forwarded to the Examination Branch by the School/Faculty before a week from the date of commencement of examination.

c) **Components of Internal Assessment**

The Internal Assessment marks shall comprise of the following;

i) Attendance — 10 Marks
ii) Internal Test — 10 Marks
iii) Assignment/Seminar/Presentation etc. — 05 Marks

NB.

i) In case, a student is detained from appearing in the examination of Theory or Practical having failed to secure 25% marks in Internal Assessment, he/she may improve the same for appearing in the relevant subsequent examination. In all other cases, the marks of Internal Assessment shall be carried forward for the subsequent examination.

ii) The concerned teacher shall preserve the records of the Internal Assessment and shall make the same available as and when required.

iii) The concerned School/Faculty shall display the marks of Internal Assessment on the Notice Board for information of the students.

11. Eligibility to appear in the Examination

The Student should fulfill the following criteria to be eligible for appearing in the end term examination;

i) He/she should bear a good moral character.

ii) He/she should be on the rolls of the University during the semester.

iii) He/she should have not less than 75% of the attendance during the respective semester. In case, a student fails to secure the prescribed percentage of lectures either in Theory or Practical, he/she shall be detained from appearing in the said part of examination (Theory or practical or both, as the case may be).

iv) He/she should not be a defaulter of payment of tuition fee or any other dues of the University and no disciplinary action should be pending against him/her.

Note: In case, a student fails to secure 75% attendance in Theory or Practical or both, he/she will be detained from appearing in Theory or Practical or both examinations, as the case may be.

12. Exemption from Attendance/Condonation of Shortage of Attendance

The shortage of attendance can be condoned/ relaxed as under;

S.No	Category for Exemption/Condonation of lectures/attendance	Ground for Exemption/Condonation	Competent Authority
*1	All periods of the day of Blood donation	Voluntarily blood donation to the blood bank	Dean of the School/Faculty
*2	All periods of the day of Examination	For appearing in the supplementary Examinations (Th./Pr./Vive-Voce)	-do-
*3	10 Days attendance during a Semester	For participation in University or Inter University/College Sports Tournaments / Youth Festivals, NCC/NSS camps/ University Educational Excursions	-do-

*Provided that: 1. He/she has obtained prior approval of the Dean of School/faculty. 2. Credit may be given only for the days on which lectures were delivered or tutorials or practical work done during the period of participation in the aforesaid events.

S.No.	Category for Exemption/Condonation of lectures/attendance	Ground for Exemption/Condonation	Competent Authority
	Condonation /Relaxation up to 5% during a Semester	Genuine reason such as illness, transfer of parents, sudden death in blood relation, on production of proof.	1. The concerned Dean of his own or on the recommendation of HOD 2. Vice-Chancellor of his own or on the recommendation of Concerned Dean

13. Setting of Question Papers and Re-Checking, Evaluation/Re-evaluation of Answer book(s)

As per provisions in the First Ordinance and rules and regulations of the University.

14. Grace Marks

As per provisions in the First Ordinance of the University.

15. Improvement of Examination Result

A student may be permitted to improve his/her result subject to the followings:

i) The student will be permitted to appear in improvement examination as an ex-student with regular batches for the purpose of improvement of CGPA/Division.

ii) Only one chance for improvement for a Semester will be given. The chance must be availed within a period of 1 year from passing the final examination.

iii) In case the nature of result does not improve i.e. up to CGPA 5, 6, 7, 8 and 9, his/her improvement result shall be declared as **"PRS"** (Previous Result Stands).

iv) There will be no separate examination for improvement i.e. the student intending to improve his/her result shall appear along with the regular batches in accordance with the syllabus prescribed for the regular batches.

16. Issuance of DGS, Award of Degree

A student shall be issued Detailed Grade Statement for each examination and shall be awarded Degree on successful completion of the course. The division and performance shall be indicated in the Degree as depicted in **Grading Method** against **Clause No. 19.**

17. Inter University Migration

a) A student of this University may seek Migration as per provision in the First Ordinance of the University.

b) Any student intending to seek Migration to this University may do so subject to the following;

i) The Migration cannot be claimed as a matter of right and shall subject to the availability of seat.

ii) The Migration shall be allowed only in 2nd year (3rd semester).

iii) The student must have pursued the previous Exam(s) under semester system.

iv) At least 50% papers, of the papers passed by him/her in the previous Institute/University must have matched with the papers prescribed by this University.

v) Rest of the unmatched Subjects/Papers will be required to be passed by him/her from this University as deficient Subjects/Papers.

18. Choice Based Credit System

Definitions of Key Words

1. **Academic Year:** Two consecutive (one odd + one even) Semesters constitute one academic year.
2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed courses (core, elective or minor or soft skill courses).
3. **Course**: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ self-study etc. or a combination of some of these.
4. **Credit Based Semester System (CBSS):** Under the CBSS, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be completed by the students.
5. **Credit Point:** It is the product of grade point and number of credits for a course.
6. **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.
7. **Cumulative Grade Point Average (CGPA):** It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
8. **Grade Point:** It is a numerical weight allotted to each letter grade on a 10-point scale.
9. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.

10. **Programme:** An educational programme leading to award of a Degree, Diploma or Certificate.

11. **Semester Grade Point Average (SGPA):** It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

12. **Semester:** Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to December and even semester from January to May/June.

13. **Transcript and Detailed Grade Certificate/Statement (DGS):** Based on the earned credit points, a detailed grade Certificate/Statement (DGS) shall be issued to all the registered students after every semester. The grade Certificate/Statement will display the course details (Course Code, its nomenclature, total credit points and letter grade) along with SGPA of that semester and CGPA in the final semester.

Range of Percentage of Marks	Letter Grade	Grade Points	Range of Grade Points	Classification
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8 < 9	Excellent
70 & above but less than 80	A (Very Good)	8	7 < 8	1st Div. with Distinction
60 & above but less than 70	B+ (Good)	7	6 < 7	1st Division
50 & above but less than 60	B (Above Average)	6	5 < 6	2nd Division
Above 40 but less than 50	C (Pass-Average)	5	Above 4 < 5	3rd Division
35 To 40	P (Pass)	4	3.5 To 4	Pass
Below minimum pass marks	F (Fail)	0	-	-

19. Grading Method

The grading method for evaluating students' performance involves award, of grade according to the range of total marks in the course. The grade will be awarded based on marks out of 100, as depicted below:

Formula for Computation of SGPA & CGPA

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$SGPA (S_i) = \sum (C_i \times G_i) / \sum C_i$$

Where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

$$CGPA = \sum (S_i \times S_i) / \sum C_i$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be worked up to 2 decimal points and mentioned in the DGS and transcripts.

iv). Formula for calculation of aggregate pass percentage CGPA x 10

Example

Course	Credit	Grade Letter	Grade Point Block	Range of Grade Points(Actual Grade Value as per marks obtd.	Earned Credit Points (Credit ×Actual Grade Value)
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=20.1
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				135.9

Thus, **SGPA** = 135.9/20 = 6.79

Similarly, suppose SGPA for 2^{nd}, 3^{rd} , and 4^{th} semester are 7.85, 5.6 and 6.0 with credits 22, 24 and 22 respectively than for a two year programme, the CGPA will be computed as follows

CGPA= 20 × 6.79 + 22× 7.85 + 24 × 5.6 + 22 × 6.0/88 = 6.53

Formula for calculating percentage of marks

CGPA × 10 e.g. 6.53 × 10 = 65.3

20. Other Provisions

i) Nothing in this Ordinance shall debar the University from amending the Ordinance and the same shall be applicable to all the students whether old or new.
ii) Any other provision not contained in the Ordinance shall be governed by the rule and regulations framed by the University from time to time.
iii) All disputes shall Subject to Gurugram Court Jurisdiction.

PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters. The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students.
Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades. The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student’s performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course**: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course**: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

2.1 **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

2.2 **Dissertation/Project**: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

2.3 **Generic Elective (GE) Course**: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 24/12 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

M.Sc (Physics)

Semester I

Course	Course Code	Credits	Course Type
Mathematical Methods in Physics		4	CC
Classical Mechanics		4	CC
Quantum Mechanics		4	CC
Electronics		4	CC
Laboratory I		4	CC
List of Generic for other Departments			
Modern Optics		4	GEC*
Introduction to Experimental Physics		4	GEC*
			Total Credits: 24

Semester II

Course	Course Code	Credits	Course Type
Statistical Mechanics		4	CC
Classical Electrodynamics		4	CC
Solid State Physics		4	CC
Laboratory II		4	CC
For other departments			
Mechanics		4	GEC*
Environmental Physics		4	GEC*
Anyone of the following two courses			
Physics of Electronic Material and Devices		4	DCEC
Advanced Quantum Mechanics		4	DCEC
Seminar Presentation (Compulsory)		2	DCEC
			Total Credits: 26

This GEC* course can only be taken by the students of other departments. The department may offer more than one elective course depending on specialization and strength of faculty members, and the student has to opt one of them.

Semester III

Course	Course Code	Credits	Course Type
Atomic, Molecular Physics and Laser		4	CC
Nuclear & Particle Physics		4	CC
Thin Film and Integrated Devices		4	CC
Laboratory III		4	CC
Any two of the following courses			
Computational Physics		4	DCEC
Electronic Communication		4	DCEC
Spectroscopy		4	DCEC
Physics of Nanomaterials		4	DCEC
Advanced Statistical Mechanics		4	DCEC
General Theory of Relativity		4	DCEC
Seminar Presentation (Compulsory)		2	DCEC
			Total Credits: 26

Semester IV

Course	Course Code	Credits	Course Type
Major Project/Dissertation		24	PROJECT
OR			
Minor Project		16	PROJECT
Any two of the following courses			
Nuclear Physics: Interaction and Model		4	DCEC
Microprocessor and Microcontroller		4	DCEC
Nonlinear Dynamics		4	DCEC
Introduction to Astrophysics and Cosmology		4	DCEC

Superconductivity: Conventional and High Temperature Superconductors		4	DCEC
			Total Credits: 24

Course Type

- Core Course (CC)
- Generic Elective Course (GEC)
- Discipline Centric Elective Course (DCEC)

Semester	**Credits**			**Total Credits**	**Total marks**
	Core Courses	**Elective Courses**			
		DCEC	**GEC**		
I	21		4	24	600
II	16	6	4	26	650
III	16	10		26	650
IV	16	8		24	600
Total	69	24	8	100	2500

Mathematical Methods in Physics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

CLASSROOM AND LAB LEARNING

Computational Techniques

Root of functions, interpolation, extrapolation, Integration by trapezoid and Simpson's rule, solution of first order differential equation using Runge-Kutta method, Finite difference methods.

Section-B

DIGITAL AND CLASS ROOM LEARNING

Tensors Analysis

Coordinate transformations, scalars, contravariant and covariant vectors, mixed and covariant tensor of second rank, addition, subtraction and contraction of tensors, quotient rule. Christoffel symbols, transformation of Christoffel symbols, covariant differentiation, Ricci's theorem, divergence, Curl and Laplacian tensor form, Stress and strain tensors, Hook's law in tensor form.

Section-C

DIGITAL AIDED LEARNING

Complex Variables

Functions of complex variable, Limits and continuity, differentiation, Analytical functions, Cauchy-Riemannn conditions, Cauchy Integral theorem, Cauchy integral formula, Derivatives of analytical functions, Liouville's theorem. Power series Taylor's theorem, Laurent's theorem.

DIGITAL AND SELF LEARNING

Calculus of residues–poles, essential singularities and branch points, residue theorem, Jordan's lemma, singularities on contours of integration, evaluation of definite integrals.

Section-D

DIGITAL AND CLASS ROOM LEARNING

Fourier Transforms

Fourier Transforms: Development of the Fourier integral from the Fourier Series, Fourier and inverse Fourier transform, Simple Applications: Finite wave train, Wave train with Gaussian amplitude, solution of wave equation as an application. Convolution theorem. Intensity in terms of spectral density for quasi monochromic EM Waves, Momentum representation.

References:

1. **George Arfken**, Mathematical Methods for Physicists, Academic Press.
2. **L. A. Pipe**, Applied Mathematics for Engineers and Physicists, McGraw Hill.
3, **Merle C. Potter and Jack Goldberg**, Mathematical Methods, Prentice Hall of India.
4. **Fredrick W. Byron and Robert W. Fuller**, Mathematics of Classical and Quantum Physics, Dover Publications.
5. **E.Kreyszig**, Advanced Engineering Mathematics, John Wiley & Sons.
6. **K.F.Riley, M.P. Hobson, and S.J.Bence**, Mathematical methods for Physicists and Engineers Cambridge University Press.

Classical Mechanics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND CLASS ROOM LEARNING

Lagrangian Equation of Motion & Central Force Problem:
Newtonian mechanics of one and many particle systems, Virtual work, Constraints: holonomic and non-holonomic, D'Alembert's Principle and Euler-Lagrange Equation of motion, velocity dependent potentials, simple applications of Lagrangian formulation. Hamilton Principle, Calculus of Variations, Derivation of Lagrange's equation from Hamilton's principle. Conservation theorems and Symmetry Properties, Noether's theorem.

CLASSROOM AND LAB LEARNING

Two body central force problem: Reduction to equivalent one body problem, equation of motion and first integrals, Equivalent one-dimension problem and classification of orbits. Inertial and Non-inertial frame of references, Coriolis force.

Section-B

DIGITAL AIDED LEARNING

Hamilton's Equations of Motion:
Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivation of Hamilton's canonical equation from Hamilton's variational principle. The principle of least action.

Section-C

DIGITAL AND SELF LEARNING

Canonical Transformation and Hamilton-Jacobi Theory:
Canonical transformation, integral invariant of Poincare, Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation. Infinitesimal contact transformation and generators of symmetry, Liouville's theorem. Hamilton-Jacobi equation and its application. Action angle variable: adiabatic invariance of action variable,the Kepler problem in action angle variables.

Section-D

DIGITAL AND CLASS ROOM LEARNING

Small Oscillations &Rigid Body Motion:
Stable and unstable equilibrium; Theory of small oscillations in Lagrangian formulation, normal coordinates and its applications, Free vibration of linear harmonic oscillator. Orthogonal transformation, Euler's theorem, Eigenvalues of the inertia tensor, Euler equations, force free motion of a rigid body.

References:
1. **Herbert Goldstein, Charles Poole, John Safko,** Classical Mechanics, Pearson Education.
2. **L.D. Landau and E.M. Lifshitz,** Mechanics, Butterworth-Heinemann.
3. **N.C. Rana and P.S. Joag,** Classical Mechanics, McGraw Hill.
4. **Ronald L. Greene,** Classical Mechanics with Maple, Springer.
5. **A.Sommerfeld,** Mechanics, Academic Press.
6. **I. Percival and D. Richards**, Introduction to Dynamics, Cambridge University Press.

Quantum Mechanics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Origin and Structure of Quantum Mechanics (QM)

Review of chronological developments of quantum mechanics.

Linear spaces and Operators: Hilbert space; Dimension and basis of vector space.

Direc Notation:Kets & Bras

Hermition & Unitery Operators: Commutation relation, significance of eigen vector and eigen values of an operator, uncertainty principle for two arbitrary operators, unitary transformation, Matrix representation: of kets, bras and operators and change of bases.

Section-B

DIGITAL AIDED LEARNING

Quantum Dynamics:

Problem in one dimension (1D) with different types of potential functions such as particle in box, barrier potential, harmonic oscillator: analytical and algebraic methods. 3 D problems: Hydrogen Atom.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Angular Momenta &Approximate Analysis:

Orbital angular momentum, angular momentum algebra, raising and lowering operators; Matrix representation for $j = 1/2$ and $j = 1$; Spin angular momentum; Addition of two angular momentum, Clebsch-Gordan (CG) Coefficients.

Section-D

CLASSROOM AND LAB LEARNING

Time-dependent Perturbation Theory& Scattering Theory:

Perturbation Theory: Time-independent non-degenerate and degenerate cases, Time-dependent Perturbation theory; variational methods, and WKB method.

Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

References:

1. **Ashok Das and A. C. Melissinos,** Quantum Mechanics, Gordon and Breach Science Publishers.
2. B.H. Bransden & C.A. Joachim, Quantum Mechanics, Pearson Publication
3. **P. A. M. Dirac,** Lectures on Quantum Mechanics, Dover Publications.
4. **R. Shankar,** Principles of Quantum Mechanics, Springer.
5. **Albert Messiah,** Quantum Mechanics, Dover Publications.
6. **L.I. Schiff,** Quantum Mechanics, McGraw Publications.
7. **Claude Cohen,** Quantum Mechanics, Wiley.
8. **J.J. Sakurai,** Modern Quantum Mechanics, Pearson Education.
9. **E. Merzbecher,** Quantum Mechanics, John Wiley.

Electronics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Introduction to Network:

Network analysis: Kirchhoff's Laws and Star-Delta networks. Network theorems: Superposition, Thevenin, Norton, & Maximum Power Transfer. Two port networks: z, y, h, and t parameters.

Section-B

DIGITAL AND CLASS ROOM LEARNING

Electronic Devices:

Review of p-n junction, Schottky diode, metal-semiconductor and metal-oxide semiconductor junctions, BJT, JFET, MESFET & MOSFET.

Basic differential amplifier circuit, operational amplifier characteristics and applications: Addition, Subtraction, Integrator, Differentiator; 555 Timer, astable and monostable multivibrator; zero crossing detector. Amplifiers at low and high frequencies.

Section-C

DIGITAL AIDED LEARNING

Digital Electronics:

Overview of Gates, SOP, POS, Homo and hetero junction devices, combinational and sequential digital systems, flip-flops: (RS, JK, Master Slave), counters: synchronous/asynchronous and decade.

Section-D

CLASSROOM AND LAB LEARNING

Electronic Instruments:

A/D and D/A converter, photodiode, solar cell, photo detectors, 8085 microprocessor, Regulated Power supplies, phase shift and Wien bridge oscillators, digital oscilloscopes.

References:
1. **P. Horowitz and W. Hill,** The Art of Electronics, Cambridge University Press.
2. **J. Millman and A. Grabel,** Microelectronics, McGraw Hill.
3. **J.J. Cathey,** Schaum's Outline of Electronic Devices and Circuits, McGraw Hill.
4. **M. Forrest,** Electronic Sensor Circuits and Projects, Master Publishing.
5. **Ajoy Ghatak and K. Thygarajan,** Optical electronics, Cambridge Univ. Press.
6. **S.M. Sze**, Semiconductor Devices - Physics and Technology : (John Wiley), 2002.
7. **Zee**, Physics of semiconductor devices.
8. **Millman and Halkias** ,Integrated Electronics : (Tata McGraw Hill) 1991.
9. **A.P. Malvino**, Electronic Principles : (Tata McGraw, New Delhi), 7th edition, 2009.
10. **W. Kleitz**, Digital Electronics: A Practical Approach, Pearson.
11. **J.H. Moore, C.C. Davis and M.A. Coplan**, Building Scientific Apparatus, Addison Wesley.
12. **R.S. Gaonkar**, Microprocessor Architecture, Programming and Applications with 8085 : (Prentice Hall) 2002.

Laboratory I

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

1. Ionization potential of Lithium
2. Zeeman Effect
3. Dissociation Energy of I2 molecule
4. Hall Effect
5. Four Probe Method
6. Electron Spin Resonance
7. Telexometer
8. Faraday Effect
9. Frank-Hertz experiment
10. Compton Effect
11. Atomic Spectra of two-Electron Systems
12. Iodine Spectra
13. H-alpha Spectra
14. Coupled Oscillations

Students assigned the general laboratory work will perform at least eight (08) experiments of the above mentioned list. Experiments of equal standard may be added. Workshop soldering and designing of experiments should be included.

Reference:

1. Worsnop and Flint, Experimental Physics.
2. A. C. Melissinos, J. Napolitano, Experiments in Modern Physics, Academic Press.
3. Geeta Shenon, B.Sc Practical Physics, Latest Edition.

Modern Optics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

An overview of Geometrical and Wave Optics: Laws of Reflection, Refraction, Total Internal Reflection; Ideas of Interference, Diffraction, Polarisation, Dispersion.

Section-B

DIGITAL AIDED ROOM LEARNING

Fresnel Relations: Conductors, Thin Films: Reflection Model, Matrix Formalism, Coating Design, Fourier Optics: Wave Propagation,

CLASSROOM AND LAB LEARNING

Fraunhofer Diffraction, Fresnel Diffraction, Spatial Filtering, Holography.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Coherence, Interference and Visibility, Laser Physics: Overview, Gain Saturation, Light-Atom Interactions, Optical Gain and Pumping Schemes, Output Characteristics.

Light Shifts and Optical Forces, Atom-Photon interactions.

Section-D

Fibre Optics: Mode Analysis, Loss and Dispersion, Photonics Band-gap Crystals. Introduction/Basic idea of LED.

References:

1. **Pedrotti,** Introduction to Optics, Pearson.
2. **A. Ghatak,** Optics, Tata McGraw-Hill.
3. **G. R. Fowles,** Introduction to Modern Optics, Dover Publication.
4. **B. E. A. Saleh and M. C. Teich,** Fundamentals of Photonics, Wiley.
5. **E. Hecht,** Optics, Addison Wesley.
6. **J. T. Verdeyen,** Laser Electronics, Prentice-Hall.
7. **A. E. Siegman,** Lasers, University Science Book.

Introduction to Experimental Physics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Science of Experimental Physics: Background, Objectives, Error Analysis, Graphical Analysis, Writing about Experiments, Design of Experiments.

Section-B

Probability and Statistics in Experimental Physics: Basic Concepts, Specific Discrete Distributions, Normal Distribution and other Continuous Distributions, Monte-Carlo Method, Inverse Probability: Confidence Limit.

Section-C

Curve-Fitting Methods: Methods for Estimating Parameters, Regression Analysis, The Regularization Method, Interpolating Functions and Unfolding Problems, Fitting Data with Correlations and Constraints.

Section-D

Some Fundamental Experiments in Physics: Frequency of Oscillations in Simple Pendulum, Single, Double and N slits Diffraction Experiments, Relation between Refractive Index and Wavelength: Hartmann Formulae, Hall Effect, Ionization Potential of Mercury, Oscillations in Compound Pendulum, more experiments of similar nature may also be discussed.

References:

1. **D.W. Preston and E.R. Dietz,** The Art of Experimental Physics, Academic Press.
2. **C. Cooke,** An Introduction to Experimental Physics, University College London.
3. **B.P. Roe,** Probability and Statistics in Experimental Physics, Springer.

Semester II

Statistical Mechanics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Elementary Probability Theory:

Preliminary Concepts:mean values, standard deviation, various moments; Random walk problem, Binomial distribution, Poisson distribution, Gaussian distributions, Central Limit Theorem.

Section-B

DIGITAL AIDED LEARNING

Review of Thermodynamics:

Extensive and intensive variables, laws of thermodynamics, Legendre transformations and thermodynamic potentials, Maxwell relations,

CLASSROOM AND LAB LEARNING

Applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) dielectric material.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Classical Statistical Mechanics:

Micro-canonical ensembles and their equivalence, Canonical and grand canonical ensembles, partition function, thermodynamic variables in terms of partition function, ideal gas, Gibbs paradox, validity of classical approximation, equipartition theorem. Maxwell-Boltzmann gas velocity and speed distribution. Chemical potential, Free energy and connection with thermodynamic variables, First and Second order phase transitions; phase equilibrium.

Section-D

DIGITAL AIDED ROOM LEARNING

Quantum Statistical Mechanics:

Density Matrix, ensembles in quantum statistical mechanics, simple applications of density matrix. Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac statistics.
Bose system: Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation, Bose- Einstein condensation, experiments on atomic BEC, BEC in a harmonic potential.
Fermi System: Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat, white dwarf stars.

References:
1. **F. Reif,** Fundamentals of Statistical and Thermal Physics, McGraw Hill.
2. **K. Huang,** Statistical Mechanics, John Wiley & Sons.
3. **R. K. Pathria,** Statistical Mechanics, Pergamon Press.
4. **B. B. Laud,** Fundamentals of Statistical Mechanics, New Age.
5. **Mark W. Zemansky and Richard H. Dittman,** Heat and Thermodynamics, McGraw Hill.
6. **L. D. Landau and E. M. Lifshitz,** Statistical Physics, Butterworth-Heinemann.
7. **Richard P. Feynman,** Statistical Mechanics, Westview Press.
8. **J. P. Sethna,** Statistical Mechanics: Entropy, Order Parameter and Complexity, Oxford University Press.

Classical Electrodynamics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Electrostatics

Differential equation for electric field, Poisson and Laplace equations, formal solution for potential with Green's functions, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy

Section-B

DIGITAL AND CLASS ROOM LEARNING

Magnetostatics & Maxwell's Equations:

Biot savart law Differential equation for static magnetic field, vector potential, magnetic field from localized current distributions, examples of magnetostatic problems,

Displacement current, Maxwell's equations, vector and scalar potentials, Gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws, inhomogeneous wave equation and Green's function solution.

Section-C

DIGITAL AIDED LEARNING

Electromagnetic Waves:

Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion.

CLASSROOM AND LAB LEARNING

Wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces, propagation modes in wave guides, resonant modes in cavities.

Section-D

Radiation and Relativistic Electrodynamics:

Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.Four-vectors relevant to electrodynamics, electromagnetic field tensor and Maxwell's equations, transformation of fields, fields of uniformly moving particles.

References:

1. **J.D. Jackson,** Classical Electrodynamics, Wiley.
2. **David J. Griffiths,** Introduction to Electrodynamics, Benjamin Cummings.
3. **L.D. Landau and E.M. Lifshitz,** Classical Theory of Electrodynamics, Addison-Wesley.
4. **L.D. Landau and E.M. Lifshitz,** Electrodynamics of Continuous Media, Addison Wesley.
5. **Wolfgang K. H. Panofsky and Melba Phillips,** Classical Electricity and Magnetism, Dover Publications.
6. **Joseph Edminister,** Schaum's outline of electromagnetics
7. **Walter Greiner**, Classical Electrodynamics

Solid State Physics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Crystal structure:

Crystal structures and lattices with basis, Miller indices, Common crystal structures, Reciprocal lattice, Brillouin zones,

CLASSROOM AND LAB LEARNING

X-ray diffraction by a crystal and their equivalence, Laue equations, Ewald construction, Brillouin interpretation, Crystal and atomic structure factors, Structure factor; Experimental methods of structure analysis: Types of probe beam, the Laue, rotating crystal and powder methods.

Section-B

DIGITAL AIDED LEARNING

Lattice dynamics and thermal properties:

Classical theory of lattice dynamics: Vibrations of crystals with monatomic basis and Two atomic basis, Dispersion relation, Group velocity, Acoustical and optical modes; Phonons: Quantization of lattice vibration, Phonon momentum, Inelastic scattering of neutrons by phonons; Thermal properties: heat capacity, Density of states, Normal modes, Debye and Einstein models.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Electronic properties of solids:

Free electron gas model: Electrical conductivity, Ohm's law and electronic specific heat, Drude Model of electrical and thermal conductivity, Density of states, Heat capacity, Hall effect and thermoelectric power, Fermi energy, Effect of temperature, effective mass, Limitations of the free electron gas model, Band theory of solids: Periodic potential, Bloch's theorem, Kronig-Penney model, Approximate solution near a zone boundary, Periodic, extended and reduced zone schemes of energy band representation, Classification into metals, semiconductors and insulators; Tight binding method and its application to SC and BCC structures.

Section-D

DIGITAL AND CLASS ROOM LEARNING

Superconductivity:

Introduction to Superconductivity, effect of magnetic field, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Thermodynamics of the superconducting transition, London equation, Coherence length, BCS theory of superconductivity, Flux quantization in a superconducting ring; DC and AC Josephson effects; Macroscopic long-range quantum interference; High Tc superconductors

References:

1. **Charles Kittel,**Introduction to Solid State Physics, Wiley.
2. **Neil W. Ashcroft and N. David Mermin,**Solid State Physics, Holt, Rinehart and Winston.
3. **Rajnikant,**Applied Solid State Physics, Wiley.
4. **H. Ibach and H. Luth,** Solid State Physics: An Introduction to Theory and Experiment, Springer.
5. **J. M. Ziman,**Principles of the Theory of Solids, Cambridge University Press.
6. **M. A. Wahab**, Solid State Physics: Structure and Properties of Materials, 2nd Edition, Narosa Book Distributors.
7. **J. P. Srivastava**, Elements of Solid State Physics, Prentice-Hall of India.

Laboratory II

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4

1. Addition, Subtraction and Binary to BCD conversion
2. JK, Master Slave Flip-Flop, up-down counter, 4 bit counter
3. Multivibrator
4. Differential Amplifier using Op Amp
5. Op-amps and its application: Inverting and Non-inverting of given gain; Integrator and Differentiator
6. IC 555 Timer: Astable and Monostable Multivibrator
7. Design of CE Amplifier
8. Design of Regulated Power Supply
9. Arithmetic Logic Unit
10. Digital to Analog Converter (maximum 4-bit)
11. Experiments on MUX, DEMUX, Decoder and shift register
12. I-V characteristics of Photodiode/Solar Cells
13. Voltage regulation of Zener diodes
14. Designing decade counter
15. Characteristics of MOSFET

Computational experiments using computer programming
1. Finite and infinite series
2. Root finding: (bisection, Secant and Newton-Raphson methods)
3. Solving first and second order ordinary differential equations including simultaneous equations (Euler and Runge-Kutta methods)
4. Numerical integration (trapezoidal, Simpson, Gauss quadrature, methods)
5. Matrices (arrays of variable sizes, addition, multiplication, eigenvalues, eigenvectors, inversion, solutions of simultaneous equations)

Students assigned the general laboratory work will perform at least twelve (12) experiments from the above mentioned. More experiments of similar nature may be added.

References:

1. W. Kleitz, Digital Electronics: A Practical Approach, Pearson.
2. J.H. Moore, C.C. Davis and M.A. Coplan, Building Scientific Apparatus, Addison Wesley.
3. V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India.
4. V. Rajaraman, Computer Programming in FORTRAN 90/95.

MECHANICS

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. There will be eight questions covering the entire syllabus out of which four are to be attempted by the student selecting one from each section. Q. No. 1 will be compulsory (short answer type five parts are to be attempted out of six) 3X5=15. All questions carry equal marks.
2. Internal evaluation is to be made on the basis of the parameters to be decided by the concerned faculty in the consultation with the Head of the department.

Section- A

DIGITAL AND SELF LEARNING

Vector Integration: Line integrals, Surface area and surface integrals, Volume integrals.
Integral Theorems: Green's theorem, Gauss divergence theorem, Stoke's theorem. **12hrs**

Section- B

DIGITAL AIDED LEARNING

Curvilinear Coordinates: Orthogonal coordinates Unit vectors in curvilinear systems, Arc length and volume elements, the gradient, Divergence and curl, Special orthogonal coordinate systems.

DIGITAL AND CLASS ROOM LEARNING

Tensor Analysis: Coordinate transformations, Einstein summation convention, Tensors of different ranks, Contravariant, Covariant and mixed tensors, Symmetric and skew symmetric tensors, Addition, Subtraction, Inner and outer products of tensors, Contraction theorem, Quotient law, The line element and metric tensor, Christoffel symbols. **16 Hrs**

Section- C

DIGITAL AND CLASS ROOM LEARNING

Newtonian mechanics and Lagrange formulation: Newtonian mechanics of one body and Many particle systems, constraints: holonomic and non-holonomic, D' Alembert's Principle and Lagrange equation of motion and its applications.

Hamiltonian formulation: Introduction of Hamilton's Equation of motion and simple applications of Hamiltonian formulation. **16hrs**

Section- D

CLASSROOM AND LAB LEARNING

Special Theory of Relativity and Lorentz Transformations: Frame of reference, Galilean transformations for space and time, Michelson- Morley experiment, Lorentz transformation equations, Length contraction, Time dilation, variation of mass with velocity, Equivalence of mass and energy.

16hrs

Suggested Books :

1. G. E. Hay, Vector and Tensor Analysis, (Dover Publications, Inc., 1979)
2. G. R. Fowles and G. L. Cassiday, Analytical Mechanics, (Thomson Brooks/Cole, 2005)
3. H. Goldstein, C. P. Poole and J. L. Safko, Classical Mechanics, (Addison-Wesley, Publishing Co., 2001)
4. M. R. Spiegel, Theoretical Mechanics, (McGraw Hill Book Company, 1980)
5. M. R. Spiegel, Vector Analysis, (McGraw Hill Book Company, 1981)
6. D. C. Kay, Tensor Calculus, (McGraw Hill Book Company, 1988)
7. E. C. Young, Vector and Tensor Analysis, (Marcel Dekker, Inc., 1993)
8. L. N. Hand and J. D. Finch, Analytical Mechanics, (Cambridge University Press, 1998)

Environmental Physics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Introduction to Energy:

Importance of energy in science and society. Types of energy (mechanical, heat, chemical, nuclear, electrical). Law of conservation of energy. Energy transformations. Mechanical energy: force, work, kinetic and potential energy, PE diagrams, conservation of mechanical energy, bound systems. Electricity Basics.

Section-B

CLASSROOM AND LAB LEARNING

Heat Energy and Kinetic Theory:

Heat and Temperature. Internal Energy, Specific Heat. Ideal gas equation. Kinetic theory interpretation of pressure and temperature. Work, heat, and the first law of thermodynamics. Adiabatic lapse rate. Radiant energy. Blackbody radiation. Heat engines and the second law of thermodynamics. The Carnot cycle. Applications of the second law to various energy transformation processes: heat pumps and refrigerators; different engine cycles. Entropy and disorder.

Section-C

DIGITAL AIDED LEARNING

Energy and Climate Change:

Energy balance of the Earth. Greenhouse effect. Climate feedbacks (water, clouds, ice albedo). Global Climate Models. Evidence for climate change. Paleo-climate. Climate change impacts. Climate change mitigation. Target CO_2 levels.

Section-D

DIGITAL AND CLASS ROOM LEARNING

Energy Source:

Chemical energy. Energy in biology, photosynthesis, respiration. Energy use in the human body, energy content of food. Fossil fuels and their origin (coal, oil, natural gas). Problems with fossil fuels, greenhouse pollution, peak oil. Alternatives to fossil fuels. Alternative energy resource: Wind energy, energy from water on land, ocean energy. Biomass and other sources.

References:

1. **R. A. Hinrichs and M. Kleinbach,** Energy, Its Use and the Environment, Brooks Cole.
2. **C. W. Rose,** An Introduction to the Environmental Physics of Soil, Water and Watersheds,

Cambridge University Press.
3. **P. Hughes, N. J. Mason,** Introduction to Physics: Planet Earth, Life and Climate, Taylor & Francis.
4. **J. Monteith, M. Unsworth,** Principles of Environmental Physics: Plants, Animals and the Atmosphere, Elsevier.
5. **Egbert Boeker & Rienk Van Groundelle,** Environmental Physics (John Wiley).
6. **J.T.Hougtyion,** The Physics of Atmosphere (Cambridge University Press, 1977).
7. **J.T. Widell and J. Weir,** Renewable Energy Resources (Elbs, 1988).
8. **Sol Wieder,** An Introduction of Solar Energy for scientists and Engineers (John Wiley 1982).
9. **R.N. Keshavamurthy and M. Shankar Rao,** The Physics of Monsoons (Allied Publishers 1992).
10. **K.L.Kumar,** Engineering Fluid Mechanics (S.Chand, 1994).
11. **waLandau &Lifshitz,** Fluid Mechanics, Pergamon Press (2000).

Physics of Electronic Material and Devices

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Physical Mechanisms-I:
Crystal structures of Electronic materials (Elemental, III-IV and VI semiconductors), Energy Band consideration in solids in relation to semiconductors, Direct and Indirect bands in semiconductor, Electron/Hole concentration and Fermi energy in intrinsic/Extrinsic semiconductor continuity equation.

Section-B

DIGITAL AIDED LEARNING

Physical Mechanisms-II
Carrier mobility in semiconductors, Electron and Hole conductivity in semiconductors, Shallow impurities in semiconductors (Ionization Energies), Deep Impurity states in semiconductors, Carrier Trapping and recombination/generation in semiconductors, Shockley Read theory of recombination, Switching in Electronic Devices.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Electronic Devices:
Metal/Semiconductor Junction or (Abrupt P-N Junction), Current-voltage characteristics, C-V measurements, Estimation of Barrier Height and carrier concentration from C-V characteristics, Surface/Interface States, Role of interface States in Junction Diodes. Field Effect devices, C-V characteristics of MIS diodes (Frequency dependence), Estimation of Interface Trapped charges by capacitance conductance, method CCD (Charge Coupled Devices).

Section-D

CLASSROOM AND LAB LEARNING

Microwave and Photonics Devices:
Tunnel Diode, MIS Tunnel Diode, Degenerate and Non-degenerate semiconductor, MIS Switch Diode, MIM Tunnel diode. IMPATT Diode. Characteristics, breakdown Voltage, Avalanche Region and Drift Region, Transferred Electron devices.
Photonics Devices: LED and LASER, Photo detectors, Solar-cells.

References:

1. **S.M. Sze,**Physics of Semiconductor Devices, Wiley.
2. **Jasprit Singh,**Semiconductor Devices Basic Principles, Wiley.
3. **A.S. Grove,**Physics and Technology of Semiconductor Devices, Wiley.
4. **B.L. Sharma,**Metal/Semiconductor Schottky Barrier Junction and their Applications, Plenum Press.
5. **E. H.Rhoderick,**Metal/Semiconductor Contacts, Clarendon Press.

Advanced Quantum Mechanics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Symmetry in Quantum mechanics:

Symmetry Operations and Unitary Transformations, conservation principles, space and time translation, rotation, space inversion and time reversal, symmetry and degeneracy.

Section-B

DIGITAL AND CLASS ROOM LEARNING

Relativistic Quantum Mechanics:

Klein Gordon equation, Dirac equation, negative energy solutions, antiparticles, Dirac hole theory, Feynman interpretation of antiparticles, Gamma matrices and their properties, Covariance of Dirac equation, Charge conjugation, Parity & Time reversal invariance, Bilinear covariants, Plane wave solution, Two component theory of neutrino, Spin & Helicity, Relativistic Hydrogen atom problem.

Section-C

DIGITAL AIDED LEARNING

Classical Field Theory:

Interaction Picture; Constant and harmonic perturbations; Fermi Golden rule; Sudden and adiabatic approximations. Beta decay as an example.

Lagrangian density and equation of motion for field, Symmetries and conservation laws, Noether’s theorem.

Section-D

DIGITAL AND CLASS ROOM LEARNING/CLASSROOM AND LAB LEARNING

Second Quantization:

First Quantization: Many Body Quantum Mechanics; Slater Determinant. Second Quantization: Creation & Annihilation Operators, Number Operator; Non-Interacting Bose & Fermi Gas; Hamiltonian for the interacting system; Adding Spin.

References:

1. **C. Cohen-Tannoudji, Bernard Diu and FrankLaloe,** Quantum Mechanics, Wiley.
2. **Albert Messiah,** Quantum Mechanics, Dover Publications.
3. **R.Shankar,** Principles of Quantum Mechanics, Springer.
4. **L.I. Schiff,** Quantum Mechanics, McGraw Hill.
5. **J.J. Sakurai,** Modern Quantum Mechanics, Pearson Education.
6. **E. Merzbecher,** Quantum Mechanics, John Wiley.
7. **J. D. Bjorken and S.D. Drell,**Relativistic Quantum Mechanics, McGraw Hill.
8. **Amitabha Lahiri and P.B. Pal,**A First Book on Quantum Field Theory, CRC Press.

Seminar Presentation

This may include subject/research oriented topics.

Atomic, Molecular Physics and Lasers

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Atomic Spectra I:

Review of Atomic Models: Rutherford's Model, Bohr's model, Sommerfeld's model, Revision of quantum numbers, exclusion principle, electronic configuration. Relativistic correction to energy levels of an atom.

CLASSROOM AND LAB LEARNING

Atom in a weak uniform external electric field – first and second order Stark effect,
Stern-Gerlach experiment for electron spin.

Section-B

DIGITAL AIDED LEARNING

Atomic Spectra II:

Spin-orbit interaction and fine structure, LS and JJ coupling, Relativistic correction to spectra of hydrogen atom, Hyperfine structure and isotope shift, Auger Effect and Frank Condon Principle. Born-Oppenheimer approximation.

CLASSROOM AND LAB LEARNING

Lamb shift, effect of magnetic field on the hydrogen atom spectra, Zeeman and Paschen-Back effect.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Molecular spectra:

Rotational levels in diatomic and polyatomic molecules, vibrational levels in diatomic and polyatomic molecules, diatomic vibrating rotator, Born-Oppenheimer approximation, symmetry of the molecules and vibrational levels.

CLASSROOM AND LAB LEARNING

Experimental aspects of vibrational and rotational spectroscopy of molecules, polarization of light and Raman effect, Raman Spectroscopy (Brief Introduction).

Section-D

DIGITAL AND CLASS ROOM LEARNING

Lasers:

Spontaneous and stimulated emission, Spatial and temporal Coherence, Einstein A and B coefficients, Optical Pumping, Population Inversion, Modes of resonator, Q-switching and Mode Locking, Ultra short pulse generation,

CLASSROOM AND LAB LEARNING

He-Ne Laser and Ruby Laser- Principle, Construction and working, Application of lasers in the field of medicine and Industry.

References:

1. **B. H.Bransden and C. J Joachain,**Physics of Atoms and Molecules, Prentice Hall.
2. **K. Thyagarajan and A.K. Ghatak,**Lasers - Theory and Applications, Plenum Press.
3. **H.E. White,**Introduction to Atomic Spectra, McGraw Hill.
4. **H. G. Kuhn,**Introduction to Atomic Spectra, McGraw Hill.
5. **R. Eisberg and R. Resnick,** Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley.
6. **Arthur Beiser,** Perspectives of Modern Physics, McGraw Hill.
7. **Gerhard Herzberg,** Molecular Spectra and Molecular Structure, Krieger Pub Co.
8. **C. N. Banwell,** Fundamentals of Molecular Spectroscopy, Tata McGraw Hill.

Nuclear & Particle Physics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A
DIGITAL AND SELF LEARNING

Introductory Concept of Nuclei:
Nuclear angular momentum, Nuclear magnetic dipole moment and Electric quadruple moment, Parity quantum number, Statistics of nuclear particles, Isobaric spin concept, Systematic of stable nuclei.
Nuclear Disintegration: Simple theories of decay, Properties of neutrino, Non conservation of parity and Wu's experiment in beta decay, Electron capture, Internal conversion.

Section-B
DIGITAL AIDED LEARNING

Inter Nucleon Forces:
Properties and simple theory of the deuteron ground state, Spin dependence and tensor component of nuclear forces, Nucleon-nucleon scattering at low energy, Charge-independence of nuclear forces, Many–nucleon systems and saturation of nuclear forces, Exchange forces, Elements of meson theory.

Section-C

CLASSROOM AND LAB LEARNING/ DIGITAL AND CLASS ROOM LEARNING

Nuclear Structure and Models:
Fermi gas model, Experimental evidence for shell structure in nuclei, Basic assumption for shell model, Single- particle energy levels in central potential, Spin-orbit potential and prediction of magic numbers, Extreme single- particle model, Prediction of angular moment, Parities and magnetic moment of nuclear ground states, Liquid drop model, Semi-empirical mass formula, Nuclear fission, The unified model.

Section-D
CLASSROOM AND LAB LEARNING

Particle Physics:
Properties and origin, Elementary particles, Properties, classification, type of interactions and conservation laws, Properties of mesons, Resonance particles, Strange particles and Strangeness quantum number, Simple ideas of group theory, Symmetry and conservation laws, CP and CPT invariance, Special symmetry groups SU (2) and SU (3)classification of hadrons, Quarks, Gell- Mann-Okubu mass formula.

References:

1. **Roy & Nigam,**Nuclear Physics, Wiley.
2. **H. Enge,**Introduction to nuclear Physics, Addison Wesley.
3. **J.M. Blatt and V.F. Weisskopf,**Theoretical Nuclear Physics, Springer.
4. **J.D. Walecka,**Theoretical Nuclear and Subnuclear Physics, World Scientific.
5. **M.Leon,**Particle Physics:An introduction, Academic Press.
6. **F.I. Stancu,**Group Theory in Subnuclear Physics, Clarendon Press.
7. **B. R. Martin and G. Shaw,**Particle Physics, Wiley.

Thin Film and Integrated Devices

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Materials for Integrated Circuits:

Classification of IC, CMOS Process Overview, Electronic grade silicon, Crystal growth, Czeehralski and float zone crystal growing methods, Silicon shaping lapping, Polishing and wafer preparation, Hot Processes-I: Oxidation and Diffusion, Oxidation of silicon, oxide deposition by thermal dry oxidation and wet oxidation method Diffusion Process, Diffusion Coefficient, Fick's 1st and 2nd Laws of Diffusion, Vacancy –Impurity interactions, Dopants and Dopant Sources, Doping by Diffusion, ion implantation, Diffusion Process Control, Diffusion Systems, Implantation Technology, Selective Implantation, Junction depth, Channeling, Lattice Damage, Annealing, Dopant Diffusion and Related Operations: Equipment for Diffusion and Related Operations.

Section-B

DIGITAL AIDED LEARNING

Thin Films: Metals and Nonmetals

Vacuum Science and Technology, Evaporation theory and electron beam evaporation, evaporation system, idea of DC and R.F. sputtering system.

CLASSROOM AND LAB LEARNING

Physical vapour deposition methods, Design construction of vacuum coating units, Chemicals Vapour Deposition, Reactors for Chemical Vapour Deposition, CVD Applications, Epitaxy methods for thin film deposition, Vapour-Phase Epitaxy, Photolithography, Photoresist Processing and Etching.

Section-C

CLASSROOM AND LAB LEARNING

Lithography:

Wafer Cleaning methods, Wafer Preparation method: photoresist coating methods, soft backing of photo resist, post exposure backing of photo resist, Negative photoresist, Positive photoresist, Contrast and sensitivity of photoresist, Chemical Modulus Transfer Function (CMTF) of Photoresist, Resist Exposure (single, bi-layer and multi-level photoresist exposure) and Resist Development, Hard Baking and Resist curing, Photolithographic Process Control. Photolithography: An Overview, Photo lithography source, Photolithographic methods: Contact, proximity and projection and their resolution limit, Idea of electron beam lithography, Idea of an X- ray lithography.

Section-D

DIGITAL AND CLASS ROOM LEARNING

Interconnections and Contacts and Packaging and Yield

Ohmic Contact Formation, Contact Resistance, Electro-migration, Diffused Interconnections, Poly-silicon Interconnections, Buried Contacts, Butted Contacts, Silicides, Multilayer Contacts, Liftoff Process, Multilevel Metallization. Testing, Die Separation, Die Attachment, Wire Bonding, Packages, Flip-Chip Process, Tape-Automated-Bonding Process, Yield, Uniform and Nonuniform Defect Densities.

References:

1. **Millman and Taub,**Integrated Electronics, McGraw Hill.
2. **Millman and Gros,**Microelectronics, McGraw Hill.
3. **K.L. Chopra,**Thin Film Phenomena, McGraw Hill.
4. **L. I.Marshel and R. Glang,**Hand Book of Thin Film, McGraw Hill.
5. **S.M. Sze,**VLSI Technology, McGraw Hill.

Laboratory III

Each student is required to perform at least five experiments from Section A and at least three experiments from any one of the optional subtopics of Section B: (i) Electronics (ii) Thin Film and Nano-Material (iii) Numerical Techniques; depending upon the courses opted under discipline centric elective course.

Paper Code: Time Allowed: 3 Hours
Max. Marks: 100 Credits: 4

Section A

1. Kerr Effect
2. Curie Temperature
3. B-H curve
4. Solid State Nuclear Track Detector (SSNTD)
5. G.M. Counters: characteristics, deadtime and counting statistics
6. Scintillation detector-energy calibration, resolution and determination of gamma ray energy
7. Prism Spectrometer
8. Grating Spectrometer
9. Interferometric method for thin film thickness and strain measurement
10. Ultra-Voilet Visible
11. Surface Plasmon Resonance (SPR)
12. Laser Diffraction
13. Gas Hydrogen Spectra
14. Fourier Transform Infrared Spectroscopy (FTIR)
15. Alpha Spectroscopy with Surface Barrier Detector
16. X-Ray Diffraction
17. Verification of Hartmann formula for prism spectrogram
18. Measurement of optical spectrum of an alkali atom
19. Emitter of electric discharge through air in an evacuated tube
20. Measurement of optical spectrum of alkaline earth atoms
21. Measurement of Band positions and determination of vibrational constants of AlO molecule
22. Measurement of Band positions and determination of vibrational constants of N_2 molecule
23. Measurement of Band positions and determination of vibrational constants of CN molecule
24. Determination of characteristic parameters of an optical fibre
25. Measurement of Raman spectrum of CCl_4

Section B

(i) Electronics

1. PCM/delta modulation and demodulation
2. Fiber optic communication
3. D/A converter interfacing and frequency/temperature measurement with microprocessor 8085/8086
4. A/D converter interfacing and AC/DC voltage/current measurement using microprocessor 8085/8086
5. PPI 8251 interfacing with microprocessor for serial communication

(ii) Thin Film and Nano-Material

1. Chemical Vapour Deposition
2. Vacuum, Thermal Evaporation and DC sputtering
3. Spin Coater
4. Surface morphological characterisation of thin film by AFM/SEM
5. Ball milling

(iii) Numerical Techniques

1. Solution of Linear algebraic equation: Gauss Jordon elimination, Singular Value Decomposition, Sparse linear system.
2. Evaluation of Functions: special functions, evaluation of functions by path integration, incomplete gamma, beta function.
3. Random Numbers: Uniform random numbers generators, statistical distributions and their properties, Rejection Methods, transformation method, simple Monte Carlo integration, Adaptive and recursive Monte Carlo methods, Test of randomness.
4. Signal Processing: FFT, IFFT, Filtering with FFT, convolution and correlation functions, application to real time series data.
5. Eigen systems: Solving eigenvalues and finding eigen functions of Schrodinger equation for analytically unsolvable potentials using variational principle.

References:

1. W.H. Press, B.P. Flannery, S.A. Teukolsky and W.T. Vetterling, Numerical Recipes in C/C++: The Art of Scientific Computing, Cambridge University Press.
2. J. P. Sethna, Statistical Mechanics: Entropy, Order Parameters, and Complexity, Oxford University Press.
3. A. C. Melissinos, J. Napolitano, Experiments in Modern Physics, Academic Press.
4. E. Balagurusamy, Numerical Methods, Tata Macgraw Hill
5. Albert Malvino, Digital Principles and Applications, Macgraw Hill inc. US

Computational Physics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING/ DIGITAL AIDED LEARNING

Stochastic Processes:
Theory of random walks and simulation of random walks in one, two and three dimensions. Elementary ideas and simulations of self-avoiding walks, additive and multiplicative stochastic processes, Brownian motion and fractional Brownian motion.

Section-B

DIGITAL AND CLASS ROOM LEARNING

Numerical Methods and Applications :
Finite Difference Method, Langevin dynamics, TDGL equation, Cahn-Hilliard equation, Burgers' equation, KPZ model.

Section-C

CLASSROOM AND LAB LEARNING

Molecular Dynamics (MD) and Monte Carlo (MC) Simulations:
Elementary ideas of Molecular dynamics; Dynamical equations and physical potentials; Verlet algorithm.Time-average and Ensemble average; Monte Carlo methods; Metropolis algorithm. Introduction to the simulations: (a) Ising model in magnetism (b) Glauber and Kawasaki dynamics.

Section-D

CLASSROOM AND LAB LEARNING

Combinatorial optimization problems:
Classification of problems; examples of optimization problems: traveling salesman problem (TSP) and satisfiability (k-SAT) problem; heuristic methods of solutions and simulated annealing technique.

References

1. **D. Frenkel & B. Smit,** Understanding Molecular Simulation, Academic Press.
2. **Kurt Binder and Heerman,** Monte Carlo Simulation in Statistical Physics.
3. **M. Plischke& B. Bergersen,** Equilibrium Statistical Physics, World Scientific.
4. **W.H. Press, B.P. Flannery, S.A. Teukolsky and W.T. Vetterling,** Numerical Recipes in C/C++: The Art of Scientific Computing, Cambridge University Press.
5. **M. P. Allen,** Computer Simulation of Liquids**.**

Electronic Communication

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Digital communication:
Need for communication: AM, FM, modulation index. Pulse – Modulation systems, sampling theorem – Low – Pass and Band – Pass signals, PAM, Channel BW for a PAM signal. Natural sampling. Flat – top sampling. Signal recovery through Holding,

CLASSROOM AND LAB LEARNING

Quantization of signals, Quantization error, Differential PCM, Delta Modulation, Adaptive Delta Modulation, CVSD.Digital Modulation Techniques: BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK.

Section-B

DIGITAL AIDED LEARNING

Mathematical representation of Noise:
Sources of noise. Frequency domain representation of noise, effect of filtering on the probability density of Gaussian noise, spectral component of noise, effect of a filter on the power spectral density of noise. Superposition of noises. Mixing involving noise. Linear filtering. Noise Bandwidth, Quadrature components of noise, Power spectral density of nc(t), ns(t) and their time derivatives.

Section-C

CLASSROOM AND LAB LEARNING

Data Transmission:
Baseband signal receiver, probability of error. Optimum filter. White noise.
Noise in pulse–code and Delta–modulation system: PCM Transmission, Calculation of Quantization noise, Output – signal power, Effect of thermal noise in D M, Output signal–to–noise ratio in PCM, DM, Quantization noise in DM, Effect of thermal noise in Delta modulation, Output signal to noise ratio in DM.

Section-D

DIGITAL AND CLASS ROOM LEARNING/ CLASSROOM AND LAB LEARNING

Computer Communication Systems:
Types of networks, Design features of a communication network, examples: TYMNET, ARPANET, ISDN, LAN.

Mobile Radio and Satellites: Time division multiple Access (TDMA), Frequency Division Multiple Access (FDMA), ALOHA, Slotted ALOHA, Carrier Sense Multiple Access (CSMA) Poisson distribution, Protocols, Cellular communications, Mobile communication via Satellites, Bandwidth consideration in INTERNET.

References:

1. **Taub and Schilling,**Principles of Communication Systems, McGraw Hill.
2. **Simon Haykin,**Communication Systems, Wiley.
3. **Jack, W. Hudson and Jerry Lucke,** Basic Communications Electronics, Master Pub
4. **Robert L. Shrader,** Electronic Communication, Glencoe K Macmillan
5. **B.P. Lathi,** Modern Digital and Analogue Electronic Communication, Oxford University Press

Spectroscopy

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Molecular structure and Vibration spectroscopy:
Molecular structure determination, Stark effect, inversion spectrum of ammonia, Applications to chemical analysis.
Vibrational spectroscopy of diatomic and simple polyatomic molecules, Harmonic Oscillator, Anharmonic Oscillator - Rotational vibrators - Normal modes of vibration of Polyatomic molecules, Experimental techniques, Applications of infrared spectroscopy, H_2O and N_2O molecules, Reflectance spectroscopy.

Section-B

DIGITAL AIDED LEARNING/ CLASSROOM AND LAB LEARNING

Raman Spectroscopy:
Classical theory of Raman Scattering - Raman effect and molecular structure, Raman effect and crystal structure, Raman effect in relation to inorganic, organic and physical chemistry, Experimental techniques, Coherent anti-Stokes Raman Spectroscopy, Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO_2 molecules, Laser Raman Spectroscopy.

Section-C

CLASSROOM AND LAB LEARNING

NMR
Theory of NMR, Bloch equations, Steady state solution of Bloch equations, Theory of chemical shifts, Experimental methods, Single Coil and double coil methods, Pulse Method, High resolution method, Applications of NMR to quantitative measurements. Quadruple Hamiltonian of NQR, Nuclear quadruple energy levels for axial and non-axial symmetry - Experimental techniques and applications.

Section-D

DIGITAL AND CLASS ROOM LEARNING

ESR and Mossbauer spectroscopy:
Quantum mechanical treatment of ESR:Nuclear interaction and hyperfine structure, Relaxation effects, Basic principles of spectrographs, Applications of ESR method, Mossbauer Effect,Recoilless

emission and absorption - Mossbauer spectrum - Experimental methods - Mossbauer spectrometer, Hyperfine interactions, Chemical Isomer shift, Magnetic hyperfine interactions, Electric quadruple interactions, Simple biological applications

References:

1. **C.N. Banwell and E.M. Mc Cash,** Fundamentals of Molecular Spectroscopy, Tata McGraw- Hill.
2. **G. Aruldas,** Molecular Structure and Spectroscopy, Prentice Hall of India.
3. **D.N. Satyanarayana,** Vibrational Spectroscopy and Applications, New Age.
4. **Raymond Chang,** Basic Principles of Spectroscopy, McGraw Hill.
5. **Martin Karplus and Richard N. Porter,** Atoms and Molecules: An Introduction For Students of Physical Chemistry, W.A. Benjamin, Inc

Physics of Nanomaterials

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

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2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Introduction to Nanostructure Materials:
Nanoscience & nanotechnology, Size dependence of properties, Moor's law, Surface energy and Melting point (quasi melting) of nanoparticles.
Band structure of solids: Free electron theory (qualitative idea) and its features, Idea of band structure, insulators, semiconductors and conductors, Energy band gaps of semiconductors, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, Variation of density of states with energy and Size of crystal.

Section-B

DIGITAL AIDED LEARNING/ DIGITAL AND CLASS ROOM LEARNING

Quantum Size Effect:
Quantum confinement, Nanomaterials structures, Two dimensional quantum system, Quantum well, Quantum wire and Quantum dot, Fabrication techniques.

Section-C

CLASSROOM AND LAB LEARNING

Synthesis of Nanomaterials:
Key issue in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom up approaches, Cluster beam evaporation, Ball Milling, Chemical bath deposition with capping agent, Carbon nanotubes (CNT)- Synthesis, Properties and Applications.

Section-D

CLASSROOM AND LAB LEARNING

Characterization techniques of Nanomaterials:
Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Shift in photoluminescence peaks, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy(TEM), Scanning Probe Microscopy (SPM), Scanning Tunnelling Electron Microscopy(STEM), and Atomic Force Microscopy (AFM).

References:

1. **Guozhong Cao,**Nanostructures & Nanomaterials, Synthesis, Properties & Applications, Imperial College Press.
2. **Charles P. Poole, Jr. Frank J. Owens,**Introduction to Nanotechnology, John Wiley & Sons.
3. **Paul Harrison,**Quantum Wells, Wires and Dots, John Wiley & Sons.
4. **D. Bimberg, M. Grundmann, N.N. Ledenstov,**Quantum Dot Hetrostructures, John Wiley & Sons.
5. **Hornyak G.L., Tibbals H.F., Dutta J.,Moore J.J.,**Introduction to Nanoscience and Nanotechnology, CRC Press.
6. **Liming Dai,**Carbon Nanotechnology, Elsevier.
7. **Michael J. O'Connell,**Carbon Nanotubes: Properties and Applications, CRC Press.
8. **T. Pradeep**, Nano-The Essentials, McGraw Hill Companies.

Advanced Statistical Mechanics

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Phase Transitions and Critical Phenomena

Thermodynamics of phase transitions, metastable states, Van der Waals' equation of state, coexistence of phases, Landau theory, critical phenomena at second-order phase transitions, spatial and temporal fluctuations, scaling hypothesis, critical exponents, universality classes.Ising model, mean-field theory, exact solution in one dimension, renormalization in one dimension.

Section-B

DIGITAL AIDED LEARNING

Nonequilibrium Systems I

Systems out of equilibrium, kinetic theory of a gas, approach to equilibrium and the H theorem, Boltzmann equation and its application to transport problems, master equation and irreversibility, simple examples, ergodic theorem.

Section-C

DIGITAL AIDED LEARNING/ DIGITAL AND CLASS ROOM LEARNING

Nonequilibrium Systems II

Brownian motion, Langevin equation, fluctuation-dissipation theorem, Einstein relation, Fokker-Planck equation.Time correlation functions, linear response theory, Kubo formula, Onsager relations.

Section-D

CLASSROOM AND LAB LEARNING

Coarse-grained Models

Hydrodynamics, Navier-Stokes equation for fluids, simple solutions for fluid flow, conservation laws and diffusion.

References:

1. **K. Huang,** Statistical Mechanics, Wiley.
2. **R.K. Pathria,** Statistical Mechanics, Elsevier.
3. **E.M. Lifshitz and L.P. Pitaevskii,** Physical Kinetics. Elsevier.
4. **D.A. McQuarrie,** Statistical Mechanics, University Science Books.
5. **L.P. Kadanoff,** Statistical Physics: Statistics, Dynamics and Renormalization, Academic.
6. **P.M. Chaikin and T.C. Lubensky,** Principles of Condensed Matter Physics, Cambridge University Press.
7. **Robert Zwanzig,** Nonequilibrium Statistical Mechanics, Oxford University Press.

General Theory of Relativity

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

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2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Equivalence principle and Tensors in GTR:
Equality of Gravitational and inertial Masses, Equivalence Principle, Principle of general Covariance; Tensor Analysis: Covariant and Contravariant tensor. Metric Tensor, Parallel Displacement and covariant differentiation, Affine conncetion and relation to metric tensor, Curvature tensor and its symmetries

Section-B

DIGITAL AIDED LEARNING

Geodesics
Equation of motion of a particle, Weak fields and newtonian approximation, Time and distance in gravitational theory, gravitational red and blue shift, experimental verification, Einstein Field Equation, Schwarzschild Solution, Mach's Principle, Radial motion towards centre, Nature of singularities, Black holes, event horizons, Kruskal coordinates.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Applications of GTR:
General orbits, constants of motion, deflection of light, precession of perihelion and radar echo, Standard, isotropic and harmonic coordinates, Post newtoninan formalism and status of observational verifications

Section-D

DIGITAL AND CLASS ROOM LEARNING/CLASSROOM AND LAB LEARNING

Energy content and equation of Motion:
Energy momentum for a perfect fluid, equation of motion from field equation for equation of dust, Action principle for field equations, conservation lawas in curved space and psuedo energy tensor for energy fields.

References:

1. **S. Weinberg**, Cosmolgy, Oxford University
2. **Ray D'Inverno**, Introducing Einstein's General Relativity, Oxford University
3. **M. Berry**, Principle of Cosmology and Gravitation, CUP
4. **Tai L. Chow**, Introduction to General theory of Relativity and Cosmology, Springer
5. **P.A.M. Dirac,** General theory of Relativity by, John Wiley
6. **L.D. Landau and E.M. Lifshitz**, The Classical Theory of Fields, Pergamon

Major Project/Dissertation

The dissertation topics will be based on special papers or elective papers and topics of current interest. A departmental committee will distribute the topics according to the skill and merit of the students.

Minor Project

The dissertation topics will be based on special papers or elective papers and topics of current interest. A departmental committee will distribute the topics according to the skill and merit of the students.

Nuclear Physics: Interaction and Model

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

N-N interaction:

Phenomenological N-N Potentials (Soft core & hard core) and meson theoretical potentials, Polarization in N-Nscattering.Probing charge distribution with electrons, Form factors, Proton form factors, Qualitative ideas on deep inelastic electron-proton scattering, Bjorken scaling and the patron model, Quark structure of the nucleon.

Section-B

DIGITAL AIDED LEARNING/CLASSROOM AND LAB LEARNING

Nuclear Models I:

Single particle model of the nucleus, Angular momenta and parities of nuclear ground states, Qualitative discussion and estimates of transition rates, Magnetic moments and Schmidt lines. Classification of shells, Seniority, Configuration mixing, Pairing Force theory

Section-C

DIGITAL AND CLASS ROOM LEARNING

Nuclear Models II:

Simple description of Two particle shell model spectroscopy.Deformable liquid drop and nuclear fission, Collective vibrations and excited states, Permanent deformation and collective rotations: Energy levels and electromagnetic properties of even-even and odd-odd formed nuclei, Nilsson model and equilibrium deformation, Coulomb Excitation Studies, Behaviour of Nuclei at high spin, Back-bending.

Section-D

DIGITAL AND CLASS ROOM LEARNING/ CLASSROOM AND LAB LEARNING

High Energy Physics

Particle Physics Experiments, Higgs Boson, LHC.

References:
1. **S. N. Ghoshal,**Nuclear Physics, S. Chand Limited.
2. **M. A.Preston and R. K. Bhaduri,**Nuclear Structure, Perseus Books Group.
3. **Brown and Jackson,**Nucleon-nucleon Interaction.
4. **S.S.M. Wong,**Introductory Nuclear Physics, Prentice Hall.
5. **M.K.Pal,** Nuclear Structure, Pearson Publication

Microprocessor and Microcontroller

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING/ DIGITAL AIDED LEARNING

Architecture :

8085 Architecture - Programmer's model - ALU - Registers and Flags - Stacks - Complete instruction set of Intel 8085 - State transition and timing diagrams - T States - Machine cycles - Instruction cycles - Addressing modes - Assembly language programs – Timing diagram for memory read and memory write cycles - time delay subroutines and delay calculations – maskable and Non-maskable Interrupts.

Section-B

DIGITAL AND CLASS ROOM LEARNING

Interfacing memory and devices– I/O and Memory mapped I/O – Simple polled I/O and Handshaking operations - Programmable keyboard/display interface 8279 - Programmable peripheral device 8255A - 8253 Timer Interface - Wave form generation (Square, triangular and ramp wave) - Programmable communication interface 8251 (USART).

Section-C

DIGITAL AIDED LEARNING

Microcontroller

Introduction – 8 and 16 bit Microcontroller families –Flash series – Embedded RISC Processor – 8051 Microcontroller Hardware – Internal registers – Addressing modes – Assembly Language Programming – Arithmetic, Logic and Sorting operations.

Section-D

CLASSROOM AND LAB LEARNING

Interfacing

Interfacing I/O Ports, External memory, counters and Timers - Serial data input/output, Interrupts – Interfacing 8051 with ADC, DAC, LED display, Keyboard, Sensors and Stepper motor.

Embedded microcontroller system – types of embedded operating system – Micro chip PIC 16C6X /7X family – features – Architecture – Memory Organization – Register file map – I/O ports – Data and flash program memory – asynchronous serial port – Applications in communication and industrial controls.

References:

1. **R.S.Gaonkar,** Microprocessor Architecture, programming and Application with the 8085. Cengage Publication
2. **V.Vijayendran,** Fundamentals of Microprocessor 8085 - Architecture, programming and interfacing. Pearson
3. **Kenneth J. Ayala,** The 8051 Micro Controller Architecture, Programming andApplications., Tata-McGraw Hills
4. **John B. Peatman,** Design with PIC Microcontrollers. Tata-McGraw Hills
5. **R.S. Gaonkar,** Microprocessor Architecture, programming and Application with the 8085, Tata-McGraw Hills

Nonlinear Dynamics

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Introduction to Dynamical Systems

Physics of nonlinear systems, dynamical equations and constants of motion, phase space, fixed points, stability analysis, bifurcations and their classification, Poincaré section and iterative maps.

Section-B

DIGITAL AIDED LEARNING/CLASSROOM AND LAB LEARNING

Dissipative Systems

One-dimensional noninvertible maps, simple and strange attractors, iterative maps, period doubling and universality, intermittency, invariant measure, Lyapunov exponents, higher dimensional systems, Hénon map, Lorenz equations, fractal geometry, generalized dimensions, examples of fractals.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Hamiltonian Systems

Integrability, Liouville's theorem, action-angle variables, introduction to perturbation techniques, KAM theorem, area-preserving maps, concepts of chaos and stochasticity.

Section-D

DIGITAL AND CLASS ROOM LEARNING

Advanced Topics

Selections from quantum chaos, cellular automata and coupled map lattices, pattern formation, solitons and completely integrable systems, turbulence.

References:
1. **E. Ott,** Chaos in Dynamical Systems, Cambridge University Press.
2. **E.A. Jackson,** Perspectives of Nonlinear Dynamics (Volumes 1 and 2), Cambridge University Press.
3. **A.J. Lichtenberg and M.A. Lieberman,** Regular and Stochastic Motion, Springer.
4. **A.M. Ozorio de Almeida,** Hamiltonian Systems: Chaos and Quantization, Cambridge University Press.
5. **M. Tabor,** Chaos and Integrability in Nonlinear Dynamics, Wiley.
6. **M. Lakshmanan and S. Rajasekar,** Nonlinear Dynamics: Integrability, Chaos andPatterns, Springer.

Introduction to Astrophysics and Cosmology

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Observational Data: Astronomical Coordinates- Celestial Sphere, Horizon, Equatorial, Ecliptic and galactic system of coordinates, Conversion from once coordinate system to another. Magnitude Scale – Apparent and absolute magnitude, distance modulus, Determination of Mass, luminosity, radius, temperature and distance of a star, H-R Diagram, Empirical mass-luminosity relation.

Section-B

CLASSROOM AND LAB LEARNING

Sun : Physical Characteristic of Sun – Basic data, solar rotation, solar magnetic fields, Photosphere- granulation, sun-spots, Babcock model of sunspot formation, solar atmosphere- chromospheres and corona, Solar activity – flares, prominences, Solar wind, activity cycle, Helioseismology

Section-C

DIGITAL AIDED LEARNING

Cosmology : Cosmological Principle, Maximally symmetric spaces, Killing vectors, Robertson Walker Metric, Redshift via Hubble's Law, Magnitude red shift relation, Hubble's Constant and deaccleration parameter

Section-D

DIGITAL AND CLASS ROOM LEARNING

Models of universe:

Einstein equation and standard model, Closed flat and open Universes, Age of the Universe, critical density and problem of missing mass or missing light. History of early Universe, helium formation, decoupling of matter and radiation, microwave background radiation.

References:

1. **M. Zeilik,** Astronomy, The evolving Universe CUP , 2002
2. **I. Morrison,** Introduction to astronomy and cosmology (Wiley 2008)
3. **P.V. Foukal,** Solar Astrophysics (Wiley-VCH 2004)
4. **J. V. Narlikar,** Introduction to Cosmology, CUP

Superconductivity: Conventional and High temperature Superconductors

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

DIGITAL AND SELF LEARNING

Conventional Superconductors:
Introduction of Superconducting materials, zero resistivity, Meissner-Ochsenfeld effect, perfect diamagnetism, type I and type II superconductors.

Section-B

DIGITAL AIDED LEARNING

London Theory and Ginzburg-Landau Theory:
London's phenomenological theory, London vortex, Penetration depth, Ginzburg-Landau theory: Order parameter, Condensation energy, Ginzburg-Landau theory of the Bulk phase transition, Ginzburg-Landau theory of inhomogeneous system, Ginzburg-Landau theory in a magnetic field, Flux quantization, thermodynamics of superconductors, specific heat below , density of states and Debye temperature, specific heat in a magnetic field, superconductor in zero field, superconductor in magnetic field.

Section-C

DIGITAL AND CLASS ROOM LEARNING

Microscopic Theory:
BCS Theory of superconductors: Cooper pairs, electron-phonon interaction, BCS order parameter, BCS Hamiltonian, Josephson effects.

CLASSROOM AND LAB LEARNING

Applications of superconducting Magnets, An application of weak superconductivity: SQUIDs.

Section-D

DIGITAL AND CLASS ROOM LEARNING/ CLASSROOM AND LAB LEARNING

High temperature Superconductors:
Crystal Structure of High Temperature Superconductors, Perovskites, Cubic Form, Orthorhombic Form, Tetragonal Form, Characteristics of High Temperature Superconductors: YBCO superconductor: Copper Oxide planes, Copper Coordination, Stacking rules, HgBaCaCuO and other high temperature superconducting systems.

References

1. **J F Annett**, Superconductivity Superfluids and Condensates, Oxford University Press, 2004
2. **G Deutscher**, New Superconductors from Ganular to High , World Scientific Publishing, 2006.
3. **C P Poole, H A Farach, R J Creswic, R Prozorov,** Superconductivity, Elsevier, 2007.
4. **P J Ford, G A Saunders**, The Rise of the Superconductors, CRC Press 2005.