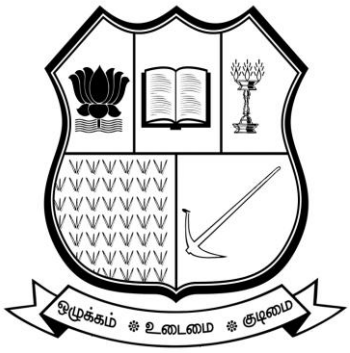
LOGANATHA NARAYANASAMY GOVERNMENT COLLEGE (AUTONOMOUS)

PONNERI- 601 204



PG & RESEARCH DEPARTMENT OF PHYSICS

M.Sc. PHYSICS SYLLABUS

Version 4.0

2020-21 batch onwards

LOGANATHA NARAYANASAMY GOVERNMENT COLLEGE (AUTONOMOUS)

PONNERI- 601 204

PG AND RESEARCH DEPARTMENT OF PHYSICS

PG BOARD OF STUDIES- (2020 - 2021)

MINUTES

The board of studies on curriculum is held on **17-03-2020.** The proposed revised syllabi are presented before the board.

This presentation contains the following enclosures along with the proposed syllabi.

1. Brief write up of relevant modifications carried out in the syllabi.
2. Subject code for the papers have been revised
3. List of papers in the syllabi for choice based credit system (PG) – Annexure-I
4. Question paper pattern – Annexure II
5. Scheme of Examination and Internal evaluation pattern-Annexure III

LOGANATHA NARAYANASAMY GOVERNMENT COLLEGE (AUTONOMOUS)

PONNERI-601 204

PG & RESEARCH DEPARTMENT OF PHYSICS

BOARD OF STUDIES - (2020 - 2021)

Meeting of Board of Studies: 17.03.2020

EXTERNAL MEMBERS OF THE BOARD

1. **Dr. Hemamalini Rajagopal,** — University Nominee & Subject Expert
   Associate Professor,
   PG & Research Department of Physics,
   Queen Mary's College,
   Chennai - 600 005.

2. **Dr. P. Murugakoothan,** — Subject Expert
   Principal,
   C.Kandaswami Naidu College for Men,
   Anna Nagar,Chennai-600102.

3. **Dr. J. Merline Shyla** — Subject Expert
   Dean of Sciences & Director-LIFE,
   PG & Research Department of Physics,
   Loyola College (Autonomous),
   Chennai-600 034.

4. **Er. C. Renganathan,** — Industrial Representative
   Director,
   Chennai Metco Pvt Ltd.,
   SP-100A Ambattur Industrial Estate,
   Chennai- 600 058.

5. **Mr. S. Asraf Ali** Alumni
   Alumni - Department of Physics,
   L. N. Govt. College,
   Ponneri - 601 204.

6. **Dr. R. Samuel Selvaraj,** Chair person
   Associate Professor & Head,
   PG & Research Department of Physics,
   L. N. Govt. College(Autonomous),
   Ponneri - 601 204.

Internal members (All staff members of the department)

7. **Dr. A. Kandasamy**

8. **Dr. K Senthil Kumar**

9. **Dr. S. Devashankar**

10. **Dr. L. Mariappan**

CHOICE BASED CREDIT SYSTEM

(Effective from the academic year 2011-2014)

1. CONDITION FOR ADMISSION

A candidate who has passed the B.Sc. Degree Examination in branch III Physics main with Mathematics as one of the ancillary subjects or B.sc Applied Science of this University with Mathematics as one of the ancillary subjects or an examination of some other University accepted by the Syndicate as equivalent thereto shall be eligible for admission to M.Sc., Degree course in Br.III Physics.

2. ELIGIBILITY FOR THE AWARD OF DEGREE

A candidate shall be eligible for the award of the degree only if he/she has undergone the prescribed course of study in LNG college, affiliated to the University for a period of not less

than two academic years, passed the examination of all the four semesters prescribed earning 90 credits and fulfilled such conditions as have been prescribed there for.

3. DURATION OF THE COURSE

Two years Courses:

The duration of the course is for two academic years consisting of four semesters.

a) Each academic year shall be divided into two semesters. The first academic year shall comprise the first and second semesters. The second academic year will have the third and fourth semesters respectively.
b) The odd semesters shall consists of the period from June to November of each year and the even semesters from December to April of each year. There shall be not less than 90 working days of each semester.

4. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS:

i. Candidates shall register their names for the First semester examination after the admission in the PG courses.
ii. Candidates shall be permitted to proceed from the First Semester up to the Final Semester irrespective of their failure in any of the Semester Examination subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subject) Semester subjects.
iii. Candidates shall be eligible to proceed to the subsequent semester, only if they earn sufficient attendance as prescribed by the Board of Studies from time to time.
iv. Provided in case of candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Principal of the College, shall be permitted to proceed to the next semester and to complete the course of study. Such candidate shall have to repeat the missed semester by rejoining after completion of final semester of the course, after paying the fee for the break of study as prescribed by the Board of Studies (University) from time to time.

5. EXAMINATIONS

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and the end of the second academic year, respectively. There shall be an Internship programme in the

Third Semester, for which a candidate should undergo training during the vacation of the second semester.

The scheme of examinations for different semesters shall be as follows:

The following procedure is followed for Internal Marks:

Theory Papers:	Internal Marks	25 marks
Best 2 tests out of 3		10 marks
Attendance		5 marks
Seminar		5 marks
Assignment		5 marks
	Total	25 marks

Break-up Details for Attendance

Below 60%	-	No marks
60% to 75%	-	3 marks
76% to 90%	-	4 marks
91% to 100%	-	5 marks

Practical:	Internal Marks	40 marks
	Attendance	5 marks
	Practical Best Test 2 out of 3	30 marks
	Record	5 marks

Project:

Internal Marks	Best 2 out of 3 presentations	20 marks
Viva		20 marks
Project Report		60 marks

6. PASSING MINIMUM:

a) There shall be no Passing Minimum for Internal.
b) For External Examination, Passing Minimum shall be of 50 %(Fifty Percentage) of the maximum marks prescribed for the paper.
c) In the aggregate (External + Internal) the passing minimum shall be of 50% for each Paper/ Practical/ Project and Viva-voce.
Grading shall be based on overall marks obtained (internal + external).

7. CLASSIFICATION OF SUCCESSFUL CANDIDATES:

Candidates who secured not less than 60% of aggregate marks (Internal + External) in the whole examination shall be declared to have passed the examination in the First Class.

All other successful candidates shall be declared to have passed in Second Class.

Candidates who obtain 75% of the marks in the aggregate (Internal + External) shall be deemed to have passed the examination in First Class with Distinction, provided they pass all the examinations (theory papers, practicals, project and viva-voce) prescribed for the course in the First appearance.

8. GRADING SYSTEM:

The term grading system indicates a Ten (10) Point Scale of evaluation of the performances of students in terms of marks obtained in the Internal and External Examination, grade points and letter grade.

TEN POINT SCALE

Conversion of marks to Grade points and letter Grade (performance in a Paper/Course)

Range of Marks		**Grade Points**		**Letter Points**		**Description**	
PG & UG		**PG & UG**		**PG & UG**		**PG & UG**	
90-100		9.0 – 10.0		O		Outstanding	
80-89		8.0 – 8.9		D^+		Excellent	
75-79		7.5 – 7.9		D		Distinction	
70-74		7.0 – 7.4		A^+		Very Good	
60-69		6.0 – 6.9		A		Good	
50-59		5.0 – 5.9		B		Average	
PG	UG	PG	UG	PG	UG	PG	UG
00-49	40-49	0.0	4.0-4.9	U	C	Re-appear	Satisfactory
	00-39		0.0		U		Re-appear
ABSENT		0.0		AAA		ABSENT	

9. RANKING:

Candidates who pass all the examinations prescribed for the course in the first appearance itself alone are eligible for Ranking / Distinction.

Provided in the case of candidates who pass all the examinations prescribed for the course with a break in the First Appearance due to the reasons as furnished in the Regulations under "Requirements for Proceeding to subsequent Semester" are only eligible for Classification.

10. APPEARANCE FOR IMPROVEMENT:

Candidates who have passed in a theory paper / papers are allowed to appear again for theory paper / papers only once in order to improve his/her marks, by paying the fee prescribed from time to time. Such candidates are allowed to improve within a maximum period of ten semesters counting from his/her first semester of his/her admission. If candidate improve his

marks, then his improved marks will be taken into consideration for the award of Classification only. Such improved marks will not be counted for the award of Prizes / Medals, Rank and Distinction. If the candidate does not show improvement in the marks, his previous marks will be taken into consideration.

Candidate will not be allowed to improve marks in the Practicals, Project, Viva-voce, Field work.

REVISION OF SYLLABI

CHANGES MADE

- Syllabi of UGC-CSIR, University of Madras, Bharathiyar University, Bharathidasan University, Thiruvalluvar University and other neighbouring P.G institutions have been referred for updation of our syllabi
- The optional papers – Elective paper, EDP and Internship papers has been suitably adjusted for equal credits
- Changes have been made in all papers taking into account the recent advances in all the fields of Physics.
- Uniformity has been maintained for Science Subjects in the

    1. Allotment of Marks
    2. Theory and Practical hours
    3. Question Paper Pattern
    4. Internal Evaluation Pattern

The details are given in the Annexure.

The above details are presented before the Board for recommendations, Suggestions and final approval after the suggestions are carried out.

ANNEXURE-I

List of papers (Syllabus) for the Choice Based Credit System (CBCS-PG)

Year/ Sem	S.No.	Category	Paper Code	Title of the Paper	Ins.Hrs / week	Credit	Exam hrs	Maximum Marks		
								Int.	Ext.	Total
I Year/ I Sem	1	Core	20PHM1A	Classical Mechanics	5	5	3	25	75	100
	2	Core	20PHM1B	Mathematical Physics-I	5	5	3	25	75	100
	3	Core	20PHM1C	Quantum Mechanics – I	5	5	3	25	75	100
	4	Elective	20PHE1A	Electronic Devices and Integrated Circuits	3	3	3	25	75	100
	5	Practical		General Experiments - I	4	Examination will be conducted at the year end				
	6	Practical		Electronic Experiments	4					
	7	Soft Skills	20PHS1A	Soft Skill – I	2	2	Viva Voce	40	60	100
				Total	**28**	**20**				**500**
I Year/ II Sem	1	Core	20PHM2A	Electromagnetic Theory	5	5	3	25	75	100
	2	Core	20PHM2B	Mathematical Physics - II	5	5	3	25	75	100
	3	Core	20PHM2C	Quantum Mechanics II	5	5	3	25	75	100
	4	Elective	20PHE2A	Microprocessor & Microcontroller	3	3	3	25	75	100
	5	Soft skills	20PHS2A	Soft Skill – II	2	2	Viva Voce	40	60	100
	6	Practical	20PHM21	General Experiments - I	4	4	4	40	60	100
	7	Practical	20PHM22	Electronic Experiments	4	4	4	40	60	100
				Total	**28**	**28**				**700**
II Year/ III Sem	1	Core	20PHM3A	Statistical Mechanics	5	5	3	25	75	100
	2	Core	20PHM3B	Nuclear and Particle Physics	5	5	3	25	75	100
	3	Core	20PHM3C	Spectroscopy	5	5	3	25	75	100
	4	Elective	20PHE3A	Research Methodology	3	3	3	25	75	100
	5	Elective	20PHD3A	Energy Physics	3	3	3	25	75	100
	6	Practical		General Experiments –II	4	Examination will be conducted at the year end				
	7	Practical		Microprocessor Experiments	4					
	8	Intern		Internship **		2				
				Total	**29**	**23**				**500**

II Year/ IV Sem	1	Core	20PHM4A	Condensed Matter Physics	5	5	3	25	75	100
	2	Elective	20PHE4A	Nano Science and Technology	3	3	3	25	75	100
	3	Practical	20PHM41	General Experiments –II	4	4	4	40	60	100
	4	Practical	20PHM42	Microprocessor Experiments	4	4	4	40	60	100
	5	Core	20PHP41	Project and Viva-Voce	7	4	Viva Voce	40	60	100
				Total	**23**	**20**				**500**
				Overall Credits		**91**				

ANNEXURE-II

CHOICE BASED CREDIT SYSTEM FOR PG

2020-2021

Total number of papers	23	91 Credits
Core Papers (Including project with viva voce)	15	70 Credits
Elective papers	05	15 Credits
Soft Skill and Internship	03	06 Credits

S.NO	Core/Elective	Hrs./Week#	No. of weeks#	Total Hrs./semester#
1	Core	25	15	375
2	Elective	03	15	45
3	Non-Major Elective	02	15	30

- Number of units in the syllabus of core papers 15
- Number of units in the syllabus of elective papers 05
- Maximum marks per paper 100
- Total marks 2000

ANNEXURE III

M. Sc. PHYSICS

CREDIT CUM SEMESTER PATTERN

(EFFECTIVE FROM THE ACADEMIC YEAR 2020 - 2021)

QUESTION PAPER PATTERN:

PART –A (50 words): Answer 10 out of 12 Questions 10 x 2 = 20 marks

PART –B (200 words): Answer 5 out of 7 Questions 5 x 5 = 25 marks

PART –C (500 words): Answer 3 out of 5 Questions 3 x 10 = 30 marks

TOTAL =75 Marks

QUESTION PAPER FOR PRACTICALS:

The external examiner will prepare a question paper on the spot with the help of the question bank supplied by the Controller's office.

MINUTES OF THE BOARD OF STUDIES MEETING HELD ON 17.03.2020

- The meeting of the PG board of studies on Physics is held on 17.03.2020. The proposed slightly modified syllabi of version 4.0 are presented before the board.
- The syllabi 4.0 is upgraded to aid students to take up research and various competitive examinations
- The subject codes for the Major, Electives, Practicals and Non major elective papers are revised.
- Mathematical Physics II is introduced in this version whereas in 3.0 only one Mathematical Physics course had been followed.
- In version 4.0, Research Methodology is converted into an elective paper with prominent modifications to help students to pursue research. This course is an apt course for now as the department is recognized as research department in recent.
- Uniformity has been maintained for Science Subjects in the

Allotment of Marks

Theory and Practical hours

Question Paper Pattern

Internal Evaluation Pattern

The details are given in the Annexure.

The above details are presented before the Board for recommendations, Suggestions and final approval after the suggestions are carried out.

All the above suggestions were carried out. The papers were shuffled and the revised list of papers is enclosed. The copy of the syllabi after carrying out the suggestions was submitted for approval.

The meeting was concluded after the above discussion.

The following members were present.

S.NO	NAME OF THE MEMBER	SIGNATURE
1	**Dr. Hemamalini Rajagopal,** University Nominee & Subject Expert	
2	**Dr. P. Murugakoothan,** Subject Expert	
3	**Dr. J. Merline Shyla** Subject Expert	

4	**Er. C. Renganathan,** Industry Representative	
5	**S. Asraf Ali** Alumni	
6	**Dr. R. Samuel Selvaraj,** Chair person	
7	**Dr. A. Kandasamy** Internal Member	
8	**Dr. K. Senthilkumar** Internal Member	
9	**Dr. S. Devashankar** Internal Member	
10	**Dr. L. Mariappan** Internal Member	

SEMESTER - I
Core Paper 1 – Classical Mechanics (20PHM1A)
(Students admitted from 2020-21 onwards)

Objective:

To introduce the classical formulation approaches like Lagrangian and Hamiltonian dynamics in understanding mechanical systems and solving problems.

Unit 1: Lagrangian Formulation

Mechanics of a system of particles - Constraints - D'Alembert's principle - Lagrange equations - velocity dependent potentials - applications – Variational principle - Hamilton's principle - Non - holonomic systems - Conservation theorems and symmetry properties. Two - body central force problem - equations of motion - first integrals - classification of orbits - conditions for closed orbits - Kepler's problem - scattering in a central force field - Lab frame - center of mass frame transformation.

Unit 2: Rigid Body Dynamics

Kinematics - degrees of freedom - Euler angles - Euler's theorem on the motion of a rigidbody - Rotations - finite and infinitesimal. Angular momentum and kinetic energy - Inertia tensor - Principal axes - Euler's equations - Torquefree motion of a rigid body - Symmetric top - Precession and nutation - applications – Motion in rotational frames – centrifugal andcoriolis forces.

Unit 3: Hamiltonian Formulation

Legendre transformation and Hamiltonian equations - Cyclic coordinates and conservation theorems - Hamiltonian equations from Variational principle - Canonical transformations - Poisson brackets – equations of motion - conservation theorems in Poisson bracket formulation - angular momentum Poisson brackets - generation of canonical transformations.

Unit 4: Canonical Transformations:

Hamilton-Jacobi theory - Hamilton - Jacobi equation - Hamilton's principal function – free particle in Cartesian coordinates - central force in spherical polar coordinates - application to harmonic oscillator problem – Actionangles - Kepler's problem - action - angle variables - simple harmonic oscillator.

Unit 5: Small Oscillations

The eigenvalue equation – the principal axis transformation - free vibrations - normal coordinates - linear triatomic molecule – double pendulum – triple pendulum – triple parallel pendulum.

Course Outcome

1. Understand the limitation of Newtonian approach to solving Classical Mechanics problems
2. Understand Lagrangian and Hamiltonian formulations
3. Apply these formulations to solve two body, scattering, rigid body dynamics and small oscillations problems
4. Appreciate the merits of Lagrangian and Hamiltonian formulations and their applicability beyond Classical Mechanics.

Books for Study

1. Classical Mechanics, by H.Goldstein, Charles Poole and John Sabko, 3rd edition, Pearson Education India, (2002)
2. Lagrangian and Hamiltonian mechanics, by M.G.Calkin, 1st Indian Reprint, Allied Publishers (2000)

Books for Reference

1. Classical Mechanics by P.V.Panat, 5th Edition, Alpha Science International, (2005)
2. Classical Mechanics by K.N.Srinivasa Rao, Universities Press (India) Private Limited (2003)
3. Lagrangian dynamics, Schaum S Outline Series by Dare A. Wells, McGraw - Hill Education (India) Pvt Ltd, (2005)
4. Problems and solutions on Mechanics, Edited by Yung – Kuo Lim, Sarat Book House, (2001)
5. Classical Mechanics by Rana & Joag, Rana,24th Reprint,Tata McGraw-Hill Education, (2001)
6. Classical Dynamics of Particles and Systems by Stephen T. Thornton, Jerry B. Marion,5th Edition, Brooks/Cole, (2004)
7. Classical Mechanics: An Undergraduate Text by R. Douglas Gregory , Cambridge University Press, (2006)

SEMESTER- I
Core Paper 2 – Mathematical Physics I (20PHM1B)
(Students admitted from 2020-21 onwards)

Objective: To study about Gram-Schmidt orthogonalisation procedure in vector space, the Christoffel symbols in tensor, application of Cauchy's residue theorem in evaluation of definite integrals, the character tables for simple molecules and the central limit theorem in probability distribution.

Unit 1: Linear Vector Space and Matrices Theory

Linear vector spaces- subspaces-Bases and dimension- Linear independence and orthogonality of vectors-Gram-Schmidt orthogonalisation procedure-Matrices Inverse - Orthogonal and Unitary matrices- Independent elements of matrix-Eigen values and Eigen vectors- Caley-HamiltonTherorem - diagonalization -complete orthonormal set of functions.

Unit 2: Tensors analysis

Notations and conventions in tensor analysis-Einsteins summation convention covariant and contravariant and mixed tensors-algebraic operations in tensors symmetric and skew symmetric tensors-tensor calculus - Christoffel symbols-kinematics in Riemann space - Riemann-Christoffel tensor.

Unit 3: Functions of a complex variable

Functions of complex variable-Analytic functions-Cauchy-Riemann equations- integration in the Complex plane - Cauchy’s theorem- Cauchy’s integral formula-Taylor and Laurent expansions- Singular Points- Cauchy's residue theorem - poles - evaluation of residues - evaluation of definite integrals.

Unit 4: Group Theory

Definitions of a group-elementary properties-sub groups-homomorphism and isomorphism of groups-representation of groups-reducible and irreducible representations-simple applications in crystallography and molecular symmetry-Lie groups - SU(2) groups and their representations.

Unit 5: Probability theory

Fundamental laws of probability- Random variables-Probability distributions-Moments of the distributions- Binomial- Poisson and Normal distributions- Conditional probability distribution-joint probability distribution- Characteristic functions- Central limit theorem-Random walks (1D, 2D and 3D) and their applications to physical processes (diffusion, paramagnetism)

Course Outcome

1. Solve problems in orthogonality of vectors and eigen values and Eigen vectors.
2. Understand the algebraic operation and calculus in tensor.
3. Solve the analytical function in complex variable and use complex variable for solving the definite integrals.
4. Use the representation of group in Crystallography and Molecular symmetry.
5. Understand different probability distribution in probability theory.

Books for study

1. Mathematical Physics –Satya Prakash, Sultan Chand & Sons; Sixth Edition, 2014.
2. Mathematical methods for Physicists - George Arfken Hans, WeberFrank E. Harris; Seventh Edition, Elsevier, 2012.

Books for Reference

1. Mathematical Physics- H.K. Dass and R. Verma. S. Chand & Co Pvt Ltd; First Edition, 1997.
2. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern, New Delhi; Second edition,2002.
3. Applied Mathematics for Engineering and Physicists - L.A. Pipes and L.R. Harvill,
4. McGraw Hill, Singapore; Third Edition, 1967.
5. Mathematical Physics - B.D. Gupta, Vikas, Publishing House Pvt Ltd., New Delhi; Fourth Edition, 2003.
6. Mathematical Physics- A.K.Ghatak, I.C.Goyalamd, S.T.Chua, Macmillan India Limited,
7. 2003.

SEMESTER-I

Core Paper 3 - Quantum Mechanics I (20PHM1C)

(Students admitted from 2020-21 onwards)

Objective: Enunciates the basic and necessary concepts of quantum mechanics leads to better understanding.

Unit 1: Basic formalism

Postulates of quantum Mechanics -The Schrodinger equation (time dependent and time independent)- Ehrenfest's theorem - Operator formalism – Expectation -Value - Stationary States - Hermitian Operators for dynamical variables - Eigen values and Eigen function - Orthonormality - Uncertainty Principle.

Unit 2: Energy Eigen value problems

Particle in a box-Three dimension – Linear Harmonic oscillator- Tunneling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom.

Unit 3: General formalism:

Hilbert's space - Dirac notation - Representation theory - Co-ordinate and momentum representations - Time evolution - Schrodinger, Heisenberg and Interaction pictures - Symmetries and conservation laws - Unitary transformations associated with translations and rotations.

Unit 4: Approximation methods

Time independent perturbation theory -first order - non-degenerate case - Stark effect in hydrogen atom - degenerate level - anharmonic oscillator - variation method -application to ground state of helium atom - WKB approximation - connection formula (no derivation) - application to simple harmonic oscillator.

Unit 5: Angular momentum and identical particles

Commutation relations for orbital angular momentum operators and its components - Eigen value spectrum - ladder operators(raising and lowering) -matrix representation of angular momentum operators(J^2,J_Z, J_+ & J_-) - addition of two angular momenta - Clebsch-Gordon coefficients - symmetry properties(no derivation)- derivation of C. G coefficients for $j_1=j_2=1/2$. System of identical particles - symmetric and antisymmetric wave functions - bosons and fermions - the exclusion principle- the density matrix.

Course Outcome

1. Understand the basic formulation of quantum Mechanics, the representations and pictures.
2. Solve Hydrogen atom and Harmonic oscillator problems.
3. Use the Quantum theory of angular momentum in atomic & molecular systems.
4. Use approximation techniques namely, Perturbation method, Variation method and WKB approximation in cases where exact solutions are absent.
5. Gain knowledge of many body systems, their statistics and second quantization.

Books for study:

1. Quantum Mechanics. Gupta, Kumar and Sharma-Jai Prakash Nath &Co,Meerut.11th edition.
2. A Text Book of Quantum Mechanics. P.M. Mathews and K. Venkatesan-Tata McGraw Hill, New Delhi, 2012.
3. Quantum Mechanics-V. Devanathan- Narosa Publishing-New Delhi , 2010
4. Quantum Mechanics. V.K. Thankappan-Wiley-Eastern, New Delhi, Revised edtion 2011

Books for Reference:

1. L. Schiff, Quantum Mechanics, Tata McGraw Hill, New Delhi, 2000.
2. G. Aruldhas, Quantum Mechanics, Prentice Hall of India ,2009.
3. A.K. Ghatak and S. Loganathan, Quantum Mechanics, McMillanIndia,3rd edition.
4. SathyaPrakash, Quantum Mechanics,KedarNath, RamNath and Co.Publications.

SEMESTER- I
Elective Paper 1 – Electronic Devices and Integrated Circuits (20PHE1A)
(Students admitted from 2020-21 onwards)

Objective: Gives exposure to the wide applications of semiconductor & optoelectronic devices and integrated circuits.

Unit 1: Opto electronic devices

Light sources and Displays - Light emitting diodes - Surface emitting LED - Edge Emitting LED - Seven segment display - LDR - Diode lasers - Photo detectors - Basic parameters - Photo diodes - p-i-n Photo diode - Solar cells - Photo transistors - IR and UV detectors.
IC Fabrication: Basic monolithic ICs-Epitaxial growth-masking- etching-impurity diffusion-fabrication of monolithic Resistors, Diodes, Transistors and Capacitors

Unit 2: Digital Electronics-I

Boolean laws and theorem-Sum-of-Products and Products-of-Sums method-Karnaugh simplifications; Multiplexers and De multiplexers; BCD-to-Decimal decoders-Seven-segment decoders; Decimal-to-BCD encoder- Types of Flip-Flops-RS Flip-Flop, Clocked RS Flip -Flop, D Flip-Flop , J-K Flip-Flop and J-K Master-Slave Flip-Flops;

Unit 3: Digital Electronics-II

Registers and Counters: Types of Registers-Serial in-Serial out, Serial in-Parallel out, Parallel in-Serial out, Parallel in-Parallel out Registers; Types of Counters-Ring Counters, Asynchronous and Synchronous Counters, D/A and A/D Converters-R-2R ladder network -Binary resistor method- Simultaneous A/D Converters

Unit 4: Op-amp and its applications

The ideal Op-Amp-inverting, non-inverting and differential amplifiers-CMRR; Op-Amp characteristics-open-loop input output characteristics, frequency response and slew rate; Op-Amp applications-adder, sub tractor, integrator, differentiator, comparator, voltage-to -current converter, current-to-voltage converter, Wien's bridge oscillator and phase shift oscillator (Instrumentation amplifier - Sample and Hold circuits) - Log and Antilog amplifiers - Multiplier and Divider - Electronic analog Computation – Solving simultaneous equations.

Unit 5: 555 Timer and applications

555 Timer - Description – Mono stable operation - Frequency divider - Astable operation - Schmitt trigger - Phase Locked Loops - Basic principles - Analog phase detector - Voltage Controlled Oscillator - Voltage to Frequency conversion - PLL IC 565 - Description - Lock-in range - Capture range - Application - Frequency multiplication.

Course Outcome:

1. Understand the Physics of opto electronic devices and Gain knowledge on IC fabrication technology and memory devices.
2. Gain in depth knowledge on Digital electronics.
3. Analyze and design linear and nonlinear integrated circuits based on operational amplifier.
4. Gain knowledge on analog devices.
5. Develop skills in analyzing circuits; Apply mathematical techniques in solving problem.

Books for Study

1. S.M. Sze, 1985, Semiconductor Devices - Physics and Technology, Wiley, New York.
2. Millman and Halkias, Integrated Electronics, McGraw-Hill, New Delhi.
3. D. Roy Choudhary, 1991, Linear integrated circuits, Wiley Eastern, New Delhi. 4. Taub and Shilling, 1983, Digital Integrated Electronics, McGraw-Hill, New Delhi.
4. J. Millman, 1979, Digital and Analog Circuits and Systems, McGraw-Hill, London.
5. George Kennedy, 1987, Electronic communication systems 3rd Edition, McGraw-Hill, London.

Books for Reference:

1. R.F. Coughlin and F.F, Driscol, 1996, Op-Amp and linear integrated circuits, Prentice Hall of India, New Delhi.
2. M.S.Tyagi, Introduction to Semiconductor Devices, Wiley, New York.
3. R.A. Gaekwad, 1994, Op-Amps and integrated circuits EEE.
4. Ramakant Gaekwad, 1981, Operational amplifiers, Wiley Eastern, New Delhi.

SEMESTER-I
Soft Skill Paper- 1 SOFT SKILL I (20PHS1A)
(Students admitted from 2020-2021 onwards)

Unit 1: Self Analysis

SWOT Analysis, Who am I, Attributes, Importance of Self Confidence, Self Esteem.

Unit 2: Creativity

Out of box thinking, Lateral Thinking.

Unit 3: Attitude

Factors influencing Attitude, Challenges and lessons from Attitude, Etiquette.

Unit 4: Motivation

Factors of motivation, Self talk, Intrinsic & Extrinsic Motivators.

Unit 5: Goal Setting

Wish List, SMART Goals, Blue print for success, Short Term, Long Term, Life Time Goals. Time Management Value of time, Diagnosing Time Management, Weekly Planner To do list, Prioritizing work. Extempore

Assessment

1. A practical and activity oriented course which has continuous assessment on class room interaction, activities etc.
2. Extempore

Books for Study

SOFT SKILLS, 2015, Career Development Centre, Green Pearl Publications .

Books for Reference:

1. Covey Sean, Seven Habits of Highly Effective Teens, New York, Fireside Publishers, 1998.
2. Carnegie Dale, How to win Friends and Influence People, New York: Simon & Schuster, 1998.
3. Thomas A Harris, I am ok, You are ok , New York-Harper and Row, 1972
4. Daniel Coleman, Emotional Intelligence, Bantam Book, 2006

SEMESTER - II
Core Paper 4 – Electromagnetic Theory (20PHM2A)
(Students admitted from 2020-21 onwards)

Objective:

Studying the laws governing the distribution and propagation of electromagnetic fields created by static and dynamic charge distributions and their interaction with matter.

Unit 1: Electrostatics

Electrostatic potential - Poisson's equation - Laplace's equation - Solution of Laplace's equation - Zonal harmonics - Addition theorem for spherical harmonics - Conducting sphere in a uniform field -Dielectrics Polarization vector - field at an external and internal points - displacement vector - polar molecules - forces on dielectrics - boundary conditions - dielectric sphere in a uniform field - dielectric properties - depolarisation field - Lorentz field - dielectric constant and total polarizability - Classius Mossotti relation - dipole orientation in solids.

Unit 2: Maxwell's equations

Faraday's laws of induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Wave equation and plane wave solution - Gauge invariance Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a systems of charges and electromagnetic fields.

Unit 3: Application of Maxwell's equations

Fields and radiation of localized sources - Oscillating electric dipole - Radiation from an oscillating electric dipole - Poynting vector and radiated power - Radiation resistance - Radiation from a linear antenna - Antenna arrays - Radiation pressure and electromagnetic momentum - Electromagnetic oscillators.

Unit 4: Wave propagation

Propagation of electromagnetic waves in isotropic and anisotropic dielectrics - Propagation in conducting media - Linear and circular polarization - Reflection and refraction at a plane interface - Propagation of waves in a rectangular wave guide - Cavity resonator - Faraday and Kerr effects.

Unit 5: Relativistic Electrodynamics

Lorentz transformation for space and time in four vector form - Invariance of D' Alembert operator - Invariance of Maxwell's field equations in terms of four vectors - electromagnetic field tensor - Maxwell's equation in covariance four tensor form - Lorentz transformation of electromagnetic fields - invariance of electromagnetic field.

Course Outcome:

1. Solve electrostatic problems in vacuum and dielectric media and understand their properties
2. Solve electrostatic some boundary value problems using various techniques.
3. Compute static magnetic fields due to various current systems
4. Solve Maxwell's equations and use them in propagation of electromagnetic waves through interfaces.
5. Understand Special Relativity and formulate Electrodynamics in a manifestly Lorentz invariant form.

Books for Study

1. J.D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd., New Delhi.
2. D.J. Griffiths, 2002, Introduction to Electrodynamics, 3rd Edition, Prentice - Hall of India, New Delhi.
3. J.R. Reitz, F.J. Milford and R.W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd Edition, Narosa Publication, New Delhi.
4. Electrodynamics, Chopra and Agarwal
5. Electromagnetic theory, Sathya Prakash
6. Electrodynamics , Gupta, kumar and Singh, S. Chand & Co, New Delhi
7. Electromagnetic Fields and waves - P. Lorrain and D.R.Corson, CBS, New Delhi, II Edn., 1996
8. Introduction to special theory of relativity – Robert Resnick, Wiley Eastern Ltd, I Edn.

Books for Reference:

1. J.D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd., New Delhi.
2. D.J. Griffiths, 2002, Introduction to Electrodynamics, 3rd Edition, Prentice - Hall of India, New Delhi.
3. J.R. Reitz, F.J. Milford and R.W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd Edition, Narosa Publication, New Delhi.
4. Principles of Electrodynamics, B.Chakraborty, Books and Allied (2002), Kolkata.

SEMESTER- II
Core Paper 5 – Mathematical Physics II (20PHM2B)
(Students admitted from 2020-21 onwards)

Objective: To provide the Recurrence relation of Legendre's differential equation and Bessel's differential equation and derive the Heat Equations in two and three dimensions, the Fourier transforms, inverse Laplace transform and the relation between beta and gamma functions.

Unit 1: Differential Equations

First and Second order differential equation-Solution of First and Second order differential equation, Legendre's differential equation: Legendre polynomials - Generating functions - Recurrence Formula, Rodrigue's formula–orthogonality of Legendre's polynomial, Laguerre's differential equation: polynomial–generating functions–Recurrence Formulae –orthogonal properties of Laguerre's polynomials, Bessel's differential equation: Bessel's polynomial–generating functions–Recurrence Formulae–orthogonal properties of Bessel's polynomial, Hermite differential equation: Hermite polynomials – generating functions – recurrence relation.

Unit 2: Partial Differential Equation and Green's Functions

Cylindrical polar and spherical polar systems - Laplace, Wave and Heat Equations in two and three dimensions.

One-dimensional problems- Qualitative idea of Green's functions in 2- and 3-dimentions

Unit 3: Fourier series and Transform

Properties of Fourier transforms - Fourier sine and cosine transforms-Power in Fourier series - Modulation theorem, Fourier transform of impulse function, Constants, Unit step function and Periodic (square wave, triangular wave & saw tooth wave) functions.

Unit 4: Laplace Transforms

Laplace Transform: Properties-Derivative function- Laplace transforms of Dirac delta function-Laplace transforms integral- applications to solution of simple differential equations- Inverse Laplace transform: Fourier Mellin Theorem-properties of inverse Laplace transform

Unit 5: Delta and gamma functions

Dirac delta function-delta sequences for one-dimensional function-properties of delta function-orthogonal function and integral representation of delta function-gamma function-Weierstrass form-factorial notation and applications-beta function- relation with gamma function.

Course Outcome

1. Construct the Recurrence relation of Legendre's differential equation and Bessel's differential equation.
2. Apply the partial differential equation in the solution of Wave and Heat Equations.
3. Represent the Fourier cosine and Sin series in the periodic function.
4. Prove the Fourier Mellin theorem in inverse Laplace transform.
5. Evaluate the gamma function and obtain the orthogonal relation of delta function.

Books for study

1. Mathematical Physics –SatyaPrakash, Sultan Chand & Sons; Sixth Edition, 2014.
2. Mathematical methods for Physicists - George Arfken Hans, Weber Frank E. Harris, Elsevier publications, Seventh Edition, 2012.

Books for Reference

1. Mathematical Physics- H.K.Dass and R.Verma. S. Chand & Co Pvt Ltd; First Edition, 1997.
2. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern, New Delhi; Second Edition, 2002.
3. Applied Mathematics for Engineering and Physicists - L.A. Pipes and L.R. Harvill, McGraw Hill, Singapore; Third Edition, 1967.
4. Mathematical Physics - B.D. Gupta, Vikas, Publishing House Pvt Ltd., New Delhi; Fourth Edition, 2003.
5. Mathematical Physics- A.K.Ghatak, I.C.Goyalamd, S.T.Chua, Macmillan India Limited, 2003.
6. Matrices and Tensors in Physics - A.W. Joshi, Wiley Eastern, New Delhi, 2002.

SEMESTER-II

Core Paper 6 - Quantum Mechanics II (20PHM2C)

(Students admitted from 2020-21 onwards)

Objectives: Gives detailed knowledge about time dependent perturbation theory, its applications, the concepts of relativity and relativity in quantum mechanics, symmetries in QM and the concepts of quantum field theory.

Unit 1: Scattering Theory

The scattering problem - formulation - Scattering amplitude - cross sections - Transformation from centre of mass to laboratory frame- Partial wave analysis - optical theorem - Phase shifts - Scattering length and effective range - Low energy scattering - Born approximation and its validity.

Unit 2: Perturbation Theory

Time dependent perturbation theory - Constant and harmonic perturbations - Transition probabilities - Fermi's-Golden rule - Selection rules for dipole radiation - Adiabatic approximation - Sudden approximation - The density matrix - spin density matrix and magnetic resonance - Semi classical treatment of an atom with electromagnetic radiation.

Unit 3: Relativistic Quantum Mechanism

Klein-Gordon equation - Failures - Dirac equation - Plane - wave solutions - Interpretation of negative energy states - Antiparticles - Spin of electron - Magnetic moment of an electron due to spin - Energy values in a coulomb potential.

Unit 4: Dirac equation

Covariant form of Dirac equation - properties of gamma matrices - Traces - Separation of the equation and the Hydrogen atom problem - Invariance of Dirac equation under Lorentz transformation - T-Transformation for the Dirac equation in presence of electromagnetic field.

Unit 5: Quantisation of Fields

Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field - Second quantization of Klein-Gordon field - creation and annihilation operators - Commutation relations - Quantization of electromagnetic field - Quantization of Schrodinger's field - Quantization of Dirac field.

Course Outcome:

1. Understand and solve time dependent problems in Quantum Mechanics and radiation theory.
2. Compute scattering cross sections using various approximation techniques.
3. Construct Central fields using Thomas – Fermi and Hartree – Fock techniques. Use these to study alkali atoms and hydrogen molecule paving a way for Atomic & Molecular modeling.
4. Understand the relativistic extension of quantum Mechanics and the origin of spin. Comprehend the limit of quantum Mechanics and the need for quantizing the field.
5. Appreciate the challenges in the emerging area of Quantum Computation.

Books for Study

1. P.M. Mathews and K. Venkatesan, 1976, A Text book of Quantum Mechanics, Tata Mc Graw-Hill, New Delhi.
2. L.I. Schiff, 1968, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill, Kogakusha, Tokyo.
3. E. Merzbacher, 1970, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York.
4. J.D. Bjorken and S.D. Drell, 1964, Relativistic Quantum Mechanics, McGraw-Hill, New York.
5. V. Devanathan, 2005, Quantum Mechanics, Narosa Publishing House, New Delhi.
6. G. Aruldhas, 2002, Quantum Mechanics, Prentice-Hall of India, New Delhi.
7. B.K. Agarwal, 1976, Quantum Mechanics and Field Theory, Lokbharti Publications, India.
8. Amitabha Lahiri and B.G. Pal, 2005, A First Book of Quantum Field Theory, Narosa Publications, New Delhi.

Books for Reference:

1. Quantum Mechanics, V.K. Thankappan, 1985, 2nd Edition, Wiley Eastern Ltd, New Delhi.
2. Angular Momentum Techniques in Quantum Mechanics,V. Devanathan, 1999, Kluwer Academic Publishers, Dordrecht.
3. Quantum Mechanics, L.D. Landau and E.M. Lifshitz, Pergomon Press, London.
4. Quantum Field Theory,Claude Itzykson and Isau Bernard Zuber, 1987, McGraw-Hill International Edition.

SEMESTER - II
Elective Paper 2 – Microprocessor and Microcontroller (20PHE2A)
(Students admitted from 2020-21 onwards)

Objective: The goal of this paper is to introduce the learner to the very popular Intel Microprocessors 8085 and 8051.

Unit 1: Architecture of 8085

Architecture and Programming of 8085 Architecture of 8085 – Organization of 8085: Control, data and address buses – registers in 8085 – Addressing modes of 8085 – Instruction sets of 8085: Instruction types – data transfer, arithmetic, logical, branching, stack and I/O instructions. Timing and sequencing: Instruction cycle, machine cycle, halt state, wait state – Timing diagram for op-code fetch, memory read and write cycles. Interrupts: Types of Interrupts – hardware and software interrupts – masking and unmasking interrupts – Assembly language programming, Simple programs using arithmetic and logical operations

Unit 2: Architecture of 8086 & Memory Interfacing

Architecture of 8086 Memory organization, Register organization: General purpose, index, pointer, segment and flag registers – Bus structure: data bus, address bus, effective and physical address and pipelining. Addressing modes of 8086: Register data – immediate, direct and indirect addressing.

Unit 3: Applications of Microprocessors

Interfacing of RAM, ROM, EPROM and EEPROM - Microprocessor based process control – closed loop control – open 1oop control. Example for closed loop control – crystal growth control – Microprocessor based temperature monitoring systems – limit setting – operator panel – block diagram – Analog to digital conversion using ADC 0809 – interfacing 8255 – Block diagram.

Unit 4: Architecture of Microcontroller 8051

Introduction – comparison between microcontroller and microprocessors – Key features of 8051 – memory organization – input and output ports – Data memory and program memory – Special function registers – control registers – counters and timers – interrupt structure.

Unit 5: Programming of Microcontroller 8051

Programming the Microcontroller 8051 Instruction set of 8051 – Arithmetic – Logical – Data transfer instructions – Addressing modes – Register addressing – direct and indirect addressing modes – Assembly language programming – simple programs to illustrate arithmetic and logical operations – Sum of numbers – biggest and smallest number in an array – software time delay.

Course Outcome

1. Understand the construction and working of various data selectors, Memory ICs and effectively apply the same in the interfacing circuits.
2. Explore the interrupt circuits available in 8085 microprocessor and understand the I/O Operations.
3. Know the interfacing of peripheral I/O devices and gain programming knowledge.
4. Deploy microcontrollers in real time applications.

Books for Study and Reference:

1. Aditya P. Mathur – Introduction to Microprocessors – Tata McGraw Hill Company – Third Edition.
2. Ramesh S. Gaonkar – Microprocessor, Architecture, Programming and Application with 8085 – Wi1ey Eastern.
3. Douglas V. Hall – Microprocessors – Interfacing, Programming and Hardware – Tata McGraw Hill – New Delhi.
4. Kenneta J. Ayala – The 8051 Microcontroller – Penram International – India.
5. Lance A. Leventhal – Introduction to Microprocessors Software, Hardware, Programming – Prentice Hall of India.
6. Kenneth L. Short – Microprocessor and Programmed Logic – Prentice Hall of India.
7. Gilmore – Microprocessors – Tata McGraw Hill – New Delhi. 8. A.P. Godse and D.A. Godse – Microprocessors and Microcontrollers – Technical Publications, Pune (2010).

SEMESTER-II

SOFT SKILL-II (20PHS2A)

(Students admitted from 2020-21 onwards)

Unit 1 - Interpersonal Skills

Gratitude Understanding the relationship between Leadership Networking & Team work. Assessing Interpersonal Skills Situation description of Interpersonal Skill. Team Work: Necessity of Team Work Personally, Socially and Educationally

Unit 2: Leadership

Skills for a good Leader, Assessment of Leadership Skills

Unit 3: Stress Management

Causes of Stress and its impact, how to manage & distress, Circle of control, Stress Busters. Emotional Intelligence What is Emotional Intelligence, emotional quotient why Emotional Intelligence matters, Emotion Scales. Managing Emotions.

Unit 4: Conflict Resolution

Conflicts in Human Relations – Reasons Case Studies, Approaches to conflict resolution.

Unit 5: Decision Making

Importance and necessity of Decision Making, Process and practical way of Decision Making, Weighing Positives & Negatives. Technical Topic Presentation

Assessment

1. A practical and activity oriented course which has a continuous assessment based on class room interaction, activities etc.,
2. Technical Topic Presentation

Books for study:

SOFT SKILLS, 2015, Career Development Centre, Green Pearl Publications.

Books for Reference:

1. Covey Sean, Seven Habit of Highly Effective Teens, New York, Fireside Publishers, 1998.

2. Carnegie Dale, How to win Friends and Influence People, New York: Simon & Schuster, 1998.

3. Thomas A Harris, I am ok, You are ok , New York-Harper and Row, 1972.

4. Daniel Coleman, Emotional Intelligence, Bantam Book, 2006

SEMESTER- III
Core Paper 7 – Statistical Mechanics (20PHM3A)
(Students admitted from 2020-21 onwards)

Objective: Gives complete understanding of how a real system should be understood by the linking of thermodynamics with kinetic theory using statistical methods

Unit 1: Phase Transitions

Phase transitions of first and second kind- Bragg-Williams approximation - Liquid gas - transition - Magnetic transition - Landau theory - Correlation of fluctuations and correlation length - Scaling hypothesis

Unit 2: Ensemble

Phase space - Density of states - Liouville's theorem - Relation between statistical and thermo dynamical quantities - Entropy of mixing - Gibbs paradox - Sackur Tetrode equation - Ensemble - Different types of Ensemble - Uses - Limit of applicability of three distribution law.

Unit 3: M.B. Statistics & Partition Function

MB ideal gas - Maxwell law of distribution of velocities - Equi-partition law of energy - Doppler Broadening of spectral lines - Classical real gas - Cluster expansion - Viral equation of state - Partition function - Relation between partition function and thermo dynamical quantities - Different types of partition function.

Unit 4: B.E. & F.D. Statistics

Ideal B.E. gas - Gas degeneracy - B.E. condensation - transition in He4 - Theory of super fluidity (London, Tisza, and Landau) - Photon gas - Plank's law of radiation - Phonon gas - Einstein and Debye's model for specific heat of solids - Ideal FD gas - Gas degeneracy - Electron gas - Thermionic emission - Pauli's theory of Paramagnetism.

Unit 5: Fluctuations

Boltzmann Transport equation - Boltzmann Transport equation for electrical conductivity, thermal conductivity, magneto resistance - viscosity.

Correlation of space-time dependent fluctuations - fluctuations and transport phenomena - Brownian motion - Langevin theory - fluctuation - dissipation theorem - The Fokker - Plank equation.

Course Outcome

1. Understand the basic principles of Statistical Mechanics and its relation to thermodynamics
2. Compute various thermodynamic quantities from partition function
3. Derive Bose – Einstein and Fermi – Dirac Statistics and apply these to study systems like Bose condensates, Electron gas, paramagnetism.

Books for study

1. Gupta Kumar, 2004, Statistical Mechanics, Pragati, Prakasham, 25th edition, Meerut.
2. Basakhi Ram and V.P. Gupta, 2000, Statistical Mechanics, Goel Publishing House, 1st Edition, Meerut.
3. E.S.R. Gopal, 2001, Statistical Mechanics and Properties of matter. Macmillan Co. of India Ltd.
4. B.K. Agarwal and Malvin Einster, 2002, Statistical Mechanics, New Age International Publisher's, New Delhi.
5. Kerson Huang, 1986, Statistical Mechanics, Wiley Eastern Ltd., New Delhi.
6. B.B. Laud, 2002, Fundamentals of Statistical Mechanics, New Age International Publisher's, New Delhi.
7. Sathya Prakash and J.P. Agarwal, 1998, Statistical Mechanics, Kedarnath Company, 7th edn., Meerut.

Books for Reference

1. A.B. Gupta and H. Roy, 2002, Thermal Physics, Books and Allied, Kolkata.
2. Kalidas, M.V.Sangaranarayanan, 2003, Non Equilibrium Thermodynamics, Macmillan India, New Delhi.
3. M. Glazer and J.Wark, 2001, Statistical Mechanics, Oxford University Press.
4. L.D. Kandanolf, 2001, Statistical Physics - Statics, Dynamics and Renormalization, World Scientific, Singapore.
5. F.W. Sears and G.L. Salinger, 1998, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition, Narosa, New Delhi.
6. R.K. Gupta, 2001, Physics of Particles, Nuclei and Materials - Recent Trends, New Horizons of Physics Series, Narosa, New Delhi.
7. R.P. Feynmann, R.B. Leighton and M.Sands, 1998, The Feynmann Lectures of Physics, Vols. 1, 2 & 3, Narosa, New Delhi.

SEMESTER- III
Core Paper 8 – Nuclear and Particle Physics (20PHM3B)
(Students admitted from 2020-21 onwards)

Objective: Gives detailed understanding of nuclear models and various physical properties of nucleus.

Unit 1: Nuclear structure and Nuclear forces

Nuclear radius- electron scattering method-nuclear magnetic dipole moment -magnetic resonance method-electric quadrupole moment –Nuclear forces-properties-central forces-ground state of the Deuteron-magnetic moment-quadrupole moment-Exchange forces -Meson theory Isotopic spin formalism.

Unit 2: Radioactivity

Alpha emission-Gammow theory α-decay - Beta decay-energy spectrum - energy release in beta decay-Fermi's theory- Fermi Kurie plot-Fermi-Gamow teller selection rules -Total decay rate-Comparative half -lives and forbidden decays-non-conversion of parity -Gamma emission- multipole radiation and selection rules internal conversion-Nuclear isomerism.

Unit 3: Nuclear models and Nuclear reactions

Liquid drop model-shell model-spin orbit coupling-spin parity and magnetic moment - predictions of shell model-electric quadrupole moment-Schmidt lines. Nuclear reactions -cross section-compound nucleus- Breit-Wigner Dispersion formula.

Unit 4: Nuclear Reactor

Chain reaction-four factor formula-Neutron diffusion-solution to neutron diffusion equation-Fermi age equation-condition of criticality of nuclear reactor and buckling. General aspects of reactor design-Research reactors-swimming pool reactor, heavy reactor-power reactors-pressurized water reactors-heavy water moderator reactor - Basic Fusion process -characteristics of fusion- fusion-Plasma confinement

Unit 5: Elementary Particles and Quark theory

Classification of elementary particles-fundamental interactions with examples -quantum numbers of elementary particles (isospin, strangeness, parity, charge)-conservation laws-CPT theorem. Quark model-elementary ideas of Symmetries- Su(2), Su(3) symmetry -octet and decouplet Gell-Mann –Okuba mass formula.

Course Outcome

1. Gain knowledge of core concepts in physics to more advanced topics in nuclear and particle physics.
2. Knowledge of basic properties of nuclei and nuclear structure. Improves the capacity of elementary problem solving skills in nuclear and particle physics.
3. Understand nuclear techniques of materials analysis and their application within industry and the medical applications of nuclear phenomena.
4. Understand basic properties of nucleus and nuclear models to study the nuclear structure properties.
5. Classify elementary particles and nuclear states in terms of their quantum numbers
6. Understand the effects of radioactivity in biological matter.
7. Enumerate the various types of nuclear reactors and distinguish them.

Books for study

1. Elements of Nuclear Physics- M.L. Pandya & R.P.S. Yadav- Kedarnath Ramnath & Co
2. Nuclear Physics-D.C. Tayal – Himalaya Publishing House.
3. Nuclear Physics-R.R. Roy & B.P. Nigam, Wiley Eastern Limited

Books for Reference

1. Elementary Particles – Michael longo- McGraw Hill Koga Kuswa Limited.
2. Nuclear Physics-V. Devanathan, Narosa Publishers, 2006
3. Nuclear chemistry –Hari Jeevan arnikar- New age International
4. Nuclear physics-Patel-New Age International
5. Introduction to Particle Physics by R. Ones

SEMESTER - III
Core Paper 9 – Spectroscopy (20PHM3C)
(Students admitted from 2020-21 onwards)

Objective:

To have depth knowledge over the basics, applications and instrumentation techniques of various molecular spectroscopic techniques.

Unit 1: Microwave Spectroscopy

Pure rotational spectra of diatomic molecules –non rigid rotator-rotational spectra of Polyatomic molecules - Study of linear molecules and symmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Experimental techniques - Molecular structure determination - Stark effect - inversion spectrum of ammonia - Applications to chemical analysis.

Unit 2: **Infrared Spectroscopy**

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 - FTIR spectroscopy

Unit 3: **Raman Spectroscopy**

Classical theory of Raman Scattering - degree of depolarisation- Raman effect and molecular structure - Raman effect in relation to inorganic, organic and physical chemistry - Experimental techniques - Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO_2 molecules-Laser Raman spectroscopy

Unit 4: NMR and NQR Techniques

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.

Quadrupole Hamiltonian of NQR - Nuclear quadrupole energy levels for axial and non-axial symmetry - Experimental techniques and applications.

Unit 5: 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.

Course Outcome

1. Understand the theory behind microwave, infrared, Raman, NMR, ESR and NQR spectroscopy techniques in molecular structure determination.
2. Understand various experimental techniques and the instrumentation required for spectroscopic experiments.
3. Analyze experimental results for molecular structure.

Books for Study

1. C.N. Banwell and E.M. McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi.
2. G. Aruldas, 2001, Molecular Structure and Spectroscopy, Prentice - Hall of India Pvt. Ltd., New Delhi.
3. D. N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, NewAge International Publications, New Delhi.
4. Walker & Straughan – Spectroscopy Vols. I & II 1976 , Chapman, London
5. Sharma, B.K. – Spectroscopy -1981, Goel, Meerut
6. Atomic and Molecular Spectroscopy – Rajappan Nair – MJP publications

Books for Reference:

1. Atta Ur Rahman, 1986, Nuclear Magnetic Resonance, Springer Verlag, New York.
2. Towne and Schawlow, 1995, Microwave Spectroscopy, McGraw-Hill,
3. D.A. Lang, Raman Spectroscopy, McGraw-Hill International, N.Y.
4. Microwave Spectroscopy - Towns and Shallow, McGraw Hill.
5. Nuclear Quadrupole Resonance – Hagas Hahn – Academic Press.
6. Principles of Mossbauer Spectroscopy – Chang, McGraw Hill.
7. High resolution NMR- Pople, McGraw Hill.

SEMESTER-III

Elective Paper 3 - Research methodology (20PHE3A)
(Students admitted from 2020-21 onwards)

Objective: In order to carry out research problem individually by following proper scientific methods.

Unit 1: Research Approach

Identification of the problem - Literature survey - Reference collection - Familiarity with ideas and concept of investigation - Internet Browsing - Drawing Inferences from data - Qualitative and Quantitative analysis - Results – Ethics in research – Plagiarism- Seminar - Synopsis writing - Art of writing a Research paper and Thesis - Power point presentation - OHP Presentation.

Unit 2: Numerical methods

Solutions of equations - iterative method - Newton - Raphson method - Numerical Integration - Simpson's 1/3 & 3/8 rules - Runge Kutta method II order - Numerical differentiation – Euler's method.

Unit 3: Statistical Techniques and Tools

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation -Regression – Multiple Regression.

Sampling distribution – Standard error – Concept of point and interval estimation – Level of significance – Degree of freedom – Analysis of variance – One way and two way classified data – 'F'-test.

Unit 4: Experimental Techniques and Data Analysis

Data Interpretation and analysis; Precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and non-linear curve fitting, chi square test; Transducers (Temperature, Pressure/ Vacuum, magnetic field, vibration, optical and particle detectors), measurement and control; Signal Conditioning and recovery, impedance matching, amplification (OP-Amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding.

Unit 5: Python

Computer Systems - Python Programming Language Computational Thinking - Python Data Types - Expressions, Variables, and Assignments – Strings – Lists – Objects & Classes – Python standard library – Simple Programmes for Numerical Methods.

Course Outcome:

1. Carryout research by following ethics
2. Develop problem facing and solving ability
3. Pursue research systematically

Books for Study

1. J. Andersson B.H. Burston and M. Poole, 1977, Thesis and Assignment writing, Wiley Eastern, London.
2. Rajammal.P. Devadas, 1976, A hand book of methodology of research, RMM Vidyalaya Press.
3. V. Rajaraman, 1993,Computer oriented Numerical Methods, 3rd Edition, PHI, New Delhi.
4. S.S. Sastry, Introductory Methods of Numerical analysis, PHI, N.Delhi
5. V. Rajaraman, Programming in C, PHI, New Delhi.

Books for Reference:

1. Numerical Mathematical Analysis, James B Scarborough, Oxford and IBH Publishing company, New Delhi,1966
2. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011.
3. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi,1999.
4. Statistical Methods , G.W. Snedecor and W.G. Cochrans, Lowa state University Press,1967.

SEMESTER-III

Internship (20PHI3A)

(Students admitted from 2020-21onwards)

SEMESTER-III

Extra Disciplinary Paper-I Energy Physics (20PHD3A)
(Students admitted from 2020-21 onwards)

Objective: To realize the availability and utilization of various energies of nature.

Unit 1: Introduction to Energy sources

Energy sources and their availability – prospects of renewable energy sources – energy from other sources – chemical energy – nuclear energy – energy storage and distribution.

Unit 2: Tidal Energy

Energy from the oceans – Energy utilization – Energy from tides – Basic principles of Tidal Power – Ocean thermal energy conversion(OTEC) - utilization of tidal energy.

Unit 3: Wind Energy

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

Unit 4: Bio mass Energy

Bio mass Energy – Bio mass conversion Technologies – wet and dry process- photosynthesis. Biogas Generation: Introduction – basic process and energetic – Advantages of anaerobic digestion – factors affecting bio digestion and generation of gas – biogas from waste fuel – Gobar gas - properties of bio gas – utilization of bio gas.

Unit 5: Solar Energy

Solar radiation and its measurements – solar cells – Solar cells for direct conversion of solar energy to electric powers – solar cell paramaters – solar cell electrical characteristics – Efficiency – solar water heater – solar crop dryers – solar cooker – solar green house..

Course Outcome:

1. Ability to develop devices based on natural resources
2. Effective utilization of various energies
3. Following proper waste management principle.

Books for Study

1. Non- convertional sources of energy by G.D. Rai, 4th edition, khanna publishers, New Delhi (1996).
2. Energy technology by S. Rao and Dr. Paru lekar
3. John Twidell and Tony wier, Renewable energy resources, Taylor and Francis group. London and New York.

Books for Reference:

1. M.P. Agarwal, Solar energy, S.Chand and Company
2. A.B. Meinel and A.P.Meinel, Applied solar energy

SEMESTER- IV
Core Paper 10 – Condensed Matter Physics (20PHM4A)
(Students admitted from 2020-21 onwards)

Objective: This course gives an understanding of the basic theoretical models to study the properties of matter from a microscopic point of view.

Unit 1: Crystal Physics

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures NaCl, Diamond Cubic, ZnS, CsCl – Atomic Packing Factor(Qualitative treatment) - Crystal diffraction – Reciprocal Lattice - Bragg's law – Scattered Wave Amplitude - Diffraction Conditions - Laue equations - Brillouin zone - Structure factor - Atomic form factor.

Unit 2: Lattice Dynamics

Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons - Debye's theory of lattice heat capacity - Thermal Conductivity - Umkalapp processes.

Unit 3: Theory of Metals and Semiconductors

Free electron gas in three dimensions - Electronic heat capacity – Wiede-mann-Franz law - Band theory of metals and semiconductors – Bloch Theorem- Electron in a periodic potential – Kronig Penny model - Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states - Hall effect.

Unit 4: Magnetism

Diamagnetism - Quantum theory of Paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of Ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets.

Unit 5: Superconductivity

Phenomenon of Superconductivity - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Type I and II Superconductors. Thermodynamics of super conducting transition - London equation - Coherence length – BCS Theory - Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - Piezoelectricity, Ferroelectricity and Pyroelectricity (Qualitative treatment).

Course Outcome

1. Understand the basic concepts behind the crystal lattice, the various types of bonds and defects in solids
2. Know the various mechanical properties of solids, its theory in particular to its lattice vibrations
3. Know the thermal properties of solids along with its important properties
4. Understand the free electron theory better. With much emphasis on the metals , its various properties like, electrical, thermal, magnetic and bond theories
5. Distinguish the various magnetic properties of solids its theories and application. With special reference to superconductors

Books for study

1. Principles of Condensed Matter Physics: P.M. Chaikin and T.C. Lubensky
2. C. Kittel, 1996, *Introduction to Solid State Physics,* 7th Edition, Wiley, New York.
3. M. Ali Omar, 1974, *Elementary Solid State Physics - Principles and Applications,* Addison - Wesley
4. H. P. Myers, 1998, *Introductory Solid State Physics*, 2nd Edition, Viva Book, New Delhi.
5. Solid State Physics-Structure and Properties of Materials : M.A. Wahab
6. Solid State Physics: N.W. Ashcroft and N.D. Mermin

Books for Reference

1. N.W. Aschroft and N.D. Mermin, Solid State Physics, Rhinehart and Winton, New York.
2. J.S. Blakemore, 1974, Solid State Physics, 2nd Edition, W.B. Saunder, Philadelphia.
3. A.J. Dekker, Solid State Physics, Macmillan India, New Delhi.
4. H.M. Rosenburg, 1993, The Solid State, 3rd Edition, Oxford University Press, Oxford.
5. S.L. Altmann, Band Theory of Metals, Pergamon, Oxford.

SEMESTER- IV
Elective Paper 4 – Nano Science and Nanotechnology (20PHE4A)
(Students admitted from 2020-21 onwards)

Objective: Sheds light over the rapidly developing field of nanoscience and technology with special focus on the methods of synthesis, characterization techniques and applications of nanomaterials.

Unit 1: Introduction to Nanotechnology

History and Importance of Nanotechnology-Opportunity at the nano scale-Length and time scale in structures- Difference between bulk and nanoscale materials and their significance- Properties at the nanoscale- Optical property- Magnetic property and electronic property-Size dependent behavior- Scaling- Mechanical properties of Nano materials and Chemical properties of Nanoparticles.

Unit 2: Classes of Nanomaterials

Zero dimensional- One-dimensional and two dimensional nanostructures – Clusters of metals semiconductors and nanocomposites - Quantum dots- Nano wells- Nano ribbons and Nano Wires- Carbon nanotubes- Single walled and Multi walled CNT-Structure- Synthesis-Properties- Functionalization and applications - Fullerenes/Bucky Balls/ C60- Synthesis-Properties- functionalization and Application.

Unit 3: Synthesis of Nano Materials

Top-down approach: Nanolithography- Soft lithography and hard lithography, Physical Vapor deposition(PVD) - Chemical Vapor Deposition(CVD) - E beam lithography - Bottom-up approach: Sol-gel processing and chemical methods - Self assembly - Laser Ablation - Sputtering - DC Magnetron Sputtering - Chemical synthesis of nanoparticles in Liquid Suspension - Use of Surfactants in maintaining the nanosize.

Unit 4: Characterization of Nanomaterials

Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM) - Comparing SEM, TEM and AFM for different classes of nanomaterials - Scanning Tunneling Microscopy(STM) - Techniques and Imaging properties -Types: Manipulating atoms molecules with STM - Scanning Tunneling Spectroscopy and Dip pen Nanolithography.

Unit 5: Applications of Nano Materials

Nanotechnology in Energy systems – Electronics – Environment - Space and Aviation - Textiles - Food & Agriculture - Automotive Industry - Solar Technology - Biotech and Pharmaceutical and drugs - Molecular Nanoelectronics – Nanobots - Photonic crystals - NEMS(Nano Electro Mechanical Systems) based device - Nanosensors and Devices.

Course Outcome:

1. Provides the necessary understanding in nanotechnology

2. Aids the students to perform project works, related to the synthesis and characterization of nanomaterials.

Books for Study:

1. Pradeep T., Nano: The Essentials, 1st Edition, Mc Graw Hill, 2007.

2. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, Ltd., 2005.

Books for References:

1. Yong Zhou, Nanomaterials and Nanotechnology, Nova Publishers 2009.
2. Charles P. Poole Jr and Frank J. Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
3. Chris Binns, Introduction to Nanoscience & Nanotechnology, 1st Edition, Willey-Publication, 2010.
4. Chattopadhay K.K., Introduction to Nanoscience and Nanotechnology, APH Publishing Corporation, 2006.
5. Parag Diwan, Handbook of Nanotechnology, Pentagon Press, 2009.

M.Sc. PRATICAL EXAMINATIONS - LIST OF EXPERIMENTS

SEMESTER-I & II

Core Practical – I (20PHM21)

General Experiments

(Any 12 experiments)

1. Young's Modulus by Elliptic Fringe method.
2. Young's Modulus – q and σ by Hyperbolic Fringe method.
3. Determination of Coefficient of viscosity of liquid – Meyer's oscillating disc method
4. Determination of Thickness of insulation by air-wedge method
5. Determination of Solar constant
6. Determination of Thickness of wire by spectrometer
7. Determination of Rydberg's constant by Hartmann's interpolation formula –Hydrogen spectrum.
8. Determination of energy loss per unit area by Ballistic Hysteresis-using CRO
9. Hartmann's interpolation formula – Solar spectrum- Fraunhoffer lines
10. Determination of Temperature coefficient – Thermistor
11. F. P. Etalon – Distance between plates
12. Thermionic work function
13. Determination of Specific heat of liquid- Ferguson's method
14. Determination of Energy band gap of semiconductors
15. Determination of L - Maxwell's Bridge.
16. Mutual inductance by Carey Forster's bridge
17. Ultrasonic diffraction
18. Bi-prism on spectrometer
19. Qualitative Analysis of solid / liquid samples- UV spectrophotometer
20. Determination of numerical aperture and attenuation of an Optical fibre - LASER

SEMESTER-I&II

Core Practical II

Electronics Experiments (20PHM22)

(Any 12 Experiments)

1. Regulated Power Supply – 5 V and 12-0-12 V
2. OPAMP –Inverting, Non-Inverting Amplifier and Voltage follower
3. OPAMP - Summer and difference and average amplifier
4. OPAMP – Solving simultaneous equations
5. OP-AMP – Phase shift network and Oscillator
6. OPAMP- Wien's bridge network and Oscillator (Gain and Attenuation characteristics)
7. OPAMP - integrator & differentiator
8. OP-AMP – Schmitt trigger
9. Construction of Astable multivibrator using 555 timer
10. Construction of Schmitt trigger using 555 timer
11. OP-AMP - D.A. converter - Binary weighted method - R/2R ladder method
12. Verification of Boolean expression - SOP & POS
13. 4 bit Shift Register-Ring counter Twisted Ring counter
14. Op-Amp-Design of Schmitt trigger
15. Asynchronous- Up and Down counter
16. Binary Adder / Subtractor
17. BCD adder using IC 7483
18. Designing n- modulo counter using IC 7490
19. Encoder / Decoder/ parity checker
20. A/D converter using comparator LM 336.

SEMESTER-III & IV

Core Practicals - III General Experiments (20PHM41)

(Any 12 experiments)

1. Hall effect - Determination of Hall coefficient, number of charge carriers, mobility and Hall angle.
2. G. M. Counter – To study the characteristics and Inverse Square law
3. G. M. Counter - To determine the linear absorption coefficient – maximum range of β rays
4. e/m – Thomson method – To determine the specific charge of an electron.
5. Michelson's interferometer – To determine the Wavelength and separation between wavelengths – Na vapour lamp
6. Determination of Susceptibility of liquid by Guoy's method
7. Determination of Susceptibility of liquid by Quincke's method
8. Ultrasonic method- To determine the compressibility of a liquid
9. L. G. Plate - Determination of thermal coefficient.
10. Edser Butler fringes- Thickness of plate
11. Stefan's Constant – To determine Stefan's constant of given plate.
12. Determination of Dielectric constant of a liquid

14 Laser beam - Interference Experiments.

(a) Interference using on optically plane glass plate and a Laser.

(b) Interference of Laser beams - Lloyd's single mirror method.]

15 Laser beam – Diffraction Experiments.

(a) Diffraction at straight edge.

(b) Laser diffraction at a straight wire.

(c) Laser diffraction at a circular aperture.

16 Microprocessor – Addition (with and without carry) Subtraction (with and without borrow)

17. Microprocessor – Multiplication & Division
18. Microprocessor – Square & square root
19. Microprocessor – BCD to Binary & Binary to BCD
20. Microprocessor – Sum of simple series
21. Microprocessor – Ascending & descending order

SEMESTER-III & IV

Core Practical - IV

Microprocessor and Computational Programming Experiments (20PHM42)

(**Any 12 experiments)**

1. Frequency counter to count upto 99
2. Study of ALU
3. D/A converter – R-2R ladder network using Microprocessor interfacing
4. Interfacing μp 8085 with DAC to generate waves
5. Interfacing μp 8085 for blinking of LED in Port A and Port B in various order
6. Interfacing μp 8085 to design mod counter
7. Interfacing μp 8085 to effect traffic signal
8. Interfacing μp 8085 with keyboard display interface IC 8279
9. Interfacing μp 8085 with IC 8279 to effect a blinking message display
10. Interfacing μp 8085 with IC 8279 to effect a rolling display
11. Interfacing μp 8085 with stepper motor
12. Clock program using μp 8085
13. ADC interfacing with μp 8085
14. Micro controller – temperature control
15. μp 8086 – addition, subtraction, multiplication and division
16. Interfacing μp 8086 – LED rolling display
17. Interfacing μp 8086 – message display
18. Preliminary programs using micro controller – addition with carry, subtraction with borrow, multiplication, division and block move
19. Programming in C- Newton- Raphson method
20. Programming in C- Simpson's 1/3 and 3/ 8 rule
21. Programming in C- Newton's Forward and backward interpolation
21. Programming in C- Trapezoidal rule

SEMESTER-III & IV

Core - Project and Viva voce (20PHP41)