SCHEME AND SYLLABI FOR

Dual Degree B.Sc. (Hons.) Physics-M.Sc. Physics

(3+2 YEARS PROGRAMME)

(Under Choice Based Credit System)

1^{st} to 6^{th} semester from academic session 2019-20

&

7^{th} to 10^{th} semester (Revised) from 2016-17 batch onward

(70:30)

DEPARTMENT OF PHYSICS

GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY

HISAR-125001, HARYANA

Vision and Mission of the Department of Physics

Vision:

To inspire the young students towards understanding and learning the fundamental concepts of Physics and their applications for the development of new technologies in the national interests.

Mission:

Physics is regarded as the most significant subject among all scientific and technical disciplines. The mission of Physics department at Guru Jambheshwar University of Science & Technology is to provide both the undergraduate and postgraduate students strong qualitative and quantitative knowledge along with developing a problem solving attitude that may open up a wide range of career choices. In addition, the mission also includes encouraging the research scholars to conduct cutting-edge research resulting in new discoveries and innovations that expands the horizons of science and technology.

This mission will be accomplished by providing students with rigorous and comprehensive knowledge as well as bringing exciting research perspectives to the student community of Physics Department at Guru Jambheshwar University of Science & Technology.

Dual Degree B.Sc. (Hons.) Physics-M.Sc. Physics (3+2 years) programme:

B.Sc. (Hons.)-M.Sc. dual degree programme in Physics has been started in the year 2016 to attract young bright students to inculcate the culture of research and development in the areas of physical sciences. The scheme and syllabi of the programme is designed with an aim to produce a skilled manpower for conducting high impact research in the academic & industrial organizations, including national research laboratories. Students passing out this 5 year programme are expected to serve as scientists at national research laboratories. The key feature of this programme is that the courses are taught on Choice Based Credit System as per the UGC module for CBCS system and specialisations are offered in material science, photonics, condensed matter physics and nuclear science. One semester minor project is an essential component of curriculum for students. Optional one semester major project work has been introduced in this course to provide research platform to enter in various scientific laboratories.

Scheme of Dual Degree B.Sc. (Hons.) Physics-M.Sc. Physics (3+2 Years) Programme under Choice Based Credit System (w.e.f. 2019-20)

ACADEMIC CURRICULUM

Semester I (Credits = 26, Marks 900)		**Semester II (Credits = 26, Marks = 900)**	
C-I	BPL 101: Physics-I (Mechanics)	C-II	BPL 201: Physics-II (Heat and Thermodynamics)
AECC-I	BXL 101: English	AECC-III	BXL 201: Hindi
AECC-II	BXL 102: Environmental Science	GE-IV	BCL 201: Chemistry-II
GE-I	BCL 101: Chemistry-I	GE-V	BML 201/BBL 201: Elementary Mathematics-II/ Elementary Biology-II (Cell Biology)
GE-II	BML 101 /BBL 101: Elementary Mathematics-I /Elementary Biology-1(Fundamentals of Biology)	GE-VI	BML 202/BBL 202 : Mathematics-II (Calculus)/Biology-II (General Biochemistry)
GE-III	BML 102/ BBL-102: Mathematics-I (Basic Algebra)/ Biology-I (Cell & Cellular Processes)	GE-VII	BXL 202: Computer Science
CP-I	BPP 101: Physics Lab-I	CP-II	BPP 201: Physics Lab-II
GEP-I	BCP 101: Chemistry Lab-I(GE-I)	GEP-III	BCP 201: Chemistry Lab-II (GE-IV)
GEP-II	BBP 101: Biology Lab-I (GE-II)	GEP-IV	BXP 201: Computer Science Lab (GE-VII)
Semester III (Credits = 24, Marks = 600)		**Semester IV(Credits = 24, Marks = 600)**	
C-III	BPL 301: Electricity & Magnetism	C-VI	BPL 401: Elements of Modern Physics
C-IV	BPL 302: Mathematical Physics-I	C-VII	BPL 402: Optics
C-V	BPL 303: Waves and Oscillations	C-VIII	BPL 403: Electromagnetic Theory
DSE-I	BPL 304: Physics of Semiconductor Devices	DSE-II	BPL 404 Methods of Experimental Physics
SEC-I	BPL 305: Basic Instrumentation Skills/Workshop	SEC-II	BPL 405: Computational Physics: Fortran Programming
CP-III	BPP 301: Physics Lab-III	CP-V	BPP 401: Physics Lab-V
CP-IV	BPP 302: Physics Lab-IV	CP-VI	BPP 402: Physics Lab-VI
Semester V (Credits = 22, Marks = 600)		**Semester VI (Credits = 22, Marks = 600)**	
C-IX	BPL 501: Basic Quantum Mechanics	C-XII	BPL 601: Classical and Statistical Mechanics
C-X	BPL 502: Analog Systems & Applications	C-XIII	BPL 602: Atomic and Molecular Physics
C-XI	BPL 503: Mathematical Physics-II	C-XIV	BPL 603: Nuclear & Particle Physics
DSE-III	BPL 504: Solid State Physics	DSE-IV	BPL 604: Introductions to Materials
CP-VII	BPP 501: Physics Lab-VII	CP-IX	BPP 601: Physics Lab-IX
CP-VIII	BPP 502: Physics Lab-VIII	CP-X	BPP 602: Physics Lab-X
Semester VII (Credits = 24, Marks = 600)		**Semester VIII (Credits = 24, Marks = 600)**	
C-XV	MPL 101: Advanced Mathematical Physics	C-XIX	MPL 201: Condensed Matter Physics
C-XVI	MPL 102: Classical Mechanics	C-XX	MPL 202: Atomic and Molecular Spectroscopy
C-XVII	MPL 103: Quantum Mechanics	C-XXI	MPL 203: Statistical Physics
C-XVIII	MPL 104: Integrated Electronics	C-XXII	MPL 204: Physics of Lasers
CP-XI	MPP 101: Physics Lab-I	CP-XIII	MPP 201: Physics Lab-III
CP-XII	MPP 102: Physics Lab-II	CP-XIV	MPP 202: Physics Lab-IV
Semester IX (Credits = 24, Marks = 600)		**Semester X (Credits = 20, Marks = 500)**	
C-XXIII	MPL 301: Nuclear Physics	P-II***	MPP-400: Project (Part-II, Major)
		OR	
C-XXIV	MPL 302: Electrodynamics	C-XXVI	MPL 401: Advanced Quantum Mechanics
C-XXV	MPL 303: Computational Physics	DSE-VI	MPL 402: Group-II (A/B/C/D)
DSE-V	MPL 304: Group I (A/B/C/D)	DSE-VII	MPL 403: Physics of Nano Materials / Spectroscopy /Radiation Physics
CP-XV	MPP 301:Physics Lab-V (Computational Physics Lab)	DSEP-I	MPP 401: Physics Lab-VI (Specialization Specific Lab)
P-I**	MPP 302: Project (Part-I, Minor)	DSEP-II	MPP 402: Physics Lab-VII (Specialization Specific Lab)

C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective; Corresponding Practical Labs: CP, DSEP, GEP will be conducted for Core Papers, DSE and GE courses respectively. GPL-General Physics Lab; UWOE: University Wide Open Elective; P-I, P-II: Project Part-I & Part-II.

Credits and Maximum Marks:

1. Core Courses (C-I - C-XXVI); Credits = 06 (04 Theory + 02 Practical) each; Total marks 150 each
2. Discipline Specific Elective* (DSE-I - DSE-VII); Credits = 06 (04 Theory + 02 Practical) each; Total marks = 150 each
3. Skill Enhancement Courses (SEC-I - SEC-II) Credits = 02 each; Total marks = 100 each
4. Ability Enhancement (AECC-I - AECC-III) Credits = 02 each; Total marks = 100 each
5. Generic Elective (GE-I - GE-VII) Credits = 06 (04 Theory + 02 Practical) each; Total marks = 150 each

Semester-I

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	**Int.**	**Total**
BXL 101	Ability Enhancement Compulsory Course-I	English	2	2	70	30	100
BXL 102	Ability Enhancement Compulsory Course-II	Environmental Science	2	2	70	30	100
BPL 101	Core Course-I	Physics-I : Mechanics	4	4	70	30	100
BCL 101	Generic Elective-I	Chemistry-I	4	4	70	30	100
BML 101 BBL 101	Generic Elective-II	Elementry Mathematics-I/ Elementry Biology-1 (Fundamentals of Biology)	4	4	70	30	100
BML 102 BBL 102	Generic Elective-III	Mathematics-I (Basic Algebra)/ Biology-I (Cell & Cellular Processes)	4	4	70	30	100
BPP 101	Core Course Practical-I	Physics Lab-I	2	4	70	30	100
BCP 101	Generic Elective Practical-I	Chemistry Lab-I	2	4	70	30	100
BBP 101	Generic Elective Practical-II	Biology Lab	2	4	70	30	100
		Total	**26**	**32**			

Notes:

i) Students who have studied mathematics at 10+1 and 10+2 level shall opt Elementary Biology-I (Paper code: BBL-101) & Mathematics-I (BML-102) and those who have studied Biology shall opt Elementary Mathematics -I (BML-101) & Biology -I (BBL-102) in 1st semester.

ii) Semester-I & II will be common for all the four programs.

Semester-II

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
BXL 201	Ability Enhancement Compulsory Course-III	Hindi	2	2	70	30	100
BPL 201	Core Course-II	Physics-II (Heat and Thermodynamics)	4	4	70	30	100
BCL 201	Generic Elective-IV	Chemistry-II	4	4	70	30	100
BML 201 BBL 201	Generic Elective-V	Elementary Mathematics-II/ Elementary Biology-II(Cell Biology)	4	4	70	30	100
BML202 BBL 202	Generic Elective-VI	Mathematics-II (Calculus)/ Biology-II (General Biochemistry)	4	4	70	30	100
BXL 202	Generic Elective-VII	Computer Science	2	2	70	30	100
BPP 201	Core Course Practical-II	Physics Lab -II	2	4	70	30	100
BCP201	Generic Elective Practical –III	Chemistry Lab-II	2	4	70	30	
BXP 201	Generic Elective Practical-IV	Computer Science Lab	2	4	70	30	100
	Total		**26**	**32**			

Notes:

i) Students who have studied mathematics at 10+1 and 10+2 level shall opt Elementary Biology-II (Paper code: BBL-201) & Mathematics-II (BML-202) and those who have studied Biology shall opt Elementary Mathematics -II (BML-201) & Biology -II (BBL-202) in 2nd semester.

ii) Semester-I & II will be common for all the four programmes.

SEMESTER-III

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
BPL 301	Core Course-III	Electricity and Magnetism	4	4	70	30	100
BPL 302	Core Course-IV	Mathematical Physics-I	4	4	70	30	100
BPL 303	Core Course-V	Waves and Oscillations	4	4	70	30	100
BPL 304	Discipline Specific Elective -I	Physics of Semiconductor Devices	4	4	70	30	100
BPL 305	Skill Enhancement Course-I	Basic Instrumentation Skills/workshop	2	2	-	100	100
BPP 301	Practical-III	Physics Lab-III	3	6	70	30	100
BPP 302	Practical-IV	Physics Lab-IV	3	6	70	30	100
		Total	24	30			

SEMESTER-IV

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
BPL 401	Core Course-VI	Elements of Modern Physics	4	4	70	30	100
BPL 402	Core Course-VII	Optics	4	4	70	30	100
BPL 403	Core Course-VIII	Electromagnetic Theory	4	4	70	30	100
BPL 404	Discipline Specific Elective -II	Methods of Experimental Physics	4	4	70	30	100
BPL 405	Skill Enhancement Course-II	Computational Physics: Fortran Programming	2	2	--	100	100
BPP 401	Practical-V	Physics Lab-V	3	6	70	30	100
BPP 402	Practical-VI	Physics Lab-VI	3	6	70	30	100
		Total	24	30			

SEMESTER-V

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
BPL 501	Core Course-IX	Basic Quantum Mechanics	4	4	70	30	100
BPL 502	Core Course-X	Analog Systems & Applications	4	4	70	30	100
BPL 503	Core Course-XI	Mathematical Physics-II	4	4	70	30	100
BPL 504	Discipline Specific Elective -III	Solid State Physics	4	4	70	30	100
BPP 501	Practical-VII	Physics Lab-VII	3	6	70	30	100
BPP 502	Practical-VIII	Physics Lab-VIII	3	6	70	30	100
		Total	22	28			

SEMESTER-VI

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
BPL 601	Core Course-XII	Classical and Statistical Mechanics	4	4	70	30	100
BPL 602	Core Course-XIII	Atomic and Molecular Physics	4	4	70	30	100
BPL 603	Core Course-XIV	Nuclear and Particle Physics	4	4	70	30	100
BPL 604	Discipline Specific Elective -IV	Introduction to Materials	4	4	70	30	100
BPP 601	Practical-IX	Physics Lab-IX	3	6	70	30	100
BPP 602	Practical-X	Physics Lab-X	3	6	70	30	100
		Total	22	28			

SEMESTER-VII

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPL 101	Core Course-XV	Advanced Mathematical Physics	4	4	70	30	100
MPL 102	Core Course-XVI	Classical Mechanics	4	4	70	30	100
MPL 103	Core Course-XVII	Quantum Mechanics	4	4	70	30	100
MPL 104	Core Course-XVIII	Integrated Electronics	4	4	70	30	100
MPP 101	Practical-XI	Physics Lab-I	4	8	70	30	100
MPP 102	Practical-XII	Physics Lab-II	4	8	70	30	100
		Total	24	32			

NOTE:

The nomenclature and content of Paper Code MPL 101 and PHL 501 are same.
The nomenclature and content of Paper Code MPL 102 and PHL 502 are same.
The nomenclature and content of Paper Code MPL 103 and PHL 503 are same.
The nomenclature and content of Paper Code MPL 104 and PHL 504 are same.

SEMESTER-VIII

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPL 201	Core Course-XIX	Condensed Matter Physics	4	4	70	30	100
MPL 202	Core Course-XX	Atomic & Molecular Spectroscopy	4	4	70	30	100
MPL 203	Core Course-XXI	Statistical Physics	4	4	70	30	100
MPL 204	Core Course-XXII	Physics of Lasers	4	4	70	30	100
MPP 201	Practical-XIII	Physics Lab-III	4	8	70	30	100
MPP 202	Practical-XIV	Physics Lab-IV	4	8	70	30	100
		Total	24	32			

NOTE:

The nomenclature and content of Paper Code MPL 201 and PHL 506 are same.
The nomenclature and content of Paper Code MPL 202 and PHL 507 are same.
The nomenclature and content of Paper Code MPL 203 and PHL 508 are same.
The nomenclature and content of Paper Code MPL 204 and PHL 509 are same.

SEMESTER-IX

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPL 301	Core Course-XXIII	Nuclear Physics	4	4	70	30	100
MPL 302	Core Course-XXIV	Electrodynamics	4	4	70	30	100
MPL 303	Core Course-XXV	Computational Physics	4	4	70	30	100
MPL 304	Discipline Specific Elective -V	Group I (A/B/C/D)	4	4	70	30	100
MPP 301	Practical-XV	Physics Lab-V (Computational Physics Lab)	4	8	70	30	100
MPP 302	Project**	Project (Part-I, Minor)	4	--	--	100	100
		Total	24				

The nomenclature and content of Paper Code PHL 511 and MPL 301 are same.
The nomenclature and content of Paper Code PHL 512 and MPL 302 are same.
The nomenclature and content of Paper Code PHL 513 and MPL 303 are same.
The nomenclature and content of Paper Code PHL 514(i) and MPL 304(i) / PHL 514(ii) and MPL 304(ii) / PHL 514(iii) and MPL 304(iii) / PHL 514(iv) and MPL 304(iv) are same.

SEMESTER-X

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPP 400	Project***	Project (Part-II, Major)	20		350	150	500

OR

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext	Int	Total
MPL 401	Core Course-XXVI	Advanced Quantum Mechanics	4	4	70	30	100
MPL 402	Discipline Specific Elective -VI	Group-II (A/B/C/D)	4	4	70	30	100
MPL 403	Discipline Specific Elective –VII*	Physics of Nano Materials / Spectroscopy/ Radiation Physics	4	4	70	30	100
MPP401	Discipline Specific Elective Lab	Physics Lab-VI (Specialization Specific Lab)	4	4	70	30	100
MPP402	Discipline Specific Elective Lab	Physics Lab-VII (Specialization Specific Lab)	4	4	70	30	100
		Total	20				

The nomenclature and content of Paper Code PHL 516 and MPL 401 are same.
The nomenclature and content of Paper Code PHL 517(i) and MPL 402(i)/ PHL 517(ii) and MPL 402(ii) / PHL 517(iii) and MPL 402(iii) / PHL 517(iv) and MPL 402(iv) are same.
The nomenclature and content of Paper Code PHL 518 and MPL 403 are same.

Important Notes:

1. The question paper shall contain 20% numerical problems in the relevant papers.
2. The department may offer one of the papers (up to 4 credit) to be done through MOOC/SWAYAM courses in a year /semester. The student shall be graded as per the evaluation done by these online courses.
3. A student may opt for the respective MOOC's courses at their own in place of DSEs with a maximum of 8 credits during the programme.
4. The evaluation of Skill Enhancement Course (SEC) (BPL-305 & BPL 405) will be done internally by the course coordinator (50% weightage for Theory) and remaining 50 % will be based on practical/presentation before a committee of 2 teachers with course coordinator as member.
5. The 4 credits assigned to Physics Lab shall include seminar and that will be a part of internal evaluation.
6. The student has to opt for DSE-V and DSE-VI from respective groups (Table 1) keeping in view the related papers of his/her area of interest. The courses will be offered depending upon the strength of students (Minimum 10 students and maximum 50% of the strength of students in a particular class) for a particular course of option subject to availability of faculty. Student is required to opt same discipline /specialization from the two groups.

TABLE- 1

Option	Group –I	Group –II
A	MPL 304(i) Materials Science-I	MPL402(i) Materials Science-II
B	MPL-304(ii) Photonics- I (Fibre Optics and Communication)	MPL402(ii) Photonics – II (Nonlinear Optics)
C	MPL304(iii) Advanced Nuclear Physics-I (Nuclear Models)	MPL402(iii) Advanced Nuclear Physics-II (Nuclear Reactions)
D	MPL 304 (iv) Theoretical Condensed Matter Physics-I	MPL 402 (iv) Theoretical Condensed Matter Physics-II

***** The student will be offered one of the papers for DSE-VII (MPL 403) from Physics of Nano materials/Spectroscopy/ Radiation Physics subject to availability of faculty.

****** In minor project, the students are required to carry out literature review/research work under the guidance of assigned supervisor by the department. At the end of the semester, a 10-15 pages' project report (Part-I, Minor, MPP 302) will be submitted and the same will be evaluated internally through presentation in front of the committee of 3-4 Teachers (including at least one Professor, constituted by the chairperson). Internal evaluation of 100 marks will comprise of 70:30, where 70 marks will be awarded by the committee and 30 marks by the concerned supervisor.

- *The candidate shall be required to submit statement of purpose (SOP) after minor project (Part-I, Semester- IX) if he/she wish to undertake major project (MPP 400) in final semester (Part-II, Semester- X) along with the consent from one of the regular faculty member of the department for supervision (The faculty can give consent to one student only). The SOP will be evaluated by four member's committee chaired by Chairperson along with supervisor as one of the member.*

- *The criteria for selection of students for major project (MPP 400) in final semester (Part-II, Semester- X) is as under:*
    - *i) The students must have passed all the lower semester exams (1^{st} to 8^{th} semester).*
    - *ii) The students merit will be framed as follows:*
        - *a) 50% weightage from 7^{th} & 8^{th} semester aggregates marks*
        - *b) 25% weightage of minor project marks (MPP-302)*
        - *c) 25% weightage of SOP evaluation*

- *The guidelines for SOP will be provided by the department.*

***A student opting for major project (MPP 400) is required to undertake 16-20 weeks' (one semester) project in semester X. He/she is supposed to submit acceptance-cum-recommendation letter from a Faculty from a National level institution /'A' grade University including GJUS&T by the end of IX^{th} semester.

The evaluation of major project report & presentation out of 500 marks will be done as follows:

1. *150 marks by the concerned supervisor based on overall internal assessment.*
2. *200 marks through presentation of major project before four member's committee chaired by Chairperson (Each member to award out of 50 marks)*
3. *150 marks by inviting the external examiner in the relevant area.*

The external examiner may be asked to evaluate up to the maximum of 10 students in the relevant area.

BXL-101: ENGLISH

Marks (Theory) : 70 **Credits : 2 (30 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Syntax

Sentence structures, Verb patterns and their usage

UNIT-II

Phonetics

Basic Concepts – Vowels, Consonants, Phonemes, Syllables, Articulation of Speech Sounds – Place and Manner of Articulation; Transcription of words and simple sentences, using International Phonetic Alphabet.

UNIT-III

Comprehension

Listening and Reading comprehension – Note taking, Reviewing, Summarising, Interpreting, Paraphrasing and Précis Writing.

UNIT-IV

Composition

Descriptive, Explanatory, Analytical and Argumentative Writing - description of simple objects like instruments, appliances, places, persons, principles, description and explanation of processes and operations; analysis and arguments in the form of debate and group discussion.

Reference books:

1. Roy A. & Sharma P.L. English for Students of Science, Orient Longman.
2. Spoken English for India by R.K. Bansal and J.B. Harrison, Orient Longman.
3.Tickoo M.L. & Subramanian A.E. Intermediate Grammar, Usage and Composition, Orient Longman.
4. Pink M.A. & Thomas S.E. English Grammar, Composition and Correspondence, S. Chand and Sons Pvt.Ltd.,Delhi.
5. Thomson & Martinet A Practical English Grammar, OUP, Delhi.
6. Hornby A.S Guide to Patterns and Usage in English, OUP, Delhi.
7. Balasubramanian T. A Textbook of English Phonetics for Indian Students, MacMillan, Chennai.
8. O‟Connor J.D. Better English Pronunciation, Cambridge Univ. Press, London.
9. McCarthy English Vocabulary in Use, Foundation Books (Cambridge University Press), Delhi.
10. Buck,Assessing Listening, Foundation Books (Cambridge University Press), Delhi.

BXL-102: ENVIRONMENTAL SCIENCE

Marks (Theory) : 70 **Credits : 2 (30 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

The Multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness.

Natural resources: Renewable and non-renewable resources

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation

b) Water resources: Use and over-utilization of surface and ground water, floods and drought.

c) Mineral resources: Use and exploitation, environmental effects of extruding.

d) Food resources: World food problems, changes caused by agriculture, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

e) Energy Resources: Growing energy needs, renewable and non-renewable energy sources use of alternative energy sources.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification

Unit-II

Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, Procedures, consumers and decomposers, Energy flow in the ecosystem, Ecological succession & Food chains, food webs and ecological pyramids.

Biodiversity and its conservation: Introduction – Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a megadiversity nation.

Unit-III

Environmental Pollution

Definition, Causes, effects and control measures of: - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution & Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

Unit-IV

Social Issues and the Environment

From Unsustainable to sustainable development, urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people- its problems and concerns. Environmental ethics: Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation, Consumerism and waste products, environment Protection Act, Air (Prevention and Control of Pollution) Act, Water(Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environment legislation & Public awareness.

Reference books:

1. De A. K. Environmental Chemistry, Wiley Eastern Ltd, 1999.
2. Bharucha E. Text book of Environmental studies, University press, Hydrabad 2005.
3. Cunningham W P., Cooper T H. Gorhani E. Hepworth M T, Environmental Enclopedia, Jaico publication House, Mumbai, 2001.
4. Miller T G. Environmental Science Wadsworth publishing corp, 2000.

BPL-101: PHYSICS - I: MECHANICS

Marks (Theory) : 70 **Credits : 4 (60 lectures)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The objective of this course is to teach the students fundamentals of Newtonian Mechanics, rigid body dynamic, concept of inverse square force and the special theory of relativity.

Unit – I

Fundamentals of Dynamics: Reference frames, Inertial and non-inertial frames of references, Conservative and non-conservative forces, Fictitious forces, Concept of potential energy, Energy diagram. Stable and unstable equilibrium, Elastic potential energy, Force as gradient of potential energy, Work & Potential energy, Impulse, Centre of Mass for a system of particles, Motion of centre of mass (discrete and continuous), Expression for kinetic energy, Linear momentum and angular momentum for a system of particles in terms of centre of mass values.

Collisions: Elastic and inelastic collisions between particles, Centre of Mass and Laboratory frames.

Unit - II

Rotational Dynamics: Equation of motion of a rigid body, Rotational motion of a rigid body in general and that of plane lamina, Rotation of angular momentum vector about a fixed axis, Angular momentum and kinetic energy of a rigid body about principal axis, Torque, Principle of conservation of angular momentum, Moment of Inertia (discrete and continuous), Calculation of moment of inertia for rectangular, cylindrical and spherical bodies, Kinetic energy of rotation, Motion involving both translation and rotation, elementary Gyroscope.

Unit – III

Inverse Square Law Force: Forces in nature (qualitative), Central forces, Law of gravitation, Gravitational potential energy, Inertial and gravitational mass, Potential energy and force between a point mass and spherical shell, a point mass and solid sphere, gravitational and electrostatic self-energy, two body problem and concept of reduced mass, Motion of a body under central force, Equation of orbit in inverse-square force field, satellite in Circular orbit & Geosynchronous orbits, Basic idea of GPS (Global Positioning System).

Unit – IV

Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Galilean transformation (velocity, acceleration)and its inadequacy, Postulates of Special Theory of Relativity, Lorentz Transformations, simultaneity, Lorentz contraction, Time dilation, Relativistic transformation of velocity, frequency and wave number, Relativistic addition of velocities, Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect, Relativistic Kinematics (decay, inelastic collision, Compton effect), Transformation of Energy, Momentum and force, Four Vectors.

Reference Books:

1. An introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 2007, McGraw-Hill.
2. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2012.
3. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
4. University Physics, F.W. Seers, M. W. Zemansky, H. D. Young, Addison-Wesley Pub. Co.
5. Fundamentals of Physics, Halliday, & Walker, Resnick John Wiley & Sons, Inc.

BCL-101: CHEMISTRY-I

Marks (Theory) : 70 **Credits : 4 (60 lectures)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – 1

Chemical Thermodynamics Objectives and limitations of Chemical Thermodynamics, state functions, thermodynamic equilibrium, work, heat, internal energy, enthalpy. First Law of Thermodynamics: First law of thermodynamics for open, closed and isolated systems. Reversible isothermal and adiabatic expansion/compression of an ideal gas.Irreversible isothermal and adiabatic expansion.Enthalpy change and its measurement, standard heats of formation and absolute enthalpies.Kirchoff's equation.

Second and Third Law: Various statements of the second law of thermodynamics. Efficiency of a cyclic process (Carnot's cycle). Entropy: Entropy changes of an ideal gas with changes in P,V, and T. Free energy and work functions. Gibbs-Helmholtz Equation, Criteria of spontaneity in terms of changes in free energy.Introduction to Third law of thermodynamics.

UNIT-II

Conductance and Electrochemistry Arrhenius theory of electrolytic dissociation.Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes.Molar conductivity at infinite dilution.Kohlrausch law of independent migration of ions.Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods.Applications of conductance to measure degree of dissociation of weak electrolytes.
Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, application of electrolysis in metallurgy and industry. Chemical cells with examples, Standard electrode (reduction) potential.

UNIT-III

Fundamentals of Organic Chemistry Electronic Displacements: Inductive Effect, Electromeric Effect, ResonanceandHyper conjugation. Cleavage of Bonds: Homolysis and Heterolysis Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting values.

UNIT-IV

Stereochemistry Conformations with respect to ethane, butane and cyclohexane.Interconversion of WedgeFormula, Newmann, Sawhorse and Fischer representations.Concept of chirality (uptotwocarbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism,Diastereomerism and Meso compounds). Threo and erythro; D and L; *cis*–*trans*nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (forupto two C=C systems).

Chemistry of Biomolecules

Occurrence, classification of Carbohydrates.Amino acids, peptides and their classification. α-Amino Acids.Zwitterions, pK_avalues, isoelectric point, components of nucleic acids, nucleosides and nucleotides.

RefrenceBooks::

1. Atkins, P.W. & Paula, J. *Physical Chemistry,* 10th Ed., Oxford University Press, 2014.
2. Castellan, G.W.,Physical Chemistry, Narosa Publishers
3. Morrison, R. N. & Boyd, R. N. *Organic Chemistry,* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Finar, I. L. *Organic Chemistry (Volume 1),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Finar, I. L. *Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products),* Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Eliel, E. L. &Wilen, S. H. *Stereochemistry of Organic Compounds,* Wiley: London,1994.
7. Kalsi, P. S. *Stereochemistry Conformation and Mechanism,* New Age International, 2005.
8. McMurry, J.E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning India Edition, 2013.

BML-101: ELEMENTARY MATHEMATICS-I

Marks (Theory) : 70 — **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 — **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Sets, Relations and Functions: Sets and their Representations, The Empty Set, Finite and Infinite Sets, Equal Sets, Subsets, Universal Set, Venn Diagrams, Operations on Sets, Complement of a Set, Practical Problems on Union and Intersection of Two Sets, Cartesian Product of Sets, Relations, Functions.

Sequences and Series: Sequences, Series, Arithmetic Progression (A.P.), Geometric Progression (G.P.), Relationship Between A.M. and G.M.

UNIT – II

Straight Lines: Introduction, Slope of a Line, Various Forms of the Equation of a Line, General Equation of a Line, Distance of a Point From a Line.

Trigonometric Functions: Angles, Trigonometric Functions, Trigonometric Functions of Sum and Difference if Two Angles, Trigonometric Equations.

UNIT –III

Permutations and Combinations: Fundamental Principle of Counting, Permutations, Combinations.

Binomial Theorem: Introduction, Binomial Theorem for Positive Integral Indices, General and Middle Terms.

UNIT – IV

Linear Inequalities: Inequalities, Algebraic Solutions of Linear Inequalities in One Variable and their Graphical Representation, Graphical Solution of Linear Inequalities in Two Variables, Solution of System of Linear Inequalities in Two Variables.

Probability: Introduction, Random Experiments, Event, Axiomatic Approach to Probability, Addition Theorems on Probability, Conditional Probability Multiplicative Law of Probability

Books Recommended:

1. Mathematics Text Book for Class XI, National Council of Educational Research and Training.
2. R.S. Verma and K.S. Sukla, Text Book on Trigonometry, Pothishala Pvt. Ltd, Allahabad.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, S. Chand & Sons.
4. Ivo Duntsch and Gunther Gediga, Set, Relations, Functions, Methodos Publishers.

BBL-101: ELEMENTARY BIOLOGY-I

Marks (Theory) : 70 | **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 | **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Introduction to concepts of biology

Themes in the study of biology; A closer look at ecosystem; A closer look at cell; The process ofScience; Biology and everyday life

Evolutionary history of biological diversity

Early earth and the origin of life; Major events in the history of life; Mechanism of Macroevolution; Phylogeny and the tree of life

UNIT – II

Classifying the diversity of life

Kingdoms of Life –Prokaryotes, Eukaryotes, Archaea

Darwinian view of life and origin of species

Darwin's theory of evolution; The evolution of populations; Concepts of species; Mechanism of speciation

Genetic approach to Biology

Patterns of inheritance and question of biology; Variation on Mendel's Law; The molecular basis of genetic information; The flow of genetic information from DNA to RNA to protein; Genetic Variation; Methodologies used to study genes and gene activities; Developmental noise; Detecting macromolecules of genetics; Model organisms for the genetic analysis; Distinction between Phenotype and Genotype

UNIT – III

Chemistry of life

The constituents of matter; Structure of an atom; The energy level of electron; The formation andfunction of molecules depends on chemical bonding between atoms; Chemical reaction make or break chemical bonds

Water and life

The water molecule is polar; Properties of water; Ionization of water

Carbon and life

Organic chemistry-the study of carbon compounds; what makes carbon special? Properties of organic compounds

UNIT – IV

Structure and function of biomolecules

Most macromolecules are Polymers; Carbohydrates act as fuel and building materials; Lipids are

group of hydrophobic molecules; Protein have diverse structures and functions; Nucleic acids store and transmit hereditary information

References:

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi
3. Griffiths, A.J.F et al (2008) Introduction to Genetic Analysis, 9th edition, W.H. Freeman & Co. NY

BML-102: MATHEMATICS-I (BASIC ALGEBRA)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT - I

Symmetric, Skew-symmetric, Hermitian and skew Hermitian matrices. Elementary operations on matrices. Rank of a matrices. Inverse of a matrix. Linear dependence and independence of rows and columns of matrices. Row rank and column rank of a matrix. Eigenvalues, eigenvectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley Hamilton theorem and its use in finding the inverse of a matrix.

UNIT - II

Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations. Unitary and Orthogonal Matrices, Bilinear and Quadratic forms.

UNIT - III

Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots. Common roots and multiple roots. Transformation of equations.

UNIT - IV

Nature of the roots of an equation, Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions.

Reference Books :

1. H.S. Hall and S.R. Knight, Higher Algebra, H.M. Publications 1994.
2. Shanti Narayan, A Text Books of Matrices.
3. Chandrika Prasad, Text Book on Algebra and Theory of Equations. Pothishala Private Ltd., Allahabad.

BBL-102: BIOLOGY-I (CELL & CELLULAR PROCESSES)

Marks (Theory) : 70 — **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 — **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT - I

Techniques in Biology

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis

UNIT - II

Cell as a unit of Life

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components

UNIT - III

Cell Organelles

• Mitochondria: Structure, marker enzymes, composition; mitochondrial biogenesis; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA

• Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA

• ER, Golgi body & Lysosomes Structures and roles. Signal peptide hypothesis, N-linked glycosylation, Role of golgi in O-linked glycosylation. Cell secretion, Lysosome formation.

• Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis

• Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

UNIT – IV

Cell Wall & Membrane

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membraneproteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selectivepermeability of the membranes; Cell wall

Cell Division.

Role of Cell division; Overview of Cell cycle; Molecular controls; Meiosis

References:

1. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
2. Raven, P.H et al (2006) Biology 7th edition Tata McGrawHill Publications, New Delhi
3. Sheeler, P and Bianchi, D.E. (2006) Cell and Molecular Biology, 3rd edition, John Wiley & sons NY

BPP-101: PHYSICS LAB – I

Marks (External) : 70 **Credits : 2**

Marks (Internal Assessment): 30 **Time : 3 Hrs**

1. ***Each student should perform at-least eight experiments.***
2. ***The students are required to calculate the error involved in a particular experiment.***
3. ***List of experiments may vary.***

List of Experiments:

1. Measurements of length (or diameter) using Vernier calliper, screw gauge and travelling microscope.
2. To determine the height of an object using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine **g** and velocity for a freely falling body using Digital Timing Technique
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal
4. Engineering Practical Physics, S.Panigrahi& B.Mallick,2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

BCP-101: CHEMISTRY LAB-I

Marks (External) : 70 **Credits : 2**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Preparation of reference solutions.
2. Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$(using $KMnO_4$, $K_2Cr_2O_7$)
3. Iodometic titrations: Determination of Cu^{2+} (using standard hypo solution).
4. To determine the surface tension of at least two liquids using stalagmometer by drop no. and drop weight methods (Use of organic solvents excluded).
5. To study the effect of surfactant on surface tension of water.
6. To determine the viscosity of at least two liquids by using Ostwald's viscometer (use of organic solvents excluded).
7. To study the process of (i) sublimation (ii) Crystallization of camphor and phthalic acid
8. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
9. Iodoform from ethanol (or acetone)
10. p-Bromoacetanilide from acetanilide

Reference:

1. Vogel A. I., Tatchell A.R., Furnis B.S., Hannaford A.J., Smith P.W.G.,Vogel's Text Book of Practical Organic Chemistry,5th Edn.,Pubs: ELBS, 1989.
2. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Pubs: Thomson Brooks/Cole,2005.
3. Mann F.G., Saunders. P.C.,Practical Organic Chemistry,Pubs:Green& Co. Ltd., London, 1978.
4. Svehla, G., Vogel's Qualitative Inorganic Analysis (revised); 7th edition, Pubs: Orient Longman, 1996.
5. Bassett, J., Denney, R.C., Jeffery, G.H., Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised); 4th edition, Pubs: Orient Longman,1978.
6. Yadav J. B., Advanced Practical physical Chemistry

BBP-101: BIOLOGY LAB

Marks (External) : 70 **Credits : 2**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. To learn a) use of microscope b) principles of fixation and staining.
2. Preparation of Normal, molar and standard solutions, phosphate buffers, serial dilutions
3. Use of micropipettes
4. Measurement of cell size by cytometry
5. To perform gram staining of bacteria.
6. To study the cytochemical distribution of nucleic acids and mucopolysaccharides with in cells/tissues from permanent slides.
7. To perform quantitative estimation of protein using the Lowry's method. Determine the concentration of the unknown sample using the standard curve plotted.
8. To study of plasmolysis &deplamolysis of *Rhoeo* leaf.
9. To study prokaryotic cells, Bacteria/fungi and eukaryotic cells.
10. To prepare squash from root tip of Aliumcepa& study various stages of mitosis.

बी.एक्स.एल–201: हिन्दी

कुल अंक: 70 | क्रैडिट –2

आंतरिक मूल्याकंन–30 | समय–3 घण्टे

खण्ड (क)

निर्धारित कवि

1 कबीरदास 2 सूरदास
3 मीराबाई 4 रसखान

खण्ड (ख)

हिन्दी साहित्य का इतिहास भक्तिकालः पाठ्यकम में निर्धारित आलोचनात्मक प्रश्न–

1 सन्तकाव्य की प्रवृतियाँ 2 सूफी काव्य की प्रवृतियाँ
3 कृ ष्ण काव्य की प्रवृतियाँ 4 राम काव्य की प्रवृतियाँ
5 भक्तिकाल का: स्वर्णयुग

खण्ड (ग)

अलंकार–अनुप्रास, श्लेष ा, यमक, उपमा, रूपक, अतिशयोक्ति, मानवीकरण, अन्योकित, समासोक्ति आदि।

खण्ड (घ)

मुहावरे एवं लोकोक्तियाँ।

खण्ड(क) के लिए निर्धारित पाठ्यपुस्तक–मध्यकालीन काव्य–कुंज : सं. डॉ रामसजन पाण्डेय प्रकाशनःखाटूश्याम प्रकाशन, 1276/5 पीर जी मोहल्ला, प्रताप टाकीज, रोहतक।

निर्देशः– सभी प्रश्न अनिवार्य हैं।

1. खण्ड (क) में निर्धारित पाठ्यपुस्तक में से व्याख्या के लिए चार अवतरण पूछे जाएँगे, जिनमें से परीक्षार्थी को किन्हीं दो की सप्रसंग व्याख्या करनी होगी। प्रत्येक व्याख्या 6 अंक की होगी। पूरा प्रश्न 12 अंक का होगा।
2. खण्ड (क) में निर्धारित कवियों में से किन्ही दो कवियों के साहित्यिक परिचय पूछे जाएँगे, जिनमें से किसी एक कवि का साहित्यिक परिचय लिखना होगा। यह प्रश्न 8 अंक का होगा।

BPL 201: Physics-II (Heat and Thermodynamics)

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers

Course Objective: The course on thermal physics is framed with the objective that students are able to understand basic concepts of thermos-dynamical systems. Students will be able to understand heart, work, temperature, entropy and the laws of thermodynamics. Behavior of real gases as thermos-dynamical systems has also been included.

UNIT - I

Zeroth and First Law of Thermodynamics: Extensive and intensive thermodynamic variables, Thermodynamic equilibrium, zeroth law and Concept of Temperature, Work and heat, State functions, First law of thermodynamics, Internal energy, Applications of first law, General relation between C_p and C_v, Work done during isothermal and adiabatic processes.

Second Law of Thermodynamics: Reversible and Irreversible process with examples, Conversion of Work into Heat and Heat into Work, Heat Engines, Carnot's Cycle, Carnot engine &its efficiency, Refrigerator & coefficient of performance, 2^{nd}Law of Thermodynamics: Kelvin-Planck andClausius Statements and their equivalence, Carnot's Theorem.

UNIT-II

Entropy and Third law of Thermodynamics: Concept of entropy, Clausius theorem, ClausiusInequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a Perfect Gas and Universe, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of Thermodynamics, Unattainability of absolute zero, T-S Diagrams, Phase Change, Classification of Phase Changes.

UNIT-III

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables; Internal Energy; Definition, importance, properties and applications of Chemical Potential, Enthalpy, Gibbsfunction and Helmholtz function.

Maxwell's Thermodynamic Relations: Derivations of Maxwell's Relations and their applications: (1) Clausius-Clapeyron equation (2) C_p- C_v value, (3) Energy equations (4) Change of temperature during adiabatic process.

UNIT-IV

Real gases: Behavior of Real Gases, Deviations from the Ideal Gas Equation. The Virial Equation, Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Van-der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves, P-V Diagrams, Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas.

Thermo-electricity: Seeback effect, Paltier effect, Thomson effect and their explanations.

Reference Books:

1. A Treatise on Heat: Meghnad Saha and B.N. Srivastava, Indian Press
2. Thermal Physics: S. Garg, R. Bansal and Ghosh, Tata McGraw-Hill
3. Concepts in Thermal Physics: S.J. Blundell and K.M. Blundell, Oxford University Press
4. Heat and Thermodynamics: An Intermediate Textbook by M. W. Zemansky and R. Dittman, McGraw-Hill.

BCL-201: CHEMISTRY-II

Marks (Theory) : 70 | **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 | **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT - I

Chemical Bonding and Molecular Structure

Introduction to Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, polarizing power and polarizability

Introduction to Covalent bonding: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonalbipyramidal and octahedral arrangements.

Ionic Solids: Factors affecting the formation of ionic solids, concept of close packing, radius ratio rule and coordination number. Calculation of limiting radius ratio for tetrahedral and octahedral sites.Structures of some common ionic solids NaCl, ZnS (zinc blende and wurtzite).

UNIT-II

Acids and Bases

Brönsted–Lowry concept, conjugate acids and bases, relative strengths of acids and bases, effects of substituent and solvent, differentiating and levelling solvents. Lewis acid-base concept, classification of Lewis acids and bases, Lux-Flood concept and solvent system concept. Hard and soft acids and bases (HSAB concept), applications of HSAB process.

Basic Coordination Chemistry

Coordinate Bond. Werner's coordination theory, ligands, chelates. Nomenclature of coordination compounds. Stereochemistry of different coordination numbers, isomerism. Valence-bond and crystal field theories of bonding in complexes. Explanation of properties such as geometry colour and magnetism.

UNIT-III

Chemical Kinetics and Catalysis

Rates of reactions, rate constant, order and molecularity of reactions. Differential rate law and integrated rate expressions for zero, first, second and third order reactions. Half-life time of a reaction. Methods for determining order of reaction. Effect of temperature on reaction rate and the concept of activation energy.

Catalysis: Homogeneous catalysis, Acid-base catalysis and enzyme catalysis. Heterogeneous catalysis.

UNIT-IV

Basics of spectroscopy

Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law.Electromagnetic radiations, Introduction to ultraviolet, visible and infrared spectroscopy, electronic transitions, λ_{max}&ε_{max}, chromophore, auxochrome, bathochromic, hypsochromicshifts.Infrared radiation and types of molecular vibrations, functional group and fingerprint region.

BOOKSSUGGESTED:

1.Cotton F.A. and Wilkinson G., Murillo C.A., Bochmann M., Advanced Inorg. Chemistry, 6th Edition, Pubs: JohnWiley & Sons. Inc., 1999.

2. Lee J.D., Concise Inorganic Chemistry, 4th edition, Pubs: ELBS,1991.

3. Huheey J.E., Keiter E.A., Keiter R.L., Inorganic Chemistry: Principles of Structures and Reactivity; 4th Edition, Pubs: Harper Collins, 1993.

4. Greenwood N.N. and Earnshaw A., Chemistry of the Elements, 2nd edition., Pubs: Butterworth/Heinemann, 1997.

5. Douglas B., Daniel D. Mc and Alexander J., Concepts of Models of Inorganic Chemistry, Pubs: John Wiley,1987.

6. Puri B.R., Sharma L. R. and Pathania M. S., Principles of Physical Chemistry, Pubs: Vishal Publishing Company, 2003.

7. Laidler K. J Chemical Kinetics, McGraw Hill.

8. Castellan G.W. Physical Chemistry, Narosa Publishers

9. Kemp W. Organic Spectroscopy

BML-201: ELEMENTARY MATHEMATICS-II

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Matrix Algebra : Introduction, types of matrices, addition and multiplication of matrix, transpose of matrix, concept of elementary row and column operations. Determinant and its properties, minors, cofactors. Application of determinants in finding area of triangle. Adjoint and inverse of square matrix. Solution of homogeneous and non-homogeneous linear equations and condition for solution.

UNIT – II

Differential Calculus : Differentiation of standard functions including function of a function (Chain rule). Differentiation of implicit functions, Logarithmic differentiation, parametric differentiation, elements of successive differentiation.

Integral Calculus : Integration as inverse of differentiation, indefinite integrals of standard forms, integration by parts, partial fractions and substitution. Formal evaluation of definite integrals.

UNIT – III

Ordinary Differential Equations : Definition and formation of ordinary differential equations, equations of first order and first degree, variable separable, homogeneous equations, linear equations (Leibnitz form) and differential equations reducible to these types, Linear differential equation of order greater than one with constant coefficients, complementary function and particular integrals.

UNIT – IV

Partial Differential Equations: Introduction and formation of P.D.E., solution of P.D.E., linear equation of first order (Lagrange's Equation), Non-Linear Equation of first order.

Vector Calculus: Differentiation of vectors, scalar and vector point functions, gradient of scalar field and directional derivative, divergence and curl of vector field and their physical interpretation.

Books Recommended:

1. Shanti Narayan : Differential and Integral Calculus, S. Chand.
2. S.L. Ross, : Differential Equations, John Wiley and sons inc., Ny,1984.
3. Shanti Narayan : A Textbook of Matrices, S. Chand.
4. Ian N. Snnedon : Elements of Partial Differential Equations, McGraw Hill.
5. Murray R. Spiegal : Vector Analysis Schaum Publishing Company, New York

BBL-201: ELEMENTARY BIOLOGY-II (CELL BIOLOGY)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation.

Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments.

Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III

Lysosomes: Vacuoles and micro bodies: Structure and functions
Ribosomes: Structures and function including role in protein synthesis.
Mitochondria: Structure and function, Genomes, biogenesis.
Chloroplasts: Structure and function, genomes, biogenesis
Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction.

Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

References:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8^{th}edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7^{th} edition. Pearson Benjamin Cummings Publishing, San Francisco.

BML-202: MATHEMATICS-II (CALCULUS)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

Definition of the limit of a function. Basic properties of limits, Continuous functions and classification of discontinuities. Differentiability. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions.

UNIT -II

Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates. Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves. Newton's method. Radius of curvature for pedal curves. Tangential polar equations. Centre of curvature. Circle of curvature. Chord of curvature, evolutes. Tests for concavity and convexity. Points of inflexion. Multiple points. Cusps, nodes & conjugate points. Type of cusps.

UNIT – III

Tracing of curves in Cartesian, parametric and polar co-ordinates. Reduction formulae. Rectification, intrinsic equations of curve.

UNIT -IV

Quadrature (area) Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution. Theorems of Pappu's and Guilden.

Books Recommended :

1. Differential and Integral Calculus, Shanti Narayan.
2. Murray R. Spiegel, Theory and Problems of Advanced Calculus. Schaun's Outline series. Schaum Publishing Co., New York.
3. N. Piskunov, Differential and Integral Calculus. Peace Publishers, Moscow.
4. Gorakh Prasad, Differential Calculus. Pothishasla Pvt. Ltd., Allahabad.
5. Gorakh Prasad, Integral Calculus. Pothishala Pvt. Ltd., Allahabad.

BBL-202: BIOLOGY-II (GENERAL BIOCHEMISTRY)

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT I

Introduction to Biochemistry:

A historical prospective. Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins.

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA

UNIT III

Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric &oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyperthermophilic archaea and bacteria. Role of: NAD+ , NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate,lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions

UNIT IV

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids.

References:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

BXL-202: COMPUTER SCIENCE

Marks (Theory) : 70 | **Credits :2 (30 lectures)**

Marks (Internal Assessment) : 30 | **Time : 3 Hrs**

Note: The question paper will consist of nine questions in all. Question no. 1 will contain seven short answer type questions without any internal choice covering the entire syllabus and shall be compulsory. The remaining eight questions will be set from the four units with two questions from each unit. Candidate is required to attempt five questions in all with one compulsory question and one question from each unit.

UNIT – I

An Overview of Computer System

Anatomy of a digital Computer, Memory Units, Main and Auxiliary Storage Devices, Input Devices, Output Devices, Classification of Computers. Radix number system: Decimal, Binary, Octal, Hexadecimal numbers and their inter-conversions; Representation of information inside the computers.

UNIT-II

Operating System Basics

The user Interface, Running Programmes, Managing files, Introduction to PC operating Systems: Unix/Linux, DOS, Windows 2000.

UNIT-III

Internet basics

Introduction to the basic concepts of Networks and Data Communications, How Internet works, Major features of internet, Emails, FTP, Using the internet.

UNIT-IV

Programming Languages

Machine-, Assembly-, High Level- Language, Assembler, Compiler, Interpreter, debuggers, Programming fundamentals: problem definition, algorithms, flow charts and their symbols, introduction to compiler, interpreter, assembler, linker and loader and their inter relationship.

Reference books:

1. Goel A., Computer Fundamentals, Pearson Education, 2010.

2. Aksoy P. &DeNardis L., Introduction to Information Technology, Cengage Learning, 2006

3. Sinha P. K. & Sinha P. Fundamentals of Computers, BPB Publishers, 2007

BPP-201: PHYSICS LAB - II

Marks (External) : 70 **Credits : 2**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note:

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To determine Mechanical Equivalent of Heat,J. by Callender and Barne's constant flow method.

2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Leeand Charlton's disc method.

5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

8. Study of Electrochemical Equivalent of Hydrogen using Voltmeter

9. Study of Newton's Law of cooling.

10. Determination of specific heat of Solids

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal,1985, Vani Pub.

BCP-201: CHEMISTRY LAB-II

Marks (External) : 70 **Credits : 2**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Complexometrictitrations: Determination of Mg^{2+}, Zn^{2+} by EDTA.
Paper Chromatography: Qualitative Analysis of any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}, Cl^- , Br^- , I^- and PO_4^{3-} and NO_3^-).
To determine the specific refractivity of at least two liquids.
Determine rate constant of acid catalyzed hydrolysis of methyl acetate.
Determination of conductance of electrolytes
The preliminary examination of physical and chemical characteristics (physical state, colour, odour and ignition test), extra element detection (N,S,Cl, Br and I).

Reference Books:

1. Vogel A. I., Tatchell A.R., Furnis B.S., Hannaford A.J., Smith P.W.G.,Vogel's Text Book of Practical Organic Chemistry,5th Edn.,Pubs: ELBS, 1989.
2. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Pubs: Thomson Brooks/Cole,2005.
3. Mann F.G., Saunders. P.C.,Practical Organic Chemistry,Pubs:Green& Co. Ltd., London, 1978.
4. Svehla, G., Vogel's Qualitative Inorganic Analysis (revised); 7th edition, Pubs: Orient Longman, 1996.
5. Bassett, J., Denney, R.C., Jeffery, G.H., Mendham, J., Vogel's Textbook of Quantitative Inorganic Analysis (revised); 4th edition, Pubs: Orient Longman,1978.
6. Das R.C. &Behra B. Experimental Physical Chemistry, , McGraw Hill.
7. Shoemaker &GailandExperiments in Physical Chemistry, McGraw Hill.
8. YadavJ. B. Advanced Practical physical Chemistry

BXP-201: COMPUTER SCIENCE LAB

Marks (External) : 70 **Credits : 2**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Programming language: C fundamentals, formatted input/ output, expressions, selection statements, loops and their applications; Basic types, arrays, functions, including recursive functions, program organization: local and external variables and scope; pointers & arrays

Representative programming in C

1. Write a program to find the largest of three numbers. (if-then-else)

2. Write a program to find the largest number out of ten numbers (for-statement)

3. Write a program to find the average mail height & average female heights in the class (input is in form of sex code, height).

4. Write a program to find roots of quadratic equation using functions and switch statements.

5. Write a program to multiply two matrices

BOOKS SUGGESTED:

Kanetkar Y. Let Us C, BPB publication

BPL -301: ELECTRICITY AND MAGNETISM

Marks (Theory) : 70 **Credits :4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course on Electricity and Magnetism deals with Coulomb's law, Electric field, potential formulation of electrostatic, Capacitors, Magnetism and magnetic materials along with the applications of these concepts	**Course Outcome:** The student will be able to understand Gauss-divergence theorem, Stokes theorem in dielectrics, electrical and magnetic properties of materials.

UNIT-I

Electrostatics: Electric field, Electric field lines, Electric flux, Divergence of electrostatic field, Gauss' Law with applications, Conservative nature of Electrostatic Field, Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Electrostatic energy of system of charges, Energy per unit volume in electrostatic field, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor, Laplace's and Poisson equations, Laplace equation in three dimension, The Uniqueness Theorems

UNIT-II

The method of images: Point charge in the presence of grounded conducting sphere, Solution of Laplace equation by separation of variables for Cartesian and spherical coordinates, Multipole expansion of potential due to arbitrary charge distribution.

Dielectric Properties: Dielectric medium, Polarization, Bound charges in a polarized dielectric and their physical interpretation, Electric displacement, Gauss's theorem in dielectrics, Parallel plate capacitor completely filled with dielectric, dielectric constant.

UNIT-III

Magnetism: Lorentz force law, Magnetic forces, Magnetostatics: Biot-Savart's law & its applications (1) straight conductor (2) circular coil (3) solenoid carrying current, Divergence and curl of magnetic field, Ampere's circuital law and it's applications for simple current configurations, Magnetic vector potential.

UNIT-IV

Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Para-, Dia- and Ferromagnetism, B-H curve and hysteresis

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width, Parallel LCR Circuit.

Reference Books:

- D.J. Griffith, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
- Electricity and Magnetism, Edward M.Purcell, 1986,McGraw-HillEducation..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- University Physics, Ronald Lane Reese, 2003, ThomsonBrooks/Cole.

BPL -302: MATHEMATICAL PHYSICS – I

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course covers basics of differential equation, vector calculus, vector algebra, vector differentiation, vector integration, probability and errors. These topics are useful for the mathematical basis of electromagnetism and quantum mechanics courses.	**Course Outcomes:** After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

UNIT-I

Vector Calculus: Recapitulation of vectors: Properties of vectors under rotations, Scalar product and its invariance under rotations, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively, Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, De and Laplacian operators, Vector identities.

UNIT-II

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, Surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss's divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials, Constrained Maximization using Lagrange Multipliers.

UNIT-III

Calculus: Recapitulation: average and instantaneous quantities Intuitive ideas of continuous, differentiable, functions and plotting of curves, Approximation: Taylor and binomial series (statements only).

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor, Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral.

UNIT-IV

Introduction to probability: Independent random variables, Probability distribution functions; Binomial, Gaussian, and Poisson distributions (with examples), Mean and variance, Dependent events: Conditional Probability, Bayes' Theorem and the idea of hypothesis testing.

Theory of Errors: Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error, Least-squares fit, Error on the slope and intercept of a fitted line.

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Elsevier.

2. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.

3. Mathematical Physics, H K Das, S Chand

BPL-303: WAVES AND OSCILLATIONS

Marks (Theory): 70 **Credits :4 (60 lectures) Marks (Internal Assessment) : 30** **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The objective of this course is to introduce the basics of oscillatory motion, wave motion, transmission linens, ultrasonic and their applications.	**Course Outcomes:** After completion of this course, students will be familiar with the concept of wave and oscillations.

UNIT – I

Simple Harmonic Oscillations(SHM): Differential equation of SHM and its solution. Simple pendulum and compound pendulum, Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle, Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats); Superposition of N Collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures with equal and unequal frequency and their uses.

UNIT - II

Damped Harmonic Oscillations: Damped motion of mechanical and electrical oscillators, critical damping, amplitude decay, energy decay, logarithmic decrement, relaxation time, Q-value. *Forced Harmonic Oscillations*: Transient and steady state behavior of a forced oscillator, Q-Value- as a measure of power absorption band width, a measure of power absorption bandwidth, as amplification factor of low frequency response; Coupled Oscillation

UNIT – III

Wave Motion: Wave Equation, Solution of wave equation, Particle and Wave Velocities, Intensity of Wave. Transverse Waves: The string as a force oscillator, Velocity of Transverse Vibrations of Stretched Strings, Reflections and transmission of waves on a string at a boundary, Reflections and transmission of Energy. Longitudinal Waves: Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction, Reflections and transmission of sound waves at a boundary, Reflections and transmission of sound intensity, Energy distribution in sound waves, Phase and Group Velocities

UNIT – IV

***Waves on transmission lines and EM wave*:** Ideal transmission lines, wave equation for transmission lines, Velocity of voltage and current waves, characteristic impedance, Transmission lines as filter, attenuation coefficients and diffusion equation. Fundamentals of ultrasonics: concept of transverse of shear, surface(Rayleigh) and Plate (Lamb) waves in solids. Introductory concepts on electromagnetic waves and its comparison with other waves.

Reference Books

1. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

2. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

3 Fundamentals and Applications of Ultrasonic Waves, J. David N. Cheeke, CRC(2002)

BPL-304: PHYSICS OF SEMICONDUCTOR DEVICES

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course enables students to develop an in-depth understanding about the physics of semiconductors through an exposure of various types of semiconductor diodes, transistors, binary number systems and logic gates.	**Course Outcomes:** After completion of this course, students will be able to understand the basics of semiconductor materials, semiconductor diodes, BJT and their characteristics along with applications in various electronic devices. The students will be able to understand binary number systems and logic gates.

UNIT – I

Physics of Semiconductors: The Energy-Band theory of Crystals, Classification of materials, Direct and indirect band gap semiconductors, Intrinsic and extrinsic semiconductors, concept of effective mass, Donor and Acceptor impurities, mass action law, Carrier Concentrations; The Fermi Level, Charge densities in semiconductors, Electrical properties of Ge and Si, Generation and recombination of charges, Carrier diffusion, Continuity equation, Injected minority-carrier charge, The Potential variation within a graded semiconductor.

UNIT – II

Semiconductor Diodes: Open circuit p-n junction, V-I characteristics and their dependence, Ideal Diode, The Diffusion capacitance, Breakdown Diodes, Tunnel Diode, Semiconductor Photodiode, LED, Diode as circuit element, Load line, Piecewise linear diode model, p-n junction as rectifier (half, full and bridge rectifier), Ripples, Filters (capacitor, inductor and π-filters), Clipping and clamping circuits.

UNIT – III

Bipolar Junction Transistors (BJT): The junction transistor and its current components, I-V characteristics, Transistor as an amplifier, Type of transistors, Common-Base (CB), Common-Emitter (CE), Common-Collector (CC) configuration, characteristics of CE, CB and CC configurations, Ebers-Moll BJT Model, Phototransistor, Switching Transistor, Biasing for transistor, load line and Q point. Types of biasing, Fixed Bias circuits, Collector to base bias circuits, Bias circuit with emitter resistance, Voltage divider bias circuits.

UNIT – IV

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions, Binary, octal and hexadecimal arithmetic (addition, subtraction by complement method, multiplication), representation of signed and unsigned numbers, Binary Coded Decimal code.

Logic Gates and Boolean algebra: Introduction to Boolean Algebra and Boolean operators: De Morgan's Theorems, Boolean Laws, simplifications of Logic Circuits using Boolean Algebra, Positive and negative logic, Truth Tables of OR, AND, NOT, construction and symbolic representation of XOR, XNOR, Universal NOR and NAND gates (DTL, TTL gates).

Reference Books:

1. Semiconductor Physics and Devices: Donald A Neaman and Dhrubes Biswas, 4th Edition, McGraw Hill, India
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill, India
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning

BPL - 305: BASIC INSTRUMENTATION SKILLS

Credits : 2(30 lectures)
Time : 3 Hrs

Marks (Internal Assessment) : 100

Note: The paper will be evaluated internally based on theory & practical.

Course Objective: The course is based on imparting practical knowledge about commonly used electronic instruments including digital multimeter and cathode ray oscilloscope to the undergraduate students of physics.	**Course Outcomes:** After completion of this course, students will be able to understand the basic equipment's used in physics laboratory.

Unit - I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc., Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance, Specifications of multimeters and their significance.

Digital Multimeter: Block diagram and working of a digital multimeter, Working principle of time interval, frequency and period measurements using universal counter/ frequency counter, Time - base stability, Accuracy and resolution.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity, Principles of voltage measurement (block diagram only), Specifications of an electronic Voltmeter/ Multimeter and their significance.

Unit – II

Cathode Ray Oscilloscope: Block diagram of basic CRO, Construction of CRT, Electron gun, electrostatic focusing and acceleration (qualitative treatment only), Brief discussion on screen phosphor, visual persistence & chemical composition, Time base operation, synchronization, Front panel controls,
Specifications of a CRO and their significance, Use of CRO for the measurement of voltage (dc and ac), frequency and time period. Special features of dual trace, Introduction to digital oscilloscope and probes, Digital storage Oscilloscope: Block diagram and principle of working.

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Digital Circuits and system. S, Venugopal, 2011, Tata McGraw Hill.
3. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

BPP-301: PHYSICS LAB - III

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To determine the value of e/m by Bar magnet
5. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
6. To study the response curve of a parallel LCR circuit and determine its (a) Anti resonant frequency and (b) Quality factor Q.
7. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
8. Determine a high resistance by leakage method using Ballistic Galvanometer.
9. Determination Wavelength of Ultrasonic Wave.
10. To study the damped oscillations
11. To study Lissajous Figures.

Reference Books

1) Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2) A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
3) A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub

BPP-302: PHYSICS LAB- IV

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. Study functioning of Cathode ray oscilloscope.
3. Study of depletion capacitance of diode and its variation with reverse bias.
4. To design circuits for OR, AND, NOT, NAND and NOR logic gates and verify their truth tables.
5. To study Zener diode as a voltage regulator.
6. To study the frequency response of passive filters (low pass, high pass, band pass, band reject) using passive devices.
7. To study half wave and full wave rectifier.
8. To Study I-V characteristics of PN Junction diode.
9. To Study input and output characteristics of n-p-n Transistor
10. To Study input and output characteristics of p-n-p Transistor
11. To study Voltage Doubler and Trippler circuits.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition ,reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011,Kitab Mahal

BPL-401: ELEMENTS OF MODERN PHYSICS

Marks (Theory): 70	**Credits: 4 (60 lectures)**
Marks (Internal Assessment): 30	**Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The aim of the course is to give students a flavor of developments in physics in the last century by introducing the concepts of quantization, dual nature of matter, basic quantum mechanics and cosmology.	**Course Outcomes:** Course Outcome: Students will be aware of foundations of modern physics, experiments forming basis of quantum mechanics, Atomic structure, wave concepts, uncertainty principle and basic idea of cosmology.

UNIT – I

Introduction to electromagnetic spectra, Properties of Thermal Radiation, Spectral Distribution of Blackbody Radiation, Kirchhoff's Law, Stefan-Boltzmann Law and Wien's Distribution and Displacement law, Rayleigh-Jean's Law, Ultraviolet Catastrophe, Planck's postulates of black body radiation, Planck's Law of Blackbody Radiation and its experimental verification. Photoelectric effect, Einstein's explanation and its experimental verification (R. Millikan). Compton scattering, Pair production and annihilation, Bremsstrahlung effect, Cherenkov radiation. X-ray Spectra of atoms and its production.

UNIT – II

Atomic structure: Rutherford scattering, Rutherford's model and its drawbacks, Bohr atomic model; quantization rule, atomic stability, calculation of energy levels for hydrogen like atoms and their spectra, effect of nuclear mass on spectra, Correspondence principle, Franck-Hertz experiment.

Wave properties of matter: De-Broglie wavelength and matter waves; Wave-particle duality, Davison and Germer experiment, wave packets, phase velocity, group velocity and their relations. Electron microscope.

Uncertainty principle: Heisenberg's uncertainty principle; Estimating minimum energy of a confined particle using uncertainty principle, Energy-time uncertainty principle. Applications

UNIT – III

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Concept of wave function: Origin and probability interpretation of wave function, properties of wave-function. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example

UNIT – IV

Cosmology: The Expansion of the Universe, The Cosmic Microwave Background Radiation, Dark Matter, The General Theory of Relativity, Tests of General Relativity, Stellar Evolution and Black Holes, Cosmology and General Relativity, The Big Bang Cosmology, The Formation of Nuclei and Atoms, Experimental Cosmology.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Modern Physics, Knneth S.Krane, JOHN WILEY & SONS, INC

BPL 402: Optics

Marks (Theory) : 70 **Credits : 4 (60 lectures)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The course covers basics of several optical phenomena including Geometrical optics specifically present day ray tracing, image evaluation; Wave Optics consisting interference, diffraction and polarization of light. Further, the course provides an insight of practical applications of Lasers and Optical fibers.	**Course Outcomes:** After completion of this course, students will be able to understand the geometric optics, interference, diffraction, polarization of light wave and laser.

UNIT- I

Geometrical Optics: Paraxial theory for refraction and reflection by spherical surfaces, Lens, Mirrors and prisms, Newton imaging equation, paraxial parameters lateral and longitudinal magnifications, Image evaluation- Spot diagram, ray intercept curves, contrast and optical transfer function. Aberrations in optical systems: Chromatic and monochromatic aberrations, Imaging and non-imaging optical systems: magnifiers, eyepieces, microscope, telescope and binocular.

UNIT- II

Interference of light waves: Intensity distribution in Young's experiment, concept of spatial and temporal coherence, coherence time and coherence length. Examples of interference by division of amplitude: interference in thin films and wedges, Newton's rings, interference by division of wavefront: Fresnel's biprism,MichelsonInterferometers,Diffraction: Fraunhoffer and Fresnel diffraction- analytical and graphical solutions for diffraction from Single and multiple slits, Resolution of optical systems, Grating and its application

UNIT-III

Polarization: Different states of polarization, double refraction, Huygens' construction for uniaxial crystals, polaroids and their uses. Production and analysis of plane, circularly and elliptically polarized light by retardation plates and rotary polarization and optical activity, Fresnel's explanation of optical activity: Biquartz and half shade polarimeter.

UNIT – IV

Lasers: Basic concept of stimulated emission, amplification and population inversion; Main components of lasers: (i) Active Medium (ii) Pumping (iii) Optical Resonator; Einstein's 'A' and 'B' coefficients and their relationship; Properties of laser beam: Monochromaticity, Directionality, Intensity, Coherence (Spatial & Temporal coherence); Energy levels, Excitation mechanism and Applications of Gas laser (He-Ne) and Solid state laser (Ruby).

Reference Books:

1. Optics, AjoyGhatak, 2008, Tata McGraw Hill
2. Optics, Hetch,2008, Pearson
3. Fundamentals of Photonics, SPIE, Opens Source

BPL-403: Electromagnetic Theory

Marks (Theory) : 70 **Credits : 4 (60 lectures) Marks (Internal Assessment) : 30** **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The course on Electricity and Magnetism deals with the Electromagnetic induction, Maxwell's Equations, Electromagnetic wave propagation, Poynting's Vector and electromagnetic field transformation.	**Course Outcomes:** The student will be able to understand electromagnetic induction and it's applications, Maxwell's equations and generation of electromagnetic fields, wave propagation through vacuum and isotropic dielectric medium

UNIT-I

Motional EMF, Faraday's Law of induction, Induced electric field, Lenz's law, Inductance,Self induction of a single coil, Mutual induction of two coils, Transformers, Energy stored in magnetic field,

Maxwell`sequations: Maxwell's fixing of Ampere's law, Displacement current, Maxwell's equations in vacuum.

UNIT-II

Maxwell's equations in matter, Boundary Conditions, Continuity equation, Poynting Theorem and Poynting vector, Maxwell Stress tensor, Conservation of Momentum and angular momentum in electromagnetic field, Energydensity in electromagnetic field.

UNIT-III

The wave equation, Sinusoidal waves, Wave equations for **E** and **B** fields, Electromagnetic wave propagation through vacuum and isotropicdielectricmedium,transversenatureofEMwaves,Energy and momentum in EM waves, Propagation in linear media, Reflection and transmission at Normal and Oblique incidence, Brewster's angle, Wave guides, TEM waves

UNIT-IV

Scalar and vector potential for electromagnetic fields, Gauge Transformation, Coulomb Gauge, Lorentz Gauge,Electric and magnetic dipole radiation (no derivation needed, discussion of results only), Magnetism as relativistic phenomenon, Transformation of electric and magnetic fields between two inertial frames.

Reference Books:

- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
- ElectricityandMagnetism,EdwardM.Purcell,1986,McGraw-HillEducation..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- University Physics, Ronald Lane Reese, 2003, ThomsonBrooks/Cole.

BPL -404: METHODS OF EXPERIMENTAL PHYSICS

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

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Course Objective: This course aims to cover the fundamental principles involved in the methods of measurement in the experimental physics. The focus is on the teaching undergraduate students about direct and indirect methods of accurate measurements of fundamental physical quantities.	**Course Outcomes:** After completion of this course, students will be familiar with the methods of measurement in the experimental physics.

UNIT – I

Measurements: Accuracy and precision, Sources of uncertainty and experimental errors, Concepts of standards, traceability and calibration, Basic of Statistical analysis of data and curve fitting, Measurement of Length: Calipers, Micrometer, Dial indicator, Triangulation technique, Theodolite, Range Finder.

Measurement of Angles and Arc: Inclinometers and laser levelers, Auto collimator, Angular Encoders Measurement of Time: Oscillator and Clocks, Atomic Clock.

UNIT – II

Transducers and its characteristics: Selection of instrumentation transducers, Modeling a transducer with typical example of electrical parameter measurements like current, voltage, resistance and capacitance, DC and AC Bridge Measurements, Strain gauge and Wheatstone Bridge, Gas and liquid thermometer, Thermoelectric Sensors: Resistance Temperature Detectors (RTD), Thermistor, Thermocouples, Linear variable differential transformer (LVDT), Capacitance change transducers.

UNIT – III

Spectroscopic Instruments: Prism Spectrometers and Grating spectrometer, Measurement of refractive index and dispersion, Applications of Lasers Measurement of displacement, Fiber endoscopy, Measurements with Fresnel Bi Prism, Measurements and Newton’s rings, Measurement of surface profile by autocollimator and interferometer, Triangulation techniques using laser and its applications.

UNIT – IV

Other measurements: Measurement of flow of liquid and gases, Measurement of Pressure, Vacuum gauges, Piezo-electric oscillator and its application in thin film thickness monitor, Optical thickness monitors; Radiation Sensors: Underlying Principle and basic construction of Gas filled detectors: ionization chamber, Scintillation detector.

Reference Books

1) Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2) Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3) The Physics of Metrology, Alexius J. Hebra, Springer 2010

BPL-405: Computational Physics: Fortran Programming

Credits : 2 (30 lectures)

Marks (Internal Assessment) :100 **Time : 3 Hrs**

Note: The paper will be evaluated internally based on theory & practical.

Course Objective: The present course is focused on basic of FORTRAN languages for solving physics problems/ Formulae.	**Course Outcomes:** After completion of this course, students will be able to do the FORTRAN programming for the basic formulae used in physics.

UNIT - I

Introduction to Fortran: Computer architecture and organization, memory and input/output devices, Binary and decimal arithmetic, Fortran character set, Data types and integer constant, variables, Arithmetic expression, Assignment statement, Format statement, Read/write statement, Unformatted input/output statements, Algorithm, Flowcharts.

UNIT - II

Fortran statement & subprograms: GOTO, Computed GOTO, Arithmetic If, logical If, If Then Else, Nested If Then Else, DO loops, Continue statement, Nested do loop. Data statement, Double precision, Logical data, Complex data, While structure, Arrays and subscripted variables, Subprograms.

UNIT – III

Errors: Round off error, Truncation error, Machine error, Random error, Propagation of errors. Loss of Significance: Significant Digits, Computer caused loss of significance, Avoiding loss of significance in subtraction.

Solutions of algebraic equations: Bisection method, Iteration method, Newton-Raphson method, Muller's method, Quotient-Difference method, Secant Method.

UNIT – IV

Algorithm, flowchart and program: Finding the roots of a quadratic equations, motion of a projectile, summing a series of numbers, finding factorial of given number, motion in a central force field, addition and multiplication of two matrices, solution of algebraic equations using Bisection and Newton Raphson method.

Reference Books:

1. Fortran 77 and Numerical Methods, C.Xavier, New Age International 1994.
2. William E. Mayo and Martin Cwiakala, Programming with Fortran 77, Schaum's outline serios, McGraw Hill, Inc.
3. Fortran 77, Programming and applications by RC Verma et al. Allied Publishers, New Delhi.
4. R C Desai, Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi.

BPP-401: PHYSICS LAB- V

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To determine the frequency of an electric tuning fork by Melde's experiment.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Newton's Rings.
5. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
6. To determine wavelength of laser using plane diffraction grating.
7. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffraction grating.
9. To find the polarization angle of laser light using polarizer and analyzer.
10. To verify Malus law of polarization
11. Measurement of focal length of Mirrors and Lenses

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

BPP- 402 PHYSICS LAB-VI

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine the Planck's constant using LEDs of at least 4 different colours.
4. To determine the thickness of a thin wire using a laser Source.
5. To determine the wavelength of laser source using diffraction of single slit.
6. To determine the wavelength of laser source using diffraction of double slits.
7. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
8. Comparing intensity of light sources and verify inverse square law.
9. To find the specific rotation coefficient for cane sugar using polarimeter.
10. Study the characteristics of Photodiodes
11. To determine the particle size of lycopodium powder.

Referred Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

BPL-501: Basic Quantum Mechanics

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The course content covers foundations of quantum mechanics, Schrodinger wave equation and applications to one dimensional problems, Hydrogen Atom and time dependent and independent Schrodinger equation	**Course Outcomes:** The students will be equipped with basics of quantum Mechanics, Schrodinger wave equation and its applications.

UNIT -I

Linear Vector Space and Matrix Mechanics: Vector spaces, Hilbert spaces, square integrable functions, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Infinitesimal and Finite Unitary operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Parity operators, Matrix Mehanics and Wave Mechanics, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator.

UNIT-II

Schrodinger Wave Equation: wave function, Normalization, Probability current density,Expectation values, Eigen values and eigen functions, Time evolution of expectation values, stationary states, Ehrenfest Theorem, Degeneracy and orthogonality, Operator formalism and its algebra, Hermitian operators and their properties, Linearity and Superposition Principles, Matrix representation of an operator, Momentum and energy operators, Commutator, Wave Packets, Application to spread of Gaussian Wave packet, Time dependent Schrodinger equation and dynamical evolution of a quantum state, General solution in terms of linear combinations of stationary states.

UNIT -III

Problems in One- Dimension: Discrete and continuous spectrum, Symmetric Potentials and Parity, Free Particle, Potential Step, Potential Barrier and well, 1-D infinite square well potential, Simple harmonic oscillator: Energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy, 1-d Finite potential well problem, Reflection and transmission (tunnel effect) of wavepacket from rectangular potential well.

UNIT -IV

Quantum theory of Hydrogen atom: Schrodinger equation for H-atom, Separation of variables, Quantum numbers, Electron probability density, Radiative transition, Selection rules, Angular momentum operators and their Commutation relations,Schrodinger equation in spherical symmetric potential, Stern-Gerlach experiment

Identical particles: Symmetric and antisymmetric wave functions, distinguishability of identical particles, the exclusion principle, the connection with statistical mechanics, collisions of identical particles, Spin angular momentum: connection between spin and statistics, Atomic levels of Helium atoms as an example of two electron system.

Reference Books :

1. Quantum Mechanics: J.L. Powell and B. Crasemann
2. Quantum Mechanics, D.J Griffith, Pearson publication
3. Quantum Mechanics, A. Ghatak&Loknathan, Mackmilan India Ltd.
4. Quantum Physics ,S.Gasiorowicz , Wiley

BPL-502: ANALOG SYSTEMS AND APPLICATIONS

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: To introduce students to fundamentals of circuit designs, Amplifiers, Oscillators, Hybrid parameters and to provide in-depth theoretical base of Digital Electronics.	Course Outcomes: After completion of this course, students will be able to understand the basics of network theorems, amplifiers, oscillators, h-parameters. In addition to this student will able to understand the digital electronics.

UNIT-I

Ideal constant-voltage and constant-current Sources, Kirchhoff's Current Law & Kirchhoff's Voltage Law, Mesh & Node Analysis, Thevenin theorem, Norton theorem, Star Delta Transformation, Superposition theorem, Reciprocity Theorem, Maximum Power Transfer theorem, Applications to dc circuits.

UNIT-II

Concept of feedback in amplifier, Type of feedback, Small signal amplifiers, Analysis of stage amplifier by Graphical and Equivalent Circuit methods, Requirement of multistage amplifiers, Gain of multistage amplifier, Coupling of two stages, Frequency response of RC-coupled amplifiers, Distortion in amplifier, Classification of amplifiers, Power amplifier, Push-pull amplifier, Voltage gain in feedback amplifier, Negative feedback and its advantages, Classification of oscillators, LC and RC oscillators.

UNIT-III

Graphical Analysis of the CE Configuration, Two-port Devices and the Hybrid Model, Transistor Hybrid Model, Conversion Formulas for the Parameters of the Three Transistor Configurations, Analysis of a Transistor Amplifier Circuit Using h Parameters, The Emitter Follower, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Cascading Transistor Amplifiers, Simplified Common-emitter Hybrid Model, The Common-emitter Amplifier with an Emitter Resistance.

UNIT-IV

Integrated Circuits (IC): Fabrication and Characteristics: Integrated circuit Technology, Basic monolithic IC, Epitaxial Growth, Masking and Etching, Diffusion of impurities, Transistors for Monolithic circuits, Monolithic diodes, Integrated resistors, Integrated capacitors and inductors, Large scale and medium scale integration (LSI and MSI), Metal Semiconductor contacts

Reference Books:

1. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill Education, India
2. A text book in Electrical Technology, B. L. Theraja, S. Chand & Co.
3. Circuit and Networks, 2nd Edition, A Sudhakar and Shyammohan S Palli, Tata McGraw-Hill
4. Integrated electronics by Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill Education, India

BPL-503: MATHEMATICAL PHYSICS-II

Marks (Theory) : 70 — **Credits : 4(60 lectures)**

Marks (Internal Assessment) : 30 — **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The present course provides an introduction to the Fourier series for periodic functions and their applications. It also develops an understanding of Special mathematical functions required for advanced physics problems.	**Course Outcomes:** After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

UNIT – I

Fourier Series: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval, Even and odd functions and their Fourier expansions Application, Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series, Parseval Identity.

Some Special Integrals: Beta and Gamma Functions and its Relation, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).

Dirac Delta function and its properties: Definition of Dirac delta function, Representation as limit of a Gaussian function and rectangular function, Properties of Dirac delta function.

UNIT – II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations, Legendre, Bessel, Hermite and Laguerre Differential Equations, Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials.

Bessel Functions of the First Kind: Generating Function, simple recurrence relations, Zeros of Bessel Functions (Jo(x) and J1(x)) and Orthogonality.

UNIT-III

Complex Analysis: Brief Revision of Complex Numbers and their GraphicalRepresentation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy’s Integral formula. Simply and multiply connected region.

Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

UNIT – IV

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes, Diffusion Equation.

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.

2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.

3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

BPL -504: SOLID STATE PHYSICS

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The aim of the course is to familiarize the students with the concepts of Crystal structure, reciprocal lattice, bonding in solids, elastic constants and magnetic properties of solids.	**Course Outcomes:** After completion of this course, students will be able to understand the basics of crystal structure, reciprocal lattice, bonding in solids, elastic constants and magnetic properties of solids.

UNIT – I

Crystal Structure: Introduction toCrystalline, amorphous solids**,** Crystal lattice and Translation Vectors, Unit cell and basis, Primitive and non-primitive lattices, Symmetry operations, Point groups and space groups, Bravais lattices in 2D and 3D, Lattice planes, Miller Indices, Interplanner spacing, Crystal structures: sc, bcc, fcc and hcp, Examples: NaCl, CsCl, Diamond and ZnS structure.

UNIT – II

Reciprocal lattice: Bragg's law, Fourier analysis of electron density, reciprocal lattice, Diffraction condition in reciprocal space, Laue's equations, Ewald construction, Brillioun zones and Weigner Seitz cell concepts, Brillioun zones construction, Reciprocal lattice (sc, bcc, fcc), Fourier analysis of basis, Atomic scattering factors, Geometrical structure factor, X-ray diffraction method: Laue, Rotating and powder crystal methods.

UNIT – III

Bonding in solids: Force between atoms, Cohesion of atoms and cohesive energy, Crystal of inert gases, Van der Waal interaction, Repulsive interaction, Equilibrium lattice constants, Ionic crystals, Lattice energy of ionic crystal, Madelung constant of ionic crystal, Covalent crystals, Metals, Hydrogen Bonds, Atomic radii.

Elastic constants: Elastic strains, Stress components, Stiffness constants for cubic crystals, Elastic energy density, Bulk Modulus and Compressibility, Elastic waves.

UNIT – IV

Magnetic Properties: Origin of magnetism, Types of magnetism,Dia-, Para-, Ferri-, Ferro and anti-ferromagnetic materials, Langevin's Classical and quantum Theory of Dia– and Paramagnetic, Curie's law, Weiss's Theory of Ferromagnetism, Exchange interactions, Spin Hamiltonian and the Heisenberg model; Spin waves- magnons, Ferromagnetic domains: Magnetization curve, Bloch wall, Origin of domains.

Reference Books:

1) Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2) Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth

3) Neil W Ashcroft and N David Mermin, Solid State Physics, Holt Saunders International Edn, 1976.

4) BD Cullity, Introduction to Magnetic Materials, Addison-Wesley, 1972.

5) Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

BPP - 501: PHYSICS LAB – VII

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To measure the Dielectric Constant of different specimen.
4. To draw the B-H curve of Fe using Solenoid & determine energy loss from Hysteresis.
5. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap.
6. To determine the Hall coefficient of a semiconductor sample.
7. To study of Lattice Vibrations.
8. Study of Fourier series.
9. Study of Boltzman Constant

BPP-502: PHYSICS LAB-VIII

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Verify Thevenin and Norton Network Theorem
2. To verify the Superposition, and Maximum power transfer theorems.
3. Study frequency response of R-C Coupled Amplifier
4. Study characteristics of a Push-Pull Amplifier
5. Study a LC/RC Oscillator using transistors
6. Study of Analog Communication System.
7. Study of NPN transistor as Amplifier.
8. Study of PNP transistor as Amplifier.
9. Study of Tunnel Diode characteristics.
10. Study of h-parameter of a transistor.

BPL-601: Classical and Statistical Mechanics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The objective of the course is to provide a basic knowledge of constraints, planetary motion, Langrange's formulation of classical system of particles. The course also includes the basics of classical and quantum statistical.	***Course Outcomes***: After completion of this course, students will be able to understand the basics of classical and statistical mechanics.

UNIT – I

Two-body central force problem and Lagrangian Dynamics: Constraints & their classification, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Simple applications of the Lagrangian formulation, Velocity-dependent potentials and the dissipation function, Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Cyclic coordinates, Conservation theorems and symmetry properties. Two –body central force problem: Reduction to the equivalent one-body problem, Equations of motion and first integrals, Equivalent 1-D problem and classification of orbits.

UNIT –II

Rigid Bodies- Kinematics and Dynamics: Independent coordinates of the rigid bodies, orthogonal transformations, Euler angles and Euler's theorem, Infinitesimal rotation, rate of change of a vector, Coriolis force, angular theorem, infinitesimal rotation, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of asymmetrical top.

UNIT- III

Introduction to Statistical Physics: Laws of Thermodynamics, Entropy and Disorder, Statistical Definition of Entropy, Macroscopic and Microscopic Systems, Events (dependent, independent and mutually exclusive), statistical Probability, a-priori probability, probability theorems, Tossing of Coins, Permutations and Combinations, Distribution of N distinguishable and indistinguishable particles in boxes, Macro and Micro states, Thermodynamic potentials and Thermodynamic equilibriums, phase space, Liouville's Theorem, Density Matrix, Fluctuations, Three kinds of Statistics

UNIT-IV

Classical and Quantum Statistics: Maxwell- Boltzmann Statistics applied to an ideal gas, M.B. velocity distribution law, Thermodynamical quantities, ideal Boltzmann gas, Monoatomic and Diatomic ideal gases, ideal paramagnetism, Bose- Einstein energy distribution law, Planck's Radiation Law, B-E Gas, Degeneracy and B.E. Condensation, Fermi- Dirac energy distribution Law, F.D. Gas and Degeneracy, Fermi Energy and Fermi Temperature, Zero point Energy, Zero point Pressure and average speed (at 0K) of electron gas, Specific heat Anomaly of metals and its solution, M.B. distribution as a limiting case of B.E. and F.D. distributions, Comparison of three Statistics.

Reference Books:

1. Classical Mechanics, 3rd ed.,2002 by H.Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics of particles and rigid bodies by K. C. Gupta New Age International 2008

BPL-602: ATOMIC AND MOLECULAR PHYSICS

Marks (Theory): 70 **Credits : 4(60 lectures)**

Marks (Internal Assessment): 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The present course is designed to provide the basic information on introduction to atomic spectra for one electron and multi electron systems. In addition, vibration, rotational and electronic spectra of molecules will be taught.	**Course Outcomes:** After completion of this course, students will be familiar with the atomic spectra for one and two electrons system, diatomic molecules and rotational and Vibrational spectra.

UNIT – I

Introduction to atomic spectra, one electron atoms: Bohr model of hydrogen atom, Somerfield modification of Bohr model for hydrogen atom, Quantum theory of hydrogen atoms, Quantum numbers of hydrogen atom wave function, Atomic orbitals, Vector representation of momenta and vector coupling approximations, Electron Spin, Spin orbit interaction, Vector model for atoms, Pauli Exclusion Principle, Angular momentum and magnetic moments of atoms, Coupling of angular momenta, Term symbol and derivation from electronic configuration.

UNIT –II

Two electrons systems: L-S and J-J coupling, Interaction energy in L-S and J-J coupling (sp, pd configuration), Lande interval rule, Pauli principal, selection rules, Normal and Anomalous Zeeman effects, Paschen back effect, Stark effect.

Intensities of spectral lines, General selection rule, Hyperfine structure of spectral lines: Isotope effect and effect of Nuclear spin.

UNIT-III

Diatomic molecules and their rotational spectra: Types of molecules, Diatomic linear symmetric top, Asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as rigid rotator,energy levels,Rotational spectra of diatomic molecules as non-rigid rotator, Raman Effect, Classical and quantum theory of Raman spectra, Rotational Raman spectrum. Comparison of observed rotational and Raman spectra with the observed spectra based on rigid and non-rigid rotators.

UNIT –IV

Diatomic molecules and their vibrational spectra: Vibrational energy of diatomic molecules, Molecules as Harmonic Oscillator, Energy levels, vibrational and Raman spectra, Molecules as Anharmonic Oscillator, Energy levels, vibrational and Raman spectra. Comparison of observed vibrational and Raman spectra with the observed spectra based on harmonic and anharmonic oscillators.

Recommended Reading:

1. Introduction to atomic spectra by H.E. White, McGRAW Hill Book.

2. Atomic & Molecular spectra by Raj Kumar, KedarNath Ram Nath, Meerut

3. Spectra of diatomic molecules by G. Herzberg.

BPL 603: Nuclear and Particle Physics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The objective of the course on Nuclear & Particle Physics is to familiarize the students to the basic concepts like properties of nuclei, radioactive decays, nuclear shapes, some elementary nuclear models, nuclear forces, interaction of energetic particles with matter along with the basic classification of elementary particles.	**Course Outcomes:** After taking the course, students should be able to understand some of the concepts, laws and framework of elementary models in nuclear physics together with basic classification of elementary particles

UNIT-I

Basic Properties of Nuclei: Nuclear composition (p-e and p-n hypotheses), Nuclear properties; Nuclear mass, size, spin, parity, magnetic dipole moment, quadruple moment (shape concept) and binding energy, Systematic of nuclear binding energy per nucleon curve.

Radioactivity: Law of Radioactive Decay, Half-life and mean life time, Radioactive Series, α-decay: Range of α-particles, Geiger-Nuttal law and α-particle Spectra, Gamow Theory of Alpha Decay, β-decay, Energy Spectra and Neutrino Hypothesis, γ-decay, Origin of γ-rays, Nuclear Isomerism and Internal Conversion.

UNIT- II

Nuclear Models and Nuclear Forces: Similarity between nuclear matter and liquid drop, Liquid drop model, Semi-classical mass formula, Limitations of liquid drop model, Experimental signature of shell structure in nuclei, Magic number, Nuclear Shell Model (qualitative only) and its applications, Yukawa's Hypothesis, Meson Theory of nuclear forces.

UNIT- III

Radiation Interaction: Interaction of energetic heavy charged particles (proton, Alpha particles etc.); Energy loss of heavy charged particle (Bethe formula, no derivation), Range of alpha particles, Interaction of light charged particle (Beta-particle), Interaction of Gamma Ray; Passage of Gamma radiations through matter (Photoelectric, Compton and pair production effect), Absorption of Gamma rays (Mass attenuation coefficient), Interaction of neutrons.

Nuclear Radiation Detectors: Gas filled counters; Ionization chamber, proportional counter, G.M. Counter, Scintillation detector, semiconductor detector and neutron detectors

UNIT- IV

Particle Physics: Concept of anti-particle, Discoveries of neutron, positron, pion and muon (qualitative discussion), Particle interactions; Four fundamental interactions and their comparison, Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, Concept of quark model, Color quantum number.

References:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Nuclear Physics by S. B. Patel, New Age publication
3. Introduction to the physics of nuclei and particles by R.A. Dunlap(Singapore: Thomson Asia, 2004).
4. Nuclear physics by Irving Kaplan. (Oxford & IBH, 1962).
5. Introductory nuclear physics by Kenneth S. Krane.(John Wiley & Sons, 1988).

BPL-604: Introduction to Materials

Marks (Theory): 70 | **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 | **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The aim of the course is to familiarize the students with the basic ideas about preparation properties and applications of nanomaterials, ceramic materials, polymers and composite materials	***Course Outcomes:*** After completion of this course, students will be able to understand the various types of materials and their applications in different fields.

UNIT-I

Nanomaterials: Introduction, Bottom up and Top Down approach, Classification of nanostructures: Zero dimension, one dimension and two dimensional nanostructures, Smart materials. Nanostructure fabrication by Physical Methods: Physical Vapor deposition: evaporation, sputtering, Lithography: Photolithography, Electron Beam Lithography.

UNIT –II

Ceramic materials: Introduction, Fabrication and processing of ceramics, types and general properties of ceramic materials, glass-forming constituents, glass ceramics, Processing of glass ceramics and its advantages, perovskite structure of mixed oxides, lime, cement, cement concrete, reinforced cement concrete (RCC), chemically bonded ceramics.

UNIT -III

Polymers: Introduction, Polymer types and Polymer synthesis & processing, General Properties and Applications of Thermosetting Plastics;Elastomers-types and applications, conducting polymers and their applications.

UNIT -IV

Composite Materials: Introduction and Classification of Composites, Isotropic, Anisotropic, and Orthotropic Materials, Laminates, Advantages and Disadvantages of Composite Materials, Applications of composite materials

Reference Books:

1. Introduction to Nanotechnology – Charles P. Poole Jr. and Frank J. Owens, Wiley India Pvt. Ltd., 2007.
2. Nanomaterials – Guozhong Cao, Imperial College Press, 2004.
3. W. D. Kingery, Introduction to Ceramics, Second Edition, Wiley & Sons, New York, 1999.
4. V. R. Gowariker, N. V. Viswanathan, and JayadevSreedhar, Polymer Science, New Age International (P) Limited publishers, Bangalore, 2001
5. C. A. Harper, Handbook of Plastics Elastomers and Composites, Third Edition, McGrawHill Professional Book Group, New York, 1996.
6. Fundamentals of Polymers by Anil Kumar and Rakesh K Gupta, McGraw-Hill, 1997
7. Miller, Tara, 1998, Introduction to Composites, 4th Edition, Composites Institute, Society of the Plastics Industry, New York, NY.
8. KK Chawla. Fibrous Materials. Cambridge University Press, 1998.
9. Composite Materials An Introduction R.P.L.Nijssen

BPP -601: PHYSICS LAB-IX

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Study of Crystal Oscillator
2. Magnetic field measurement using Helmotz coil.
3. Study of Solid State Power Supply.
4. Characteristic of solar cell
5. Study of dielectric constant and determination of Curie temp of Ferroelectric Ceramics.
6. To study modulation and demodulation (Amplitude and frequency).
7. To study and perform Pulse Amplitude Modulation and Demodulation.
8. To study and perform Pulse Width Modulation and Demodulation.
9. To study and perform Pulse Position Modulation and Demodulation.

BPP-602: PHYSICS LAB -X

Marks (External) : 70 **Credits : 3(60Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Determination of Characteristics of GM tube and its operating voltage, plateau length and slop
2. Verification of inverse square law of radiation for a gamma source
3. Investigation of statistical nature of radiation using G. M. Counter
4. Range of alpha particles in air using Spark Counter.
5. Resolving Time of G. M. Counter set-up.
6. Investigation of background radiation using a Servey meter device
7. Measurement of gamma spectra of Cs^{137} gamma source using a Scintillation detector.
8. Measurement of the dead time of a GM detector system.
9. Investigation of variation of attenuation coefficient of gamma ray with energy using a GM counter system

SCHEME AND SYLLABI FOR

Dual Degree B.Sc. (Hons.) Physics-M.Sc. Physics

(3+2 YEARS PROGRAMME)

(Under Choice Based Credit System)

7th to 10th semester (Revised)
from 2016-17 batch onward

(70:30)

SEMESTER-VII

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPL 101	Core Course-XV	Advanced Mathematical Physics	4	4	70	30	100
MPL 102	Core Course-XVI	Classical Mechanics	4	4	70	30	100
MPL 103	Core Course-XVII	Quantum Mechanics	4	4	70	30	100
MPL 104	Core Course-XVIII	Integrated Electronics	4	4	70	30	100
MPP 101	Practical-XI	Physics Lab-I	4	8	70	30	100
MPP 102	Practical-XII	Physics Lab-II	4	8	70	30	100
		Total	24	32			

NOTE:

The nomenclature and content of Paper Code MPL 101 and PHL 501 are same.
The nomenclature and content of Paper Code MPL 102 and PHL 502 are same.
The nomenclature and content of Paper Code MPL 103 and PHL 503 are same.
The nomenclature and content of Paper Code MPL 104 and PHL 504 are same.

SEMESTER-VIII

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPL 201	Core Course-XIX	Condensed Matter Physics	4	4	70	30	100
MPL 202	Core Course-XX	Atomic & Molecular Spectroscopy	4	4	70	30	100
MPL 203	Core Course-XXI	Statistical Physics	4	4	70	30	100
MPL 204	Core Course-XXII	Physics of Lasers	4	4	70	30	100
MPP 201	Practical-XIII	Physics Lab-III	4	8	70	30	100
MPP 202	Practical-XIV	Physics Lab-IV	4	8	70	30	100
		Total	24	32			

NOTE:

The nomenclature and content of Paper Code MPL 201 and PHL 506 are same.
The nomenclature and content of Paper Code MPL 202 and PHL 507 are same.
The nomenclature and content of Paper Code MPL 203 and PHL 508 are same.
The nomenclature and content of Paper Code MPL 204 and PHL 509 are same.

SEMESTER-IX

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPL 301	Core Course-XXIII	Nuclear Physics	4	4	70	30	100
MPL 302	Core Course-XXIV	Electrodynamics	4	4	70	30	100
MPL 303	Core Course-XXV	Computational Physics	4	4	70	30	100
MPL 304	Discipline Specific Elective -V	Group I (A/B/C/D)	4	4	70	30	100
MPP 301	Practical-XV	Physics Lab-V (Computational Physics Lab)	4	8	70	30	100
MPP 302	Project**	Project (Part-I, Minor)	4	--	--	100	100
		Total	24				

The nomenclature and content of Paper Code PHL 511 and MPL 301 are same.
The nomenclature and content of Paper Code PHL 512 and MPL 302 are same.
The nomenclature and content of Paper Code PHL 513 and MPL 303 are same.
The nomenclature and content of Paper Code PHL 514(i) and MPL 304(i) / PHL 514(ii) and MPL 304(ii) / PHL 514(iii) and MPL 304(iii) / PHL 514(iv) and MPL 304(iv) are same.

SEMESTER-X

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext.	Int.	Total
MPP 400	Project***	Project (Part-II, Major)	20		350	150	500

OR

Paper Code	Course opted	Nomenclature	Credits	Hr/ week	Marks		
					Ext	Int	Total
MPL 401	Core Course-XXVI	Advanced Quantum Mechanics	4	4	70	30	100
MPL 402	Discipline Specific Elective -VI	Group-II (A/B/C/D)	4	4	70	30	100
MPL 403	Discipline Specific Elective –VII*	Physics of Nano Materials / Spectroscopy/ Radiation Physics	4	4	70	30	100
MPP401	Discipline Specific Elective Lab	Physics Lab-VI (Specialization Specific Lab)	4	4	70	30	100
MPP402	Discipline Specific Elective Lab	Physics Lab-VII (Specialization Specific Lab)	4	4	70	30	100
		Total	20				

The nomenclature and content of Paper Code PHL 516 and MPL 401 are same.
The nomenclature and content of Paper Code PHL 517(i) and MPL 402(i)/ PHL 517(ii) and MPL 402(ii) / PHL 517(iii) and MPL 402(iii) / PHL 517(iv) and MPL 402(iv) are same.
The nomenclature and content of Paper Code PHL 518 and MPL 403 are same.

Important Notes:

1. The question paper shall contain 20% numerical problems in the relevant papers.
2. The department may offer one of the papers (up to 4 credit) to be done through MOOC/SWAYAM courses in a year /semester. The student shall be graded as per the evaluation done by these online courses.
3. A student may opt for the respective MOOC's courses at their own in place of DSEs with a maximum of 8 credits during the programme.
4. The 4 credits assigned to Physics Lab shall include seminar and that will be a part of internal evaluation.
5. The student has to opt for DSE-V and DSE-VI from respective groups (Table 1) keeping in view the related papers of his/her area of interest. The courses will be offered depending upon the strength of students (Minimum 10 students and maximum 50% of the strength of students in a particular class) for a particular course of option subject to availability of faculty. Student is required to opt same discipline /specialization from the two groups.

TABLE- 1

Option	Group –I	Group –II
A	MPL 304(i) Materials Science-I	MPL402(i) Materials Science-II
B	MPL-304(ii) Photonics- I (Fibre Optics and Communication)	MPL402(ii) Photonics – II (Nonlinear Optics)
C	MPL304(iii) Advanced Nuclear Physics-I (Nuclear Models)	MPL402(iii) Advanced Nuclear Physics-II (Nuclear Reactions)
D	MPL 304 (iv) Theoretical Condensed Matter Physics-I	MPL 402 (iv) Theoretical Condensed Matter Physics-II

***** The student will be offered one of the papers for DSE-VII (MPL 403) from Physics of Nano materials/Spectroscopy/ Radiation Physics subject to availability of faculty.

****** In minor project, the students are required to carry out literature review/research work under the guidance of assigned supervisor by the department. At the end of the semester, a 10-15 pages' project report (Part-I, Minor, MPP 302) will be submitted and the same will be evaluated internally through presentation in front of the committee of 3-4 Teachers (including at least one Professor, constituted by the chairperson). Internal evaluation of 100 marks will comprise of 70:30, where 70 marks will be awarded by the committee and 30 marks by the concerned supervisor.

- *The candidate shall be required to submit statement of purpose (SOP) after minor project (Part-I, Semester- IX) if he/she wish to undertake major project (MPP 400) in final semester (Part-II, Semester- X) along with the consent from one of the regular faculty member of the department for supervision (The faculty can give consent to one student only). The SOP will be evaluated by four member's committee chaired by Chairperson along with supervisor as one of the member.*

- *The criteria for selection of students for major project (MPP 400) in final semester (Part-II, Semester- X) is as under:*
  - *iii) The students must have passed all the lower semester exams (1st to 8th semester).*
  - *iv) The students merit will be framed as follows:*
    - *d) 50% weightage from 7th & 8th semester aggregates marks*
    - *e) 25% weightage of minor project marks (MPP-302)*
    - *f) 25% weightage of SOP evaluation*

- *The guidelines for SOP will be provided by the department.*

***A student opting for major project (MPP 400) is required to undertake 16-20 weeks' (one semester) project in semester X. He/she is supposed to submit acceptance-cum-recommendation letter from a Faculty from a National level institution /'A' grade University including GJUS&T by the end of IXth semester.

The evaluation of major project report & presentation out of 500 marks will be done as follows:

1. *150 marks by the concerned supervisor based on overall internal assessment.*
2. *200 marks through presentation of major project before four member's committee chaired by Chairperson (Each member to award out of 50 marks)*
3. *150 marks by inviting the external examiner in the relevant area.*

The external examiner may be asked to evaluate up to the maximum of 10 students in the relevant area.

MPL 101: Advanced Mathematical Physics

Marks (Theory): 70 **CREDITS: 4 (60 Lectures)**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: This course has been formulated to introduce students to some important topics of mathematical physics which are relevant to other papers of M. Sc. Physics course. It includes matrices, group theory, special functions, functions of a complex variable and calculus of residues and integral transforms.	**Course Outcomes:** After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

Unit I

Group theory and Tensors: Definition of a group and examples, Group-multiplication table, conjugate elements and class structure, Subgroups, Isomorphism and homomorphism, Groups representation by matrices, reducible and irreducible representations, the great orthogonality theorem and its geometric interpretation, Schur's Lemmas (Only statements), character of a representation Example of C4v, Topological groups and Lie groups, three dimensional rotation group, special unitary groups SU(2) and SU(3).
Tensors in index notation, Kronecker and Levi Civita tensors, inner and outer products, contraction, symmetric and antisymmetric tensors, quotient law, Noncartesian tensors, metric tensors, covariant and contravariant tensors, Covariant differentiation. Applications.

Unit II

Special Functions: Solution of Bessel differential equation, Second solution of Bessel's equation using Wronskian, Generating function, Recurrence relations, Integral representation, Application to single slit diffraction; Legendre Polynomials and its solution, Second solution of Legendre's equation using Wronskian, Generating function, Recurrence relations and special properties, Rodrigues formula, Orthogonality, Application to electric multipoles; Associated Legendre Functions; Parity and orthogonality; Hermite and Laguerre's functions. Hilbert-Schmidt theory. Green's functions in one dimension and three dimension.

Unit III

Complex Variables: Cauchy-Riemann conditions, analyticity, Cauchy-Goursat theorem, Cauchy's Integral formula, branch points and branch cuts, multivalued functions, Taylor and Laurent expansion, singularities and convergence, calculus of residues, evaluation of definite integrals, Dispersion relation, Optical dispersions, Causality.

Fourier Series: Fourier series, Dirichlet conditions. General properties. Convolution and correlation, Advantages and applications, Gibbs phenomenon.

Unit IV

Integral Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms. 3D Fourier transforms with examples. Application of Fourier Transforms to differential equations: 1D Wave and Diffusion/Heat Flow Equations.

Laplace Transforms: Laplace Transform (LT) and its Properties, LTs of Derivatives and Integrals, LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of LT to Differential Equations: Damped Harmonic Oscillator, Forced Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.

Reference Books:

1. Group Theory for Physicists : A.W. Joshi (Wiley Eastern, New Delhi) 2011.
2. Group Theory and Quantum Mechanics by Michael Tinkham.
3. Mathematical Methods for Physicists (6th edition) by G.B. Arfken & H. J. Weber
4. Matrices and Tensors in Physics : A.W. Joshi (Wiley Eastern, New Delhi) 2005.
5. Mathematical Physics : P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
6. Introduction to Mathematical Physics : C. Harper (Prentice Hall of India, New Delhi) 2006.

MPL-102: CLASSICAL MECHANICS

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The objective of the course is to provide a basic knowledge of Kepler's laws of planetary motion, Hamiltonian dynamics and theory of small oscillations so that they can apply these methods to solve real world problems. The multi-disciplinary topic 'Chaos' will enable the students to learn the techniques to handle the problems from the field of non-linear dynamics.	**Course Outcomes**: After completion of this course, students will be able to understand the basics of Two Body problem, Hamiltonian Dynamics, Poisson Brackets relations and small oscillations. In addition to this student will be familiar with the basic of non-linear dynamics.

UNIT –I

Two-body central force problem and Hamiltonian Dynamics

Virial theorem, Differential equation for the orbit, stability of orbit under central force, conditions for closed orbits, The Kepler's laws of planetary motion and their deduction, Scattering in a central force field,Legendre transformations and the Hamilton equations of motion, Routh's procedure, The physical significance of the Hamiltonian, Derivation of Hamilton's equations from a variational principle, The principle of Least Action.

UNIT –II

Poisson and Lagrangian bracket

The equations of canonical transformation, Examples of canonical transformations, The integral invariants of Poincare, Poisson brackets, Special cases of Poisson brackets, Poisson theorem, Poisson bracket relations, Jacobi's identity and its derivation, Lagrange brackets and its properties, Relationship between Poisson and Lagrange brackets and its derivation, Infinitesimal contact transformation, Angular momenta and Poisson bracket Relations, Liouville's Theorem.

UNIT –III

H-J Theory and theory of small oscillations

Hamilton-Jacobi equation for Hamilton's principal function, Harmonic Oscillator problem, action and angle variables, problem of harmonic oscillator using action angle variable, Theory of small oscillations: Formulation of the problem, Eigenvalue equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule,

UNIT –IV

Introductory non-linear dynamics

Classical Chaos: Linear and nonlinear systems, periodic motion, Perturbation and Kolmogorov-Arnod-moser theorem, dynamics in phase space; Phase Trajectories-Singular Points, Phase Trajectories of Linear Systems, Phase Trajectories of Nonlinear Systems, Attractors, Chaotic Trajectories and Liapunov exponents, Poincare Maps, Bifurcation.

Reference Books:

1. Classical Mechanics, 3rd ed.,2002 by H.Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics of particles by Classical Mechanics by John R. Taylor 2005, University Science Books.
3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor
4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar

MPL 103: Quantum Mechanics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The primary objective of this course is to develop familiarity with various approximation methods applied to atomic, nuclear and solid-state physics and to scattering, which include: Time-independent perturbation theory and variational method.	**Course Outcome:** The students will be aware of the formal structure of the subject and will get equipped with the techniques of angular momentum, perturbation theory and scattering theory so that they can use these in various branches of physics as per their requirement.

UNIT-I

Angular Momentum: The angular momentum operators and their representation in spherical polar coordinates, solution of Schrodinger equation for spherically symmetric potentials, spherical harmonics, Angular momentum matrices and Pauli spin matrices, Connection between spin and statistics, Addition of angular momentum, Calculation of Clebsch-Gordan coefficients, Coupling of orbital and spin angular momentum. Wigner-Eckart theorem and its applications. Symmetries, conservation laws, degeneracy

UNIT-II

Stationary State Approximate Methods: Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator, Application to excited states, Ground state of helium.

Time Dependent Perturbation: General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light. Adiabatic and sudden approximations.

UNIT-III

The WKB approximation: Classical limit, Approximate solutions, Asymptotic nature of solutions, Solution near a turning point, Special case of linear turning point, Connection at the turning point, Asymptotic connection formulae, Application to energy levels of a quantum well, tunneling through a potential barrier and alpha decay

Semiclassical theory of radiation: Transition probability for absorption and induced emission, Electric dipole and forbidden transitions, Selection rules.

UNIT-IV

Scattering Theory: Basic concept of scattering, scattering amplitude, differential and total scattering cross sections, scattering by spherically symmetric potentials, partial waves and phase shifts, scattering by a perfectly absorbing sphere and by square well potential, Born approximation and its validity. its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.

Text and Reference Books:

1. Quantum Mechanics, NouredineZettili, Wiley
2. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
3. Quantum Mechanics: E. Merzbacher (John Wiley, Singapore), 2004
4. Quantum Mechanics: M.P. Khanna, (HarAnand, New Delhi), 2006.
5. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, NewDelhi) 2nd edition, 2004
6. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
7. Quantum Physics: S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.
8. Quantum Mechanics, A. Ghatak&Loknathan, Mackmilan India Ltd.

MPL 104: Integrated Electronics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: To introduce students to fundamentals of with FET, OPAMP and to provide in-depth theoretical base of various flip flops, A/D Converter, ROM and RAM.	**Course Outcomes:** After this course student will be familiar with FET, OPAMP and basic of digital electronics.

UNIT-I

The Junction Field Effect Transistor: Basic structure & Operation, pinch off voltage, single ended geometry of JFET, volt – ampere characteristic, Transfer Characteristics. FET parameters, Biasing of the FET and setting of Q point using load line. MOSFET: Enhancement MOSFET, Threshold Voltage, Depletion MOSFET, Biasing of MOSFET, comparison of p & n channel FETs, FET small signal model, JFET low frequency common source and common drain amplifiers, FET application as Voltage Variable Resistor (VVR), UJT

UNIT-II

Differential Amplifier: Circuit configuration, dual input balanced output different amplifier, D.C. & A.C. analysis, Inverting and Non-inverting inputs, CMRR, Differential Amplifier using constant current bias, current mirror, level translator.

Operational Amplifier: Block diagram, ideal electrical characteristics, equivalent circuit, transfer characteristics, Open loop OP-AMP configuration: Differential, inverting & non-inverting amplifier, OP-AMP with negative feedback (a) Voltage series feedback: Effect of feedback on closed loop voltage gain, input resistance, output resistance, band width, output offset voltage. Voltage follower; (b) Voltage shunt feedback: Effect of feedback on closed loop voltage gain, input resistance, output resistance, band width, output offset voltage.

UNIT-III

OP-AMP Applications: DC and AC amplifier (with offset null circuitry and external offset voltage compensating networks), summing, scaling, averaging (Non-inverting, Inverting and differential configuration), Integrator, Differentiator, Electronic analog computation, comparator. Oscillators: principles, Types, frequency stability, Phase shift oscillator, Wein-bridge oscillator, Square wave, Triangular wave and pulse generator

UNIT-IV

Combinational logic design: Binary Adders, Subtractors, Digital Comparator,Parity generators, Decoders/ Demultiplexers, Data selector/Multiplixer-Encoder

Sequential logic circuits: Flip-Flops – RS, JK, D, T, clocked, preset and clear operation, RAC in JK Flip-flops, master-slave JK flip-flops, Shift registers, Synchronous and Asynchronous counters, A/D Converters, D/A converter

Semiconductor Memories and its applications: ROM, PROM and EPROM, RAM, SRAM and DRAM.

Reference Books:

1. Ramakanth A. Gayakwad: OP-Amps & Linear integrated Circuits, Second Edition, 1991

2. Integrated Electronics by Millman and Halkias (Tata McGraw Hill), 2010.

3. Digital Design : Priciples and Practices, John F. Wakerly, 4th Ed.

4. Digital Principles and Applications by Malvino and Leach (Tata McGraw Hill), 2010.

5. Semiconductor Devices: Physics and Technology by S.M. Sze (John Wiley), 2007.

6. Digital Computer Electronics : Albert P. Malvino, Jerald A Brown (TataMcGraw Hill) 3rd ed. 2004.

MPP-101: PHYSICS LAB –I

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Hall Effect Experiment
   a) To determine the Hall voltage developed across the sample material.
   b) To calculate the Hall coefficient and the carrier concentration of the sample material.
2. Study of magneto- resistance.
3. Determination magnetic susceptibility with a Gouy Balance.
4. To study ESR.
5. To study the phenomenon of magnetic hysteresis and calculate the resistivity, coercivity and saturation magnetization of a material using a Hysteresis loop tracer.
6. To determine material constant, band-gap and temperature variation of characteristics of a semiconductor material
7. Determination of e/m ratio by Helical Method
8. Study of Absorption coefficients
9. Thermo-luminance study
10. Dielectric constant of dielectric material with frequency.

MPP-102: PHYSICS LAB –II

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Study of OP AMP as Inverting, Non-inverting, Adder and Subtractor.
2. Study of OP AMP as Square wave generator, Differentiator and Integrator.
3. Study of OP AMP as Current Controlled Voltage Source (CCVS) and Voltage Controlled Current Source (VCCS).
4. To determine Common Mode Rejection Ratio (CMRR) in differential Amplifier.
5. To determine Open Loop Gain in differential Amplifier.
6. Study of OP AMP as RC Phase Shift Oscillator and to determine frequency of oscillation.
7. To study and Plot the V- I Characteristics of MOSFET.
   (a) Drain Characteristics
   (b) Transfer Characteristics
8. To study and plot the V- I characteristics of JFET and to evaluate following parameters:
   (a) DC Drain resistance
   (b) Transconductance
   (c) Amplification factor
9. To study and plot the V- I characteristics of UJT and to evaluate following parameters:
   (a) Intrinsic Stand- off Ratio.
   (b) Inter base resistance.
10. To study the frequency response of Active Low pass, High pass filter circuits.
11. To study the frequency response of Active Band Pass Filter and Narrow Reject T-Notch filter circuits.

MPL -201: Condensed Matter Physics

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The aim of the course is to familiarize the students with the concepts of lattice vibrations and free electron theory, Band theory, dielectric and ferroelectric properties of materials, and Superconductivity.	**Course Outcomes**: After completion of this course, students will be able to understand the concepts of lattice vibrations and free electron theory, Band theory, dielectric and ferroelectric properties of materials, and Superconductivity.

UNIT – I

Lattice vibrations: Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity, Two atoms per primitive basis- acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons, Phonon heat capacity, Planck distribution, Density of states in 1D and 3D, Dulong and Petit's law, Debye and Einstein theories of Density of states, Debye T^3 law. Anharmonic crystal interaction, Thermal expansion and conductivity, Resistivity of phonon gas, Umklapp processes.

UNIT – II

Free electron theory of metals: Free electron gas models: energy levels and density of orbitals in 1D and 3D, Fermi Dirac distribution, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Matthiessen's rule, Umklapp scattering, Motion in magnetic fields and Hall effect, Wiedemann-Franz's law, Measurement of conductivity (Four probe method), Magneto-resistance.

Energy Band theory: Nearly free electron model, Origin of energy gap**,** Bloch functions,Kronig Penny model, wave equation of electron in a periodic potential, Number of orbitals in a band, Velocity and Effective mass of electron, Distinction between metals, semiconductors and insulators.

UNIT – III

Dielectric Properties of materials: Polarization, Local electric field at an atom, depolarization field, electric susceptibility, polarizability, Clausius-Mossotti relation, electronic polarizability, Normal and anomalous dispersion, Cauchy and Sellmeir relations, Langevin-Debye equation, Complex dielectric constant, optical phenomena

Ferroelectric Properties of materials: Structural phase transitions,ferroelectric crystals and its classification, soft optical phonons, Landau theory of phase transition, First and second order transitions, Anti-ferroelectricity, Curie-Weiss law, Ferroelectric domains, PE hysteresis, Piezoelectric effect, Pyroelectric effect, Electrostrictive effect

UNIT – IV

Superconductivity: Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Superconductors, London's Equation and Penetration Depth, Thermodynamically and optical properties: energy gap, heat capacity and entropy, Isotope effect, BCS theory, BCS ground state, Flux quantization, persistent current, Josephson effect, Macroscopic quantum interference, High TC superconductors; Critical fields and critical currents, Hall number

Reference Books:

1)Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

2) K.V. Keer, Principles of solid state physics, Wiley - Eastern, 1993.

3) Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.

4) Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

5) Introduction to Solid State Physics, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.

MPL 202: Atomic and Molecular Spectroscopy

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: In this course, students will learn important concepts of atomic and molecular physics. IR, Raman and electronic band spectra of diatomic molecules will be studied. In addition to this NMR and ESR techniques will be introduced.	**Course Outcomes:** The expected outcome is that student is familiar with different types of atomic and diatomic models and their spectra. Student will also be familiar with NMR and ESR techniques

UNIT- I

The diatomic molecule as the Vibrating Rotator: Energy levels, IR and Raman spectra; Comparison of observed spectra with the IR and Raman spectra based on vibrating-rotator model, Intensities in Rotational, Vibrational and vibrational-rotational spectra; Symmetry properties of the Rotational levels: Influence of nuclear spin. Isotope effect.
Electronic energy and Total energy: Resolution of the total Eigen function, Resolution of Total energy. Born Oppenheimer approximation,

UNIT- II

Vibrational structural of Electronic transitions: Progression and Sequences; Rotational structure of Electronic bands: Band-head formation, Fortrat parabola; Intensity distribution in the Vibrational structure: The Franck-Condon principle-Absorption and Emission (Condon parabola). Intensity distribution in the Rotational structure

UNIT- III

Classification of Electronic states: Orbital angular momentum, spin. Total angular momentum of electrons, multiplets, electronic energy of a multiplet term, alteration of multiplicities. Symmetry properties of electronic Eigen functions, coupling of rotational and electronic motion: Hund’s coupling, uncoupling phenomena, Symmetry properties of the rotational levels

UNIT- IV

NMR: Basic principles, Classical and quantum mechanical description, Bloch equations, Spin-spin and spin-lattice relaxation times, chemical shift and coupling constant, Experimental methods, single coil and double coil methods, High resolution methods; ESR: Basic principle, ESR spectrometer, nuclear interaction and hyperfine structure, relaxation effects, g-factor, Characteristics, Free radical studies and biological applications.

Reference Books:

Atomic spectra & atomic structure by G. Hertzberg;
Introduction to Atomic spectra by H.E White;
Spectra of diatomic molecules by G. Herzberg.

MPL-203 : Statistical Physics

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The aim and objective of the course on Statistical Mechanics is to equip the M.Sc. (H.S.) student with the techniques of Ensemble theory so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.	**Course Outcomes:** On successful completion of the course, students should be able to: 1. discuss the various classical ensembles and quantum ensembles 2. solve the statistical mechanics problems using ensemble theory 3. explain the connection between classical statistical mechanics and quantum statistical mechanics 4. explain the concept of density matrix

UNIT- I

Statistical Basis of Thermodynamics: Contact between Statistics and Thermodynamics, The Classical ideal gas, Gibbs Paradox and its solution.

Ensemble Theory: The micro canonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations.

UNIT- II

Density matrix Formalism: Density Matrix, statistics of indistinguishable particles, Maxwell-Boltzmann , Fermi-Dirac and Bose-Einstein statistics,properties of ideal Bose-Einstein and Fermi-Dirac gases, Degenerate Free electron gas, Pauli paramagnetism Bose-Einstein condensation, Einstein model of lattice vibration, Debye theory of specific heat laser cooling of atom as an example of Bose Condensate, Planck's radiation formula(Black body Radiation)

UNIT- III

Quantum Statistics of Ideal Systems: Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism.

UNIT- IV

Elements of Phase Transitions and Fluctuations: First- and second-order phase transitions, diamagnetism, paramagnetism, and ferromagnetism, a dynamical model of phase transitions, Ising and Heisenberg models, Thermodynamic fluctuations, random walk and Brownian motion, introduction to nonequilibrium processes, diffusion equation.

Reference Books:

F. Reif	Statistical and Thermal
K.Huang	Statistical Mechanics
R.K.Patharia	Statistical Mechanics
ESR Gopal	Statistical Mechanics

MPL-204: Physics of Lasers

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The main aims of this course are to develop a working knowledge and conceptual understanding of important topics in contemporary laser physics at a quantitative level. A key objective is to enable the student to undertake quantitative problem-solving relating to the design, performance and applications of lasers	**Course Outcomes:** Students who complete the course will learn about the physics of lasers and their applications. This course develops a conceptual understanding of the classical approach to laser physics, and a perspective of areas of applicability.

Unit-I

The Einstein Coefficients, Absorption and Emission cross-sections; Light amplification by an atomic system; Cavity modes: Number of modes in 1D, 2D and 3D cavities; Threshold condition; Origin of Line Shape function: Lorentzian and Gaussian shape functions.

Unit-II

Line Broadening mechanisms - Homogeneous broadening: Natural Broadening, Collision broadening; Inhomogeneous broadening: Doppler Broadening. Laser oscillations and amplification in Homogeneous broadened transition; Laser oscillations and amplification in Inhomogeneous broadened transitions; Saturation behaviour of homogeneously and inhomogeneously broadened transitions; Multimode oscillations; Spatial and Spectral hole burning -Lamb Dip;

Unit-III

Laser Rate Equations: Two Level laser system, Three Level laser system, Four Level Laser Systems (Threshold Population, threshold pump rate, Laser power output with suitable examples), Variation of laser power around threshold; Optimum output coupling.

Gaussian Beams and its properties, Beam waist, Rayleigh parameter; Physical description of lowest order TEM_{00} mode: Amplitude factor, Longitudinal and Radial Phase factors.

Unit-IV

Optical Resonators: Optimization of favourable losses, Resonance frequency; Active and Passive Resonators; Open Resonators; Q-factor of Resonator; Losses in Resonators: Diffraction losses; Main Parameter of Resonators (with two mirrors); Stability Criteria.

Pumping Processes: Optical Pumping; Conversion efficiency, Electrical pumping;
Physical description, Energy Levels, Excitation mechanism and applications of Nd:YAG laser, CO_2 laser and Dye laser.

Text and Reference Books:

Laser Electronics, J.T. Verdeyen, Prentice Hall (1995)
Lasers & Electro-Optics: Fundamental & Engineering C.C. Davis, Cambridge (1996)
Lasers Fundamentals, W.T. Silfvast, Cambridge (1996)
Principles of Lasers, O. Svelto, Plenum (1989)
Laser Physics, L.V. Tarasov, Mir (1983)
Quantum Electronics, A.Yavir, John Wiley (1992)
Laser: Theory & Applications, A. Ghatak & K. Tayagrajan, Macmillan India
Introduction to Laser Physics, K. Shimoda, Springer (1986)
Lasers & non-Linear Optics, B.B.Laud

MPP-201: PHYSICS LAB –III

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. To Study the characteristics of Solar Cell.
2. Study of Franck-Hertz experiment.
3. Study of energy band gap and diffusion potential of P-N junction.
4. Study of Faraday effect
5. Study of Zeeman effect
6. Determination of dielectric constant and curie temperature of a material
7. Linear and mass attenuation coefficients for the 662 keV gamma for Al, Cu and Pb materials
8. Linear and mass attenuation coefficients for the beta particles of Sr^{90} source for Al, Cu and Pb materials
9. Study of Energy Resolution of scintillation Detector as a function of $E\gamma$
10. Measurement of alpha spectra of alpha radioactive sample using a semiconductor detector and vacuum chamber
11. Study of detection efficiency of scintillation Detector as a function of $E\gamma$ using different sources.

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MPP-202: PHYSICS LAB –IV

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Analysis of operation of Counter Converter.
2. Testing the working of a Monolithic converter.
3. Study of R-S, J-K, D- and T- Type Flip Flop.
4. Study of IC555 as an astable and monostable multivibrator.
5. i) Functional verification and recording of transfer characteristics of weighted resistor D/A converter

   ii) Functional verification of D/A converter with Ladder network and recording of transfer characteristic of Ladder Network D/A converter.
   iii) Functional verification of an integrated D/A converter.
6. Determination and verification of input frequency by Wein Bridge using DPM.
7. Study of Wein Bridge Oscillator and visualize effect on output frequency with variation in RC combination.
8. Determination of power distribution within the laser beam and its spot size.
9. To measure the divergence of laser beam.
10. Distance measurement by triangularisation method using laser.

MPL 301: Nuclear Physics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The objective of the course on Nuclear Physics is to familiarize the students to the basic aspects of Nuclear Physics like wave mechanical properties of nuclei, electric and magnetic moments, nuclear shapes, nuclear forces, basic properties of neutrons detection, Nuclear reactions, types of reactions and conservation laws.	**Course Outcomes:** After taking the course, students should be able to explain central concepts, laws and models in nuclear physics, interpret basic experiments & can use basic laws and relations to solve related problems

UNIT-I

Nuclear Models: Survey of basic nuclear properties, Liquid drop model, Semi classical mass formula, Mass parabola and valley of stability, Experiment evidence for shell effect, Magic numbers, Shell model, Spin-orbit coupling, Angular momenta and parity of nuclear ground states, Magnetic moments and Schmidt lines, Nuclear Quadrupole moments, Quadrupole moments of deformed nuclei, Rotational and vibration excitation of deformed nuclei.

UNIT-II

Nuclear Decays: Beta decay, Fermi theory of beta decay, Angular momentum and parity selection rules, Shape of the beta spectrum, Total decay rate, Kurie plots, Comparative half-life, Classification of beta transitions, Selection rules for allowed and forbidden transitions,Detection and properties of neutrino, Gamma decay:Electric and magnetic multipole gamma transitions, Angular momentum and parity selection rules, Reduced transition rates (Weisskopf formula), Alpha decay: Giger-Nuttan law and tunnelling theory,Selection rules for alpha decay, Internal conversion, Nuclear isomerism, Interaction of charged particle with matter (qualitative idea).

UNIT-III

Nuclear Interaction: Two Nucleon Problem: Deuteron system, Exchange forces, Meson theory of nuclear forces, Nucleon-nucleon scattering, Effective range theory, Spin dependence and charge independence of nuclear forces.

Nuclear Reaction: Kinematics of nuclear reactions in lab and Centre of mass reference frames, Q value calculation, Concept of Cross section, Type of nuclear reactions, Direct and compound nuclear reactions, Inelastic scattering and transfer reactions, Resonances (Isobaric Analogue, Giant and Molecular), Break-up reactions.

UNIT-IV

Heavy ion reactions: Special features of heavy ions scattering (Q-and L-window), Rainbow and Glory scattering, Quasi elastic and transfer reactions, Complete and incomplete fusion, Fission: Spontaneous fission mass distributions and elementary model, Derivation of spontaneous fission condition for deformed nuclei, Search for Super Heavy Nuclei (qualitative).

Nucleosynthesis in Big-Bang (qualitative idea) and in stars ("r" and "s'' process), EMC effect (Qualitative), Experimental observations of short range correlations (SRC) between nucleons, Halo Nuclei (qualitative).

Text and Reference Books:

1. Physics of Atomic Nuclei, Vladimir Zelevinsky, Wiley-VCH, 2017
1. The Atomic Nucleus, J.M. Reid, Penguin Books, 1972
2. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988
3. R.R.Roy and B.P.Nigam, Nuclear Physics, Wiley-Eastern Ltd., 1983
4. Nuclear Physics, S. B. Patel, New Age publication
5. Basic Ideas and Concepts in Nuclear Physics: K. Heyde, (Overseas Press India) (2005).
6. Nuclear Physics: Experimental and Theoretical: H. S. Hans, (New Academic Science Ltd., Second Revised edition) (2010).

MPL-302: Electrodynamics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The main objective of this course is to understand of theoretical fundamentals of Electrodynamics and physics of plasma i.e. electromagnetic fields the one side and the interaction of charges and currents with field on other side. This includes solutions of the free wave equations, solutions with stationary sources and solutions to the equations with time dependent charge and current distributions. This also emphasis on the study of the radiation phenomena and basic concepts of plasma.	**Course Outcomes:** The intention of this part of the lectures is to analyze the fundamentals of electrodynamics on the basis of Maxwell's equations. The idea is to examine solutions of Maxwell's equations under different types of conditions. Ability to analyze electromagnetic problems and to apply mathematical methods for solving.

UNIT-I

Electromagnetic waves in a homogeneous medium-solution for free space conditions; Uniform plane waves; Wave equations for a conducting medium; Wave propagation in a loss less medium; Wave propagation in a conducting medium; Wave propagation in a good dielectric; Lorentz Invariance in Maxwell's Equations; Transformation of electromagnetic fields.

UNIT-II

Polarization: Linear, elliptical and circular Polarization; Direction cosines; Reflection and refraction of electromagnetic plane waves: Reflection by a perfect conductor – normal and oblique incidence; Reflection by a perfect dielectric – normal and oblique incidence; Power loss in a plane conductor; Polarization by reflection.

Scattering and Dispersion; Thomson Scattering, Rayleigh scattering, Coherent and Incoherent Scattered Light, Polarization of Scattered Light, Dispersion in Solids, Liquids and gases.

UNIT-III

Lienard– Wiechert Potentials and field for a point charge, Field of a charge in arbitrary motion and uniform motion; Power radiated by an accelerated charge: Larmor Formula and its relativistic generalization, Angular Distribution of Radiation emitted by an accelerated charge; Radiation emitted by charge in arbitrary motion; Bremsstrahlung, Synchrotron Radiation and Cerenkov radiation, Reaction Force of Radiation.

UNIT-IV

Elementary Concepts: Plasma Oscillations, Debye Shielding, Plasma Parameters, Magneto plasma; Plasma confinement. Waves Guides; Modes in rectangular waveguides and Dielectric Slab Wave guide; Energy flow and attenuation in waveguides; Concept of Cut off frequency; Resonant cavities; Power losses in a cavity.

Reference Books:

1. Classical Electrodynamics: J.D. Jackson, (Wiley Eastern, New Delhi) (1998).

2. Introduction to Electrodynamics: D.J. Griffiths, (Prentice Hall India, New Delhi) (2008).

3. Classical Electrodynamics: S.P. Puri, (Tata McGraw Hill, New Delhi) (2nd edition) 1997,

4. Plasma Physics: Bittencourt
5. Plasma Physics:Chen

MPL-303: Computational Physics

Marks (Theory) : 70 **Credits : 4 (60 lectures)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The present course is focused on efficient use of computer languages for solving physics problems/ Formulae using different numerical methods in FORTRAN.	**Course Outcomes:** After completion of this course, students will be able to understand the various numerical methods used in simulation and modelling in Physics. The students are also able to match the experimental results in physics with theory using these numerical tools.

UNIT- I

Interpolation and Extrapolation: Finite differences, Newton Forward and Backward formulas, Central differences, Stirling's formula, Lagrange's interpolation formula, Hermite's interpolation formula. Least square curve fitting: The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions, Data fitting with cubic splines.

Solutions of simultaneous linear algebraic equations: Gauss elimination method, Gauss Jordan elimination method, Matrix inversion method, Gauss Seidel iterative method, Matrix eigenvalues and eigenvectors: Polynomial method, Power method.

UNIT - II

Differentiation and Integration: Taylor series method, Newton's forward and backward difference formula, Stirling's formula, Trapezoidal rule, Simpson's 1/3 rule, Gaussian Quadrature, Legendre–Gauss Quadrature, Numerical double integration.

Numerical solution of differential equations: Taylor's series method, Euler and modified Euler's method, second and Forth-order Runge Kutta method, Numerical Solutions of Partial Differential Equations using Finite Difference Method.

UNIT- III

Random numbers: Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, Modeling radioactive decay. Hit and miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals; Chaotic dynamics: Some definitions, The simple pendulum, Potential energy of a dynamical system. Portraits in phase space: Undamped motion, Damped motion, Driven and damped oscillator.

UNIT– IV

Simulation of physics problems: Algorithms to simulate interference and diffraction of light, Simulation of black body radiation problem, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H_2 ion. Simulation of spectral series in hydrogen atom. Particle in one dimensional box. Simulation of Radial Schrodinger equation for Hydrogen atom.

Reference Books:

1. Fortran 77 and Numerical Methods. C. Xavier New Age International 1994.
2. R C Desai, Fortran Programming and Numerical methods, Tata McGraw Hill, New Delhi.
3. Suresh Chandra, Computer Applications in Physics, Narosa Publishing House.
4. William H. Press, Saul A Teukolsky, William T Vellerling and Brain P. Flannery, Numerical Recipes in Fortran, Cambridge University Press.
5. M L De Jong, Introduction to Computation Physics, Addison-Wesley publishing company.
6. R C Verma, P K Ahluwalia and K C Sharma, Computational Physics an Introduction, New Age International Publisher.
7. S SSastry Introductory methods of numerical Analysis, Prentice Hall of India Pvt. Ltd.
8. V Rajaraman, Computer Oriented Numerical Method, Prentice Hall of India Pvt. Ltd.
9. C Balachandra Rao and C K Santha, Numerical Methods, University Press
10. K E Atkinson, An introduction to numerical analysis, John Wiley and Sons.

MPL 304 (i): Materials Science-I

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: This course has been formulated to introduce students to various types of defects and dislocations in crystals. The students shall be able to analyse optical properties and optical processes thus involved. They should also be able to analyse various types of disordered systems and different types of solid surfaces.	**Course Outcomes:** After completing this course, students would be able to deal with various types of defects found in crystals; their optical properties; disordered systems and analysis of solid surfaces

UNIT – I

Defects in crystals : Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects; Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank-Read sources; Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in fcc, hcp and bcc lattice.

UNIT – II

Optical properties of crystals: Dielectric function of the free electron gas, Plasma optics, Dispersion relation for Electromagnetic wave, Transverse optical modes in plasma, Longitudinal plasma oscillations, Plasmons, Screened Coulomb potential, Pseudopotential component, Mott metal-insulator transition, screening and phonons in metals, Polaritons, electron-electron interaction, fermi liquid, electron-phonon interaction; polarons. Optical Processes: Optical reflectance, Kramers-Kronig Relations, Electronic Interband transitions, Excitons, Frenkel excitons, Mott-Wannier excitons, Excitons condensation into electron-hole drops, Electron spectroscopy with X-rays, Energy loss of fast particles in a solid.

UNIT – III

Disordered systems: Disorder in condensed matter -substitutional, positional and topographical disorder; Short- and long-range order; Atomic correlation function and structural descriptions of glasses and liquids; Anderson model; mobility edge; Minimum Metallic Conductivity, Qualitative application of the idea to amorphous semiconductors and hopping conduction. Various types of glasses and their applications. Glass ceramics.

UNIT-IV

Solid Surfaces and Analysis: Surface and its importance, selvedge depths of surface; Methods of Surface Analysis: Auger Electron spectroscopy (AES)- basic principle, methodology, composition analysis and depth profiling; X-ray photoelectron spectroscopy (XPS) or ESCA: principle, methodology and quantitative analysis; Glancing angle X-ray Diffraction (GXRD), basic concept, methodology and structural analysis; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM): Principle, methodology and Applications in surface analysis; Atomic Force Microscopy (AFM): Basic principle, Methodology, applications in structural analysis.

Reference Books:

1) Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings'
2) Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
3) Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
4) Solid State Physics, Mermin and Aschcrofft.
5) Fundamentals of Surface and Thin Film Analysis, L.C. Feldman and J. W. Mayer
6) Surface Analysis Methods in Material Science, D. J. O'Connor, B. A. Sexton and R. St. C. Smart (Eds), Springer Series in Surface Sciences 23

MPL 304 (ii): Photonics-I (Fibre Optics and Communication)

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The course on Fiber Optics and optical communication deals with Semiconductor Physics as it acts as the optical source in Optical communication. To make understand the idea of various types of Detectors and noise associated with detectors for improving signal to noise ratio. Optical Fiber as transmission medium, dispersion in waveguides, Attenuation are the key features of the contents	**Course Outcomes:** After introducing the idea of Light propagation through Optical waveguide, Optical sources and detectors, the student will be able to understand the concept of design of Optical communication system considering the time budget and power budget. Understanding the concept of fiber laser is important to the requirement beyond conventional lasers.

UNIT-I

Optical Sources & Detectors: General description, Laser structure, Excitation Mechanism of the Semiconductor Laser Diode and light emitting Diode, Radiative recombination in semiconductor materials, Semiconductor density of states, Occupation probability, Optical absorption and Gain, Heterostructure laser, Quantum well lasers, Modulation rates in semiconductor lasers.

Noise in Optical detectors: S/N ratio for optical power and signal currents, Background radiation, Johnson (Thermal noise), Dark current shot noise, 1/f noise, Combined effect of all the noise sources.

UNIT-II

Transmission Medium-Fiber Optics: Principle of fiber optics: Ray optics and wave propagation in infinite slab waveguide, Electromagnetic analysis of the planer waveguide, The longitudinal wavevector, Fiber types: step index and graded index fiber structures, Wave Equations for Step index Fiber, Optical modes and their properties, Number of guided modes in a waveguide, Mode field diameter, Numerical Aperture and propagation modes.

UNIT-III

Dispersion in waveguides: Material dispersion, Modal Dispersion, and waveguide Dispersion and their simultaneous effects. The ray picture of Propagation in a graded Index material: The Eikonal equation, dispersion reduction with a graded index profile and the modal picture.WKB approximation of graded index fiber, Wave equations for Step index circular waveguides, Spatial Modes in Step-index waveguides: TE/TM modes, Hybrid modes and Linearly Polarized modes, Power flow in Step-index fibers.

UNIT-IV

Attenuation and Nonlinear Effects in Waveguides:

Optical fiber Attenuation as a function of wavelength, Intrinsic absorption losses, Mechanical losses, Nonlinear effects in dielectrics, Stimulated Raman Scattering, Stimulated Brillouin scattering, Self-Phase modulation and Optical Solitons. The Optical-Fiber laser. Source to fiber power launching: Source outputs pattern, Power coupling calculation, Equilibrium NA, Lansing scheme for coupling improvement: Non-imaging microsphere. Design issues in a fiber optics communication Link:Power budget, Time budget, Optical repeaters and amplifiers.

Reference Books:

1. Fundamental of Opto-electronics by C.R.Pollock, Irwin (1995)
2. Essentials of Optoelectronics, Alan Rogers,(Chapman & Hall), 1997
3. Optical Fiber Communication by G.Keiser, 2nded.McGRaw Hill
4. Optical communication, M. MukundaRao,Universities Press (2000)
5. Optical Communication, Components & Systems, J.H. Franz &V.k. jain, Narosa (2001)
6. Optical Communication System, W.K.Pratt. (1968)

MPL 304 (iii): Advanced Nuclear Physics-I (Nuclear Models)

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Objectives: The aim and objectives of the course on Nuclear Physics-II is to expose the students of M.Sc. class to the relatively advanced topics in nuclear models so that they understand the details of the underlying aspects and it can prepare them to use all these techniques if they decide to become nuclear physicists in their career.	**Course Outcomes:** After taking the course, students should be able to understand the concepts, laws and frameworks of nuclear structure models.

UNIT-I

Nuclear Shell Model: Coupling of angular momentum, Evidence for nuclear shell structure, Extreme single particle model with square-well and harmonic oscillator potentials, spin-orbit potential, Shell model predictions.
Single-particle model, total spin for various configurations, Nuclear isomerism, Magnetic moment Schmidt lines, electric quadrupole moment, Configuration mixing, Independent particle model, L-S coupling and j-j coupling schemes.

UNIT-II

Collective Model of Nucleus: Rotation - D Matrices, Parameterization of nuclear surface, Collective surface oscillations, Derivation of the collective Hamiltonian, transformation to body-fixed frame, Collective modes of motion, Nuclear vibrations, β and γ vibrations in spheroidal nucleus and associated energy spectra, Iso-scalar vibrations, Giant resonances.
Brief overview supported by examples - Deformed rotational nuclei, rotational energy spectra for even-even nuclei and odd-A nuclei, decoupling parameter, Electric quadrupole moment and magnetic dipole moment, E2 and M1 transition probabilities, Energy spectrum with coupling of vibration and rotational motion.

UNIT-III

Cluster model and IBM: Experimental and theoretical signature of cluster structure in nuclei, Alpha and He-6 cluster model of nuclei, Pairing of nucleons, Evolution of Interactive Boson model (IBM-I, IBM-II etc.), Detail calculations for one of mid-shell nucleus.
Brief Reviews: EMC effect in nuclei, Observation of short ranged correlations between nucleons.

UNIT-IV

Harmonic anisotropic oscillator, Nilsson model, Rotational motion at very high spins, Population of high spin states, cranking shell model, Signature quantum number, Back bending phenomenon, Kinematics and dynamic moment of inertia,
Brief reviews - Nuclear Physics at extremes of stability, nuclear halos, Proton rich nuclei.

Reference Books:

1. Physics of Atomic Nuclei, Vladimir Zelevinsky, Wiley-VCH, (2017)
2. Nuclear Physics: R.R. Roy and B.P. Nigam, (New Age, New Delhi) (2009).
3. Theory of Nuclear Structure: M. K. Pal, (East-west Press, New Delhi) (1992).
4. Nuclear Structure, Bohr & Mottelson, Volume-1&2, World Scientific (1998)

MPL 304 (iv): Theoretical Condensed Matter Physics-I

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: The aim of the course is to familiarize the students with the defects in crystals, semiconductor crystals, Fermi surfaces, optical properties and processes, and about disorder systems in crystals.	***Course Outcomes:*** After completion of this course, students will be able to understand the various types of defects in crystals, about Fermi surfaces, optical properties and processes, and about disorder systems in crystals. These topics are very helpful for the students for future research in condensed matter physics.

UNIT – I

Defects in crystals : Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects**;** Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank-Read sources; Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in fcc, hcp and bcc lattice.

UNIT – II

Semiconductor crystals: Band gap, Direct and indirect absorption processes, Motion of electrons in an energy band, Holes, Effective mass, Physical interpretation of effective mass, Effective masses in semiconductors, Intrinsic carrier concentration, Intrinsic mobility, Impurity conductivity, Thermoelectric effect, Semimetals, Superlattices.

Fermi surfaces and metals: Fermi surface and its construction for square lattice (free electrons and nearly free electrons), Electron orbits, Hole orbits, Open orbits; Wigner-Seitz method for energy bands, Cohesive energy; Experimental determination of Fermi surface: Quantization of orbits in a magnetic field, De Hass-van Alphen effect.

UNIT – III

Optical properties of crystals: Dielectric function of the free electron gas, Plasma optics, Dispersion relation for Electromagnetic wave, Transverse optical modes in plasma, Longitudinal plasma oscillations, Plasmons, Screened Coulomb potential, Pseudopotential component, Mott metal-insulator transition, screening and phonons in metals, Polaritons, electron-electron interaction, fermi liquid, electron-phonon interaction; polarons.

Optical Processes: Optical reflectance, Kramers-Kronig Relations, Electronic Interband transitions, Excitons, Frenkelexcitons, Mott-Wannierexcitons, Excitons condensation into electron-hole drops, Electron spectroscopy with X-rays, Energy loss of fast particles in a solid.

UNIT – IV

Disordered systems: Disorder in condensed matter -substitutional, positional and topographical disorder; Short- and long-range order; Atomic correlation function and structural descriptions of glasses and liquids; Anderson model; mobility edge; Minimum Metallic Conductivity, Qualitative application of the idea to amorphous semiconductors and hopping conduction. Various types of glasses and their applications. Glass ceramics.

Reference Books:

1) Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings'

2) Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

3) Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth

4) Solid State Physics, Mermin and Aschcrofft.

5) Principles of the Theory of Solids (2nd edition) by J. M. Ziman(Cambridge University Press) 1972.

6) Physics of amorphous materials, Longman Group Ltd, London, New york, 1984

MPP-301: Computational Physics Lab

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least TEN experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Numerical integration using (a) Simpson 1/3 and (b) Gauss quadrature methods for one and two dimensional integrals.
2. Least square fitting (Linear).
3. To find eigen values and eigen vectors of a square matrix using power method.
4. Solution of second order differential equation using Runge –Kutta method.
   Application: Eigen values and eigenfunctions of a linear harmonic oscillator using Runge – Kutta method.
5. Solution of simultaneous linear algebraic equations by Gauss Jordan elimination method.
   Application: Illustration of Kirchoff's laws for simple electric circuits.
6. Interpolation and Extrapolation by using Lagrangian method and Newton Forward Interpolation formula.
7. To find the area of a circle by Monte – Carlo technique.
8. Simulation of nuclear radioactivity by Monte- Carlo technique.
9. Simulation of Brownian motion using Monte- Carlo technique.
10. To solve simultaneous linear equations using Gauss –Elimination method.
11. Study of frequency response curve for LCR Circuits.
12. Dynamics of damped driven pendulum.

MPP-302: PROJECT (PART-I, MINOR)

Marks (Internal evaluation**): 70** **Credits: 4**

Marks (Internal Assessment): 30

In minor project, the students are required to carry out literature review/research work under the guidance of assigned supervisor by the department. At the end of the semester, a 10-15 pages' project report (Part-I, Minor, MPP 302) will be submitted and the same will be evaluated internally through presentation in front of the committee of 3-4 Teachers (including at least one Professor, constituted by the chairperson). Internal evaluation of 100 marks will comprise of 70:30, where 70 marks will be awarded by the committee and 30 marks by the concerned supervisor.

MPP-400: Project (Part-II,Major)

Marks: 500 **Credits : 20**

The candidate shall be required to submit statement of purpose (SOP) after minor project (Part-I, Semester- IX) if he/she wish to undertake major project (MPP 400) in final semester (Part-II, Semester- X) along with the consent from one of the regular faculty member of the department for supervision (The faculty can give consent to one student only). The SOP will be evaluated by four member's committee chaired by Chairperson along with supervisor as one of the member.

A student opting for major project (MPP 400) is required to undertake 16-20 weeks' (one semester) project in semester X. He/she is supposed to submit acceptance-cum-recommendation letter from a Faculty from a National level institution /'A' grade University including GJUS&T by the end of IXth semester.

The evaluation of major project report & presentation out of 500 marks will be done as follows:

1. *150 marks by the concerned supervisor based on overall internal assessment.*
2. *200 marks through presentation of major project before four member's committee chaired by Chairperson (Each member to award out of 50 marks)*
3. *150 marks by inviting the external examiner in the relevant area.*

The external examiner may be asked to evaluate up to the maximum of 10 students in the relevant area.

MPL-401: Advance Quantum Mechanics

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: Objective of the current course is to familiarize the students in relativistic quantum mechanics and introductory quantum field theory, finally leading to them to the basics of particle physics.	**Course Outcome:** Students should be able to understand the basic formalism of relativistic quantum mechanics, field theory and introductory particle physics.

UNIT-I

Relativistic Quantum Mechanics: Klein-Gordon equation, Dirac equation and itsplane wave solutions, Properties off Dirac matrices, Significance of negative energy solutions, Spin angular momentum of the Dirac particle, The nonrelativistic limit of Dirac equation, Electron in electromagnetic fields, Spin and magnetic moment of electrons, spin-orbit interaction, Dirac equation for a particle in a central field, Fine structure of hydrogen atom, Lamb shift.

UNIT-II

Quantum Field Theory: Resume of Lagrangian and Hamiltonian formalism of a classical field, Noether theorem, Quantization of real scalar field, complex scalar field, Dirac field and e.m. field and their representations, Covariant perturbation theory of QFT, Wick's Theorem.

UNIT-III

S-matrix formulation, Path Integral formulation of field theory, Feynman rules, Feynman diagrams and their applications, Calculation of scattering cross sections, decay rates, with examples, Quantum Electrodynamics, Calculation of matrix elements - for first order andsecond order processes.

UNIT-IV

Fermions and bosons, particles and antiparticles, quarks and leptons, Interactions and fields in particle physics, Charge conjugation, Charge, parity and Time reversal invariance, CPT theorem, Cross section and decay rates for hadron-hadron interaction, Pion spin, Isospin, Particle production at high energy.

The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combinations, Standard Model, Weak Interactions: Classification of weak interactions, Parity non-conservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K-decay, Relativistic kinematics.

Reference Books:

1. A first book of Quantum Field Theory, A. Lahiri&P. Pal, (Narosa Publishers, Delhi), 2005.
2. Lectures on Quantum Field Theory, A. Das (World Scientific), 2008.
3. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, (Tata McGraw Hill, New Delhi), 2004.
4. Quantum Mechanics: M.P. Khanna, (HarAnand, New Delhi), 2006.
5. Quantum Field Theory: H. Mandl and G. Shaw, (Wiley, New York) 2010.
6. Advanced Quantum Mechanics: J.J. Sakurai (Addison-Wesley, Reading), 2004.

MPL 402 (i): Materials Science-II

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: To make students aware of different types of materials in their bulk and thin film forms and their properties	**Course Outcomes:** Students will become aware of various thin film deposition and characterization techniques, Properties of dielectric and ceramic materials in advance applications.

UNIT-I

Mechanical Properties: Stress Strain Curve; Elastic Deformation: atomic mechanism of elastic deformation andanisotropy of Young's modulus, elastic deformation of an isotropic material; Anelastic and Viscous deformation;Plastic Deformation: Schmid's law, critically resolved shear stress; Strengthening Mechanisms: work hardening,recovery, recrystallization, strengthening from grain boundaries, low angle grain boundaries. yield point. Strain aging, solid solution strengthening, two phase aggregates, strengthening from fine particles; Fracture: ideal fracture stress, brittle fracture-Griffith's theory, ductile fracture.

UNIT-II

Technological Materials: SMART materials - piezoelectric, magnetostrictive, electrostrictive materials - shape memory alloys - rheological fluids - CCD device materials and applications - solar cell materials (single crystalline, amorphous and thin films) - surface acoustic wave and sonar transducer materials and applications.

UNIT-III

Thin Films Deposition and Characterization Techniques: Thin film deposition techniques: Physical methods: thermal evaporation electron beam deposition, sputtering, molecular beam epitaxy – MBE, laser ablation. Chemical methods: chemical vapour deposition and chemical solution deposition techniques - spray pyrolysis and electro deposition. Thickness measurement -Multiple beam interference, quartz crystal, ellipsometric, stylus, Structural, Optical and electrical characterization

UNIT-IV

Crystals Growth and Characterization: Bridgman technique:Czochralski methods - Verneuil technique - zone melting – gel growth – solution growth methods – low and high temperature solution growth methods – vapour growth - epitaxial growth techniques.

Characterization: X-ray diffraction - electron microscopy, Raman spectroscopy

Liquid Crystals: Thermotropic liquid crystals, Lyotropic liquid crystals, long range, various phases of liquid crystals, Effect of electric and magnetic field, Applications and prospects of liquid crystals.

Reference Books:

1. Mechanical Metallurgy by G. E. Dieter
2. Buckley, H.E., Crystal growth, John Wiely and sons, New York,1981.
3. Elwell,D&Scheel, H.J., Crystal growth from high temperature solution, Academic Press, New York,1995.
4. Laudise, R.A. The growth of single crystals, Prentice Hall, Englewood,1970.
5. Ramasamy, P. &Santhanaraghavan. P. Crystal growth processes and methods, KRU Publications, 2000.
6. Milton Ohring, The Materials Science of Thin Films, Academic Press, 2001.
7. Donald L. Smith, Thin-Film Deposition: Principles and Practice, McGraw- Hill, 1995.
8. K.L. Chopra, Thin Film Phenomena, McGraw-Hill, 1969.

MPL 402 (ii): Photonics – II (Nonlinear Optics)

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The main aims of this course are to develop a conceptual understanding of important topics in nonlinear optics at a quantitative level. A key objective is to enable the student to undertake quantitative problem –solving aptitude relating to the design and performance of nonlinear parameters thereby acquiring an ability to put such knowledge into practice by way of numerical calculations.	**Course Outcomes:** Students who complete the course will learn about the non linear optical processes and their applications. This course develops a conceptual understanding of the Maxwell wave approach to non-linear optical interactions. Theoretical basis using coupled mode amplitude equations with the coupling of two or three waves provide understanding of the coupling processes of different waves and their-in energy exchange process.

Unit -1

Introduction to Non-linear Optics: Change in optical properties and generation of new Harmonics; Classical expansion in powers of the field induced polarization (Brief idea), Linear susceptibility; Introduction to second order and third order Non-linear optical processes; Definition of Non-linear susceptibility, Description using classical anharmonic oscillator on parabolic potential well: Centrosymmetric and non-centrosymmetric cases; Miller's Rule, Symmetry properties of Non-linear susceptibilities: Fields, Permutation and Kleinman symmetry aspects, Contracted Notation, Effective Value of d (d_{eff}).

Unit-II

Crystal symmetry and influence on spatial symmetry on second order susceptibility, idea of crystals classes and effects on symmetry and birefringence.

Wave equation for non-linear optical media; Coupled Wave Equations for Sum Frequency generation(using slowly varying amplitude approximation), phase matching conditions, wave vector mismatch, Temperature and Angle tunings for phase matching, Type I and Type II phase-matching;Manley Rowe relations.

Unit-III

Optical Mixing: Coupled wave equations for Second Harmonic Generation and for three wave interactions, Uniaxial crystals and Index Ellipsoid. Difference Frequency Generation and Parametric Amplification, Optical Parametric Oscillators. Four Wave Mixing, Optical phase conjugation, Optical Bistability: Idea of Absorptive and Refractive bistability.

Unit-IV

Self-Action effects: Intensity dependent refractive index, Idea of Self focusing of light, Self-trapping of light and Beam break up.

Electro-optic effect: Pocked and Kerr effects; Pocked effect in KDP crystal, Longitudinal and transverse configurations; Electro-optic modulator, Acousto-optic effect; Acousto-optic modulator, Design of Q switched laser; Methods of Q switching, Theory of mode locking, Methods of mode locking.

Text and Reference Books:

1. Laser Electronics, J.T. Verdeyen, Prentice Hall (1995)
2. Lasers & Electro-Optics: Fundamental & Engineering C.C.Davis, Cambridge (1996)
3. Lasers Fundamentals by W.T. Silfvast, Cambridge (1996)
4. Principles of Lasers, O. Svelto, Plenum (1989)
5. Nonlinear Opticsby R.W. Boyd, (2008)
6. Laser Physics, L.V.Tarasov, Mir (1983)
7. Quantum Electronics, A Yavir, John Wiley (1992)
8. Laser: Theory & applications, A. Ghatak&Tayagrajan, Macmillan India

MPL 402 (iii): Advanced Nuclear Physics-II (Nuclear Reactions)

Marks (Theory): 70 **Credits: 4 (60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The objective of the course on Nuclear Physics is to familiarize the students to the basic aspects of Nuclear reactions, type of reaction, compound and direct reactions, heavy ion reactions, and various reaction models.	**Course Outcomes:** After taking the course, students should be able to explain central concepts, laws and models in nuclear reactions, interpret basic experiments & can use basic laws and relations to understand and predict the outcome of a nuclear reaction.

UNIT-I

Type of nuclear reactions, Centre of mass coordinate system, Energy and mass balance, Cross-sections, Coulomb Scattering: Rutherford formula, Quantum and relativistic effects (qualitative), Electron Scattering, Polarization of target and projectiles, Scattering of identical particles, Partial wave analysis of scattering, Significance of partial waves, scattering matrix and phase shift, scattering amplitude, Total cross section and optical theorem, Penetration and reflection by coulomb barrier, Collisions including spin effects.

UNIT-II

R-matrix and boundary matching theories, Classical and Semi classical description of scattering, (Deflection function, orbits, Rainbow and glories effects), Diffraction and effect of strong absorption (Fraunhofer and Fresnel diffraction approximations), Breit-Wigner Dispersion Formula for Nuclear resonances, Compound Nucleus, Cross-section for formation of compound nucleus, Statistical theory of nuclear reactions, Reaction between heavy ions, Complete and incomplete fusion, Evaporation model of compound nucleus decay.

UNIT-III

Optical model: Optical model for nuclear reactions at low energies, Imaginary potential and absorption, Comparison with experiment results, Limitations of Optical Model.
Direct Reactions: Semi classical model of direct reaction using distorted wave born approximation, Inelastic scattering, Stripping and pickup reaction, Knock-out reactions

UNIT-IV

Nuclear Astrophysics: Fusion in stars, Production of energy and elements in stars, “r’ and “s” process, Fusion reactor (qualitative description)
Nuclear Fission: Types of fission, Fission energy and mass distributions, Fission cross section, Mass and energy distribution of fragments, Spontaneous fission.
Brief reviews - Radioactive ion beams, Production of super heavy nuclei

Reference Books:

1. Introduction to Nuclear Reactions, G.R. Satchler, 2nd edition, Macmillan Education Ltd.
2. Nuclear Physics: Experimental and Theoretical: H. S. Hans, (New Academic ScienceLtd., Second Revised edition) (2010).
3. Nuclear reactions, Paetz gen. Schieck, Hans, Springer Publication (2014)

MPL 402 (iv): Theoretical Condensed Matter Physics-II

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The main objective of this course is to understand theoretical concept of magnetic resonance, surface and interface physics, independent electron approximation and nanostructures and electron transport in condensed matter.	**Course Outcomes:** After going through the contents of course, the students will develop the research endeavour in theoretical condensed matter physics and will also learn the analytical approach for handling the problems.

Unit - I

Magnetic Resonance: Magnetic Resonance, Nuclear Magnetic Resonance, Line Width, Motional Narrowing, Hyperfine Splitting, Nuclear Quadrupole Resonance, Ferromagnetic Resonance, Shape Effects in FMR, Antiferromagnetic Resonance, Electron Paramagnetic Resonance, Principal of Maser Action

Unit - II

Surface and Interface Physics: Reconstruction and Relaxation, Surface Crystallography, Surface Electronic Structure, Thermionic Emission, Surface States, Tangential Surface Transport, Magnetoresistance in a Two- Dimensional Channel, Integral Quantized Hall Effect, IQHE in a Real Systems, Fractional Quantized Hall Effects (FQHE), p-n Junctions, Rectification, Solar Cell and Photovoltaic Detectors, Schottky Barrier, Heterostructures, n-N Heterojunction, Semiconductor Lasers, Light- Emitting Diodes, Scanning Tunnelling Microscopy

Unit-III

Beyond the independent electron approximation: The basic Hamiltonian in a solid: Electronic and ionic parts, Born-Oppenheimer Approximation; The Hartree equations, Connection with variational principle; Exchange: The Hartree-Fock approximation, Hartree-Fock theory of free electrons- One electron energy, Band width, DOS, Effective mass, Ground state energy, exchange energy, correlation energy (only concept); Screening in a free electron gas: The Dielectric function, Thomas-Fermi theory of screening, Calculation of Lindhard response function, Lindhard theory of screening, Friedel oscillations, Frequency dependent Lindhard screening (no derivation).

Unit- IV

Nanostructures and Electron Transport: Nanostructures; Imaging techniques (principle): Electron microscopy (TEM, SEM), Optical microscopy, Scanning tunneling microscopy, Atomic force microscopy; Electronic structure of 1D systems: 1D sub-bands, Van Hove singularities; 1D metals-Coulomb interactions and lattice couplings; Electrical transport in 1D: Conductance quantization and the Landauer formula, Two barriers I n series- Resonant tunneling, Incoherent addition and Ohm's law, Coherence-Localization; Electronic structure of 0D systems (Quantum dots): Quantized energy levels, Semiconductor and metallic dots, Optical spectra, Discrete charge states and charging energy; Electrical transport in 0D- Coulomb blockade phenomenon

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
3. Solid State Physics, Neil W. Ashcroft and N. David Mermin
4. Electronic Structure of Materials by Rajendra Prasad
5. The Wave Mechanics of Electrons in Metals by Stanley Raimes

MPL 403 (i): Physics of Nano Materials

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The course gives an overview of Nanoscience & Technology including basics of sensors, quantum dots, Lithography. Fabrication and characterization of nanomaterials is the important component.	**Course Outcomes:** The course is made to understand the need of nanotechnology. Various fabrication and characterization techniques for nanomaterials will help the students for seeking jobs in future industry.

UNIT-I

Introduction: Introduction to Nano science, Historical background & developments, Richard Feynman Statement, Top down and Bottom up approach, Surface to Volume Ratio, Quantum confinement, Size effect in nano system, Quantum dots, Nanowires, Different Allotropes of carbon, Introduction to CNTs, Structure of CNTs, Types of CNTs- SWNTs, MWNTs, Bucky balls (C_{60}), Graphene, Semiconductor Nano particles–types, properties and applications.

UNIT-II

Synthesis Technique: Dry & Wet Etching, Ball Milling, Vacuum technique, Mean free path, Rotary Pump, Diffusion Pump, Vacuum gauges (Pirani & Penning), PVD (Physical vapor deposition) Arc discharge Method, Spin Coating, Dip coating, Langmuir Blodgett Film.

UNIT-III

Characterization & Instrumentation Technique for Nanotechnology: Interaction of electron beam with solid specimen, Introduction to Electron Microscopy: principle and operation of SEM and TEM, EDX, Introduction to Scanning Probe Microscopes (SPM): Principle and operation of STM & AFM, Principle, operation and applications of X -ray Diffraction: XRD, XRF.

UNIT-IV

Applications of Nanomaterials: Effect of Size on Florescence w.r.t. Q.D size, Particle size analyzer: Study of nano impurity in water (PPM) by Atomic Absorption Spectroscopy (AAS). Applications of Nanotechnology in Food, Textile & Medical Science. Biosensor.

Nanotweezers, Lithographic Techniques: AFM based nanolithography and Nano manipulation, Dip pen lithography, Optical Lithography. Role of plants in nanoparticle synthesis basics only.

Books/ References:

1. Introduction to Nanoscience by Gabor L Hornyak and Joydeep Dutta
2. Nanophysics and Nanotechnology by Edward L Wolf
3. Nanotechnology: Principles and Practices by Sulabha K Kulkarni
4. Carbon Nanotubes – Basic Concepts and Physical Properties by Reich S and Maultzsch J
5. Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Cao G
6. The Chemistry of Nanomaterials: Synthesis,Properties and Applications by C N R Rao and Achim Müller
7. Nanomaterials by Jinsung Kim
8. Biosensors- Fundamentals and Applications by A P F Turner I Karube and I G Wilson
9. Optical Properties of Metal Clusters by M Vollmer and U Kreibig
10. Hari Singh Nalwa (2011) Encyclopedia of Nano Science &Nanotechnology, American Scientific Publishers.
11. Lüth, Hans 2010 Solid Surfaces, Interfaces and Thin Films. Springer.
12. Vajtai, R 2013. Springer Handbook of nanomaterials, Springer.

MPL 403 (ii): Spectroscopy

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objectives: The course gives an overview about the spectrographs and monochromators used in various spectroscopic techniques. Key objective is to enable student to learn and understand the different spectroscopic techniques to determine the small absorption in a given medium.	**Course Outcomes:** On completion of the course, the student will develop an understanding for realization of different spectroscopic techniques. It will provide research endeavour in photonics and will also help the students for seeking jobs in optics industry.

Unit I

Spectrographs and Monochromators: Basic Properties, Speed of a Spectrometer, Spectral Transmission, Spectral Resolving Power, Free Spectral Range; Prism Spectrometer; Grating Spectrometer; Interferometers: Basic Concepts of Michelson and Multiple-Beam Interferometers; Plane Fabry-Perot Interferometer, Spectroscopic Comparison between Spectrometers and Interferometers,

Unit II

Advantages of Lasers in Spectroscopy, High-Sensitivity Methods of Absorption Spectroscopy, Frequency Modulation, Intracavity Absorption (single mode); Direct Determination of Absorbed Photons: Fluorescence Excitation Spectroscopy, Photoacoustic Spectroscopy, Optothermal Spectroscopy; Basic concepts of Fourier Transform Spectroscopy

Unit III

Laser Magnetic Resonance, Laser-Induced Fluorescence, Molecular Spectroscopy by Laser-Induced Fluorescence, Experimental Aspects of LIF, Linear and Nonlinear Absorption Spectroscopy, Basic concepts of Saturation and Multiphoton Spectroscopy

Unit IV

Laser Raman Spectroscopy: Basic Considerations, Experimental Techniques of Linear Laser Raman Spectroscopy; Nonlinear Raman Spectroscopy: Stimulated Raman Scattering, Coherent Anti-Stokes Raman Spectroscopy; Basic concepts and application of Time Resolved Spectroscopy

References:

Laser Spectroscopy, W. Demtroder, Springer, 2nd Edition (1996)
An Introduction to Laser Spectroscopy, David L Andrews and A A Demidov Springer
High Resolution spectroscopy by J Michael Hollas, Butterworths.
Lasers Fundamentals, W.T. Silfvast, Cambridge (1996)
Laser Physics, L.V. Tarasov, Mir (1983)
Quantum Electronics, A.Yavir, John Wiley (1992)
Introduction to Laser Physics, K. Shimoda, Springer (1986)
Lasers & non-Linear Optics, B.B.Laud

MPL 403 (iii): Radiation Physics

Marks (Theory): 70 **Credits: 4(60 lectures)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems in the relevant papers.

Course Objective: To make students aware of interaction of radiations with matter and different phenomenon associated. How the energy and dose of nuclear radiations affects cells of living beings. The main objective of this course will also be to make students aware of radiation measurement, use of radiation for useful purpose and their effects on biological process.	**Course Objective**: Students will become aware of different phenomenon associated with interaction of radiations with matter and radiations energy and dose measurement, units different types of radiation detectors with principal of working. Students will also be aware of radiological risk and their assessment.

Unit I

Radiation Sources: Radioactivity, Modes of radioactive disintegration, Nature and properties of nuclear radiations, Radioactive decay, Half life time, Source activity, Laboratory sources of nuclear radiation (Alpha source, Beta source and Neutron sources).

Interaction of Radiation with Matter: Modes of interaction: ionization, excitation, elastic and inelastic scattering, Bremsstrahlung, Cerenkov radiation, Concepts of specific ionization, mean free path; Interaction of Light Charged Particles with matter; Interaction of Heavy Charged Particles with matter; Interaction of Electromagnetic Radiations with matter: Photoelectric effect, Compton Scattering, and Pair production; Attenuation of Gamma Radiation: Linear and mass attenuation coefficient; Interaction of Neutrons with matter: elastic scattering, inelastic scattering, capture, and fission.

Unit II

Radiation Detectors and Monitors: Principles of radiation detection; Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Crystal detector, Semi-conductor Detectors (Junction type detector, Lithium drift Germanium detector, Silicon based Pixel & Strip detectors, and HPGe), Neutron Detectors, Thermo – Luminescent Dosimeters (TLD), Chemical detectors (Photographic Emulsions Films), Radiation Monitoring Instruments and Calibration check of radiation monitoring equipment.

Unit III

Radiation quantities and units: Exposure, Dose, Equivalent Dose, Effective Dose, KERMA, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC).

Biological Effects of Ionizing Radiation: Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect).

Unit IV

Radiation Hazard Evaluation and Control: Radiation Hazard: Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment
(iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness.
Operational Limits: Principles of Radiological Protection: Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students
Production of Radioisotopes and Labelled Compounds: Introduction, Separation of Isotopes, Production of labelled compounds, Specific Activity of labelled compounds, Storage, Quality, and Purity of Radio-labelled compounds.

References:

1. Introduction to Radiological Physics and Radiation Dosimetry, by Frank H. Attix, John Wiley & Sons, 1986.
2. Radiation Detection and Measurement 4th Edition by Glenn F. Knoll
3. Physics and Engineering of Radiation Detection by Syed Ahmed, Laurentian University, Ontario, Canada
4. Measurement and Detection of Radiation, Fourth Edition by Nicholas Tsoulfanidis and Sheldon Landsberger

MPP 401: PHYSICS LAB-VI (Specialization Specific Lab)

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least Six experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

The experiments will comprise related to the specialization opted in Semester-IX.

MPP 402: PHYSICS LAB-VII (Specialization Specific Lab)

Marks (External) : 70 **Credits : 4**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

1. Each student should perform at-least Six experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

The experiments will comprise related to the specialization opted in Semester-X.