HIMACHAL PRADESH TECHNICAL UNIVERSITY
HAMIRPUR

Syllabus & Examination Scheme

for

M. Sc. Physics

(Two Years Program Spread Over Four Semesters)

As per National Education Policy (NEP) -2020

w.e.f. the Academic Year 2023-2024

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1. Preamble

M.Sc. Physics program is named as Master of Science in Physics (M.Sc. Physics). The syllabus for this program is framed having course categories viz. core, elective (discipline specific, skill enhancement, inter-departmental) and value-added courses etc. which are incorporated as its components following the University Grants Commission (UGC) guidelines. Department of Physics also made an attempt to revise the curriculum of M.Sc. Physics in alignment with National Education Policy-2020. With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasizing on integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and constitutional values through value-based courses. The whole course structure also enables the students to select subjects as per their interest. Also, diverse lab experiments, research projects and seminars allow the students to understand the fundamental aspects of the subject. Furthermore, continuous assessment is an integral part of the whole scheme, which will facilitate systematic and thorough learning towards better understanding of the subject.

2. Program Objectives (POs)

M.Sc. Physics program aims to train the students in high level theoretical knowledge enabling them to tackle practical complex problems in institutional/industrial fields. In addition, M.Sc. Physics Program is meant to develop professional skills among the students which play a major role in academic and industrial life and also give students the experience of teamwork. This program also inculcates strong student competencies in Physics and its applications in a technologically rich as well as interactive environment. It enables the students to apply scientific knowledge for deeper understanding of nature and to identify/analyze advanced scientific problems. The main objectives are as follow:

- To foster the scientific attitude and in-depth knowledge of scientific and technological concepts of Physics.
- To enrich knowledge through problem solving, minor/major projects, seminars, tutorials, review of research articles/papers, participation in scientific events, study visits, laboratory experiments etc.
- To familiarize with recent scientific and technological developments.
- To create a foundation for research and development in Physics.
- To help students to learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
- To train students in skills related to research, education, and industry.
- To help students to build-up a progressive and successful career in Physics.

3. Program Learning Outcomes (PLOs)

Students enrolled in the Master Program offered by the Department under the School of Basic Science and Applied Sciences will have the opportunity to learn and master the following components in addition to attain important essential skills and abilities. After the completion of program, the students will be able to:

- Deliver basic disciplinary knowledge gained during the program.
- Describe advanced knowledge gained during the program.
- Identify, formulate, investigate, and analyze scientific problems and innovatively to design and create products and solutions to real life problems.
- Develop a research aptitude and apply knowledge to find the solution of burning research problems.
- Gain knowledge with the holistic and multidisciplinary approach across the fields.
- Inculcate the professional and ethical attitude and ability to relate with social problems.

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4. Curriculum Structure

M.Sc. Physics program will have a curriculum with syllabi consisting of following types of courses:

- **Core Course (CC):** A course which should compulsorily be studied by a candidate as a core requirementis termed as a Core compulsory course.
- **Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.

  Value added (VAC), Skill Enhancement (SEC) & Inter Departmental (ID) Elective Course: Generally, a course which can be chosen from a pool of courses, and which may be very specific or specialized or advanced or supportive to the discipline/interdisciplinary subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's values/proficiency/skill is called an Elective Course. These courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills and to improve the employability skills of students. Inter-Departmental course(s) offered by the Department of Physics will be opted by the students from other Departments. The students of the Physics Department may also opt the same course only after the permission of Head of the Department/ Authority of the University. The syllabi of above courses may be same University wide and these may be mandatory or optional electives.

  The Department may offer more than one optional/elective Inter departmental courses during the running semester depending upon the specialization and strength of the faculty members after taking approval from the University Authorities.

  Laboratory: This course is very essential for gain the practical knowledge and to improve hands-on-practice.
- **Project/Seminar (RP):** A course is designed to acquire special/advanced knowledge in terms of project and seminar presentation. Candidates study such courses on the basis of the areas of their interest along with advisory support from the teacher/faculty member.

  In addition to the above, other minor electives, Institutional Training/Summer Internship/Survey/ SWAYAM/ MOOC/NPTEL may also be offered to inculcate experiential learning.

5. Scheme/Guidelines for the Examinations (Theory, Practical and others)

The pass percentage in each subject will be 40%.

- **For Theory and Practical Examinations:**
  Irrespective of credits, each paper will be of 100 marks (60 marks for external examinations and 40 marks for internal assessment) and the duration of paper will be 3 hours.

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Format of Question Paper for the End Semester Examination

Roll No:…….. **Total Pages:……..**

(Month-Year)
M.Sc. Physics Examination
Subject-Code
Subject Name
Semester-

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. (12 or 8,4)
2. (a)
   (b) (12 or 8,4)

Section B

3. (a)
   (b)
   (12 or 8,4)
4. (12 or 8,4)

Section C

5. (a)
   (b) (12 or 8,4)
6. (12 or 8,4)

Section D

7. (12 or 8,4)
8. (12 or 8,4)

Section E (Compulsory)

9. (a)
   (b)
   (c)
   (d)
   (e)
   (f) (6x2=12)

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- **Instruction for Periodical (theory, practical & other) Examinations**

During one semester, there will be two periodical examinations for theory courses and one periodical examination for practical and other course categories. The question paper will consist of three sections A, B and C having total 20 marks. Section A will be compulsory and will have short answer type questions consisting of eight parts, each of one mark covering the syllabus mentioned. Sections B and C will contain descriptive type questions of six marks each. Sections B and C will have two questions and the candidates will attempt three questions in all, i.e. one question each from the sections B and C. Section-A is compulsory.

- **Instruction to Question paper setting (Internal)**

Roll No_____ **Total Pages**_____

Mid Semester Exam – Month/Year
Paper Code (Title)
M.Sc. Physics, Semester---

Time: 1:30 Hours **Max. Marks: 20**

The candidates shall limit their answers precisely within the answer-book issued to them and no supplementary/continuation sheet will be issued.

Note: Attempt three questions in all by selecting one question from each section B and C. Section-A is compulsory.

Section A (Compulsory)

1. (a-h) (8x1=8 or 2x4)

Section B

2 (1x6)

or

3. (1x6)

Section C

4 (1x6)

or

5. (1x6)

- **For the Preparation of Report (Research Project/Seminar):**

The project report/seminar report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, methodology, result and discussion conclusion and references etc. The paper size to be used should be A-4 size. The font size should be 12 with Times Roman font. The text of the report may be typed in 1.15 or 1.5 space. The print-out of the report shall be done on both sides of the paper (instead of single side printing). The candidate shall be required to submit two spiraled/hard bound copies of the report along with a CD in the department as per the date announced.

The list of topics will be provided by the Department/University and the students will choose the area of his/her interest and get registered under the concerned faculty after appearing in an oral interview and with the final approval from the Head of the Department. The candidate shall be required to maintain his/her project diary (logbook) of work in the organization or under the guide/supervisor. The student has to formulate the project problem / research problem with the help of her/his guide and submit the project

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proposal / research proposal within 10 days at the starting of project for further approval.

The report will be evaluated internally by the supervisor allotted to the student during the semester and the candidate will present his/her work through presentation/viva before the external examiner at the end of semester and will be awarded marks. The candidate is required to submit the final/revised copies of the report within one week after the viva -voce/presentation conducted in the presence of internal as well as external examiners.

Internal assessment of the project work/seminar will be carried out by respective faculty members assigned to them as mentor/supervisor as per evaluation scheme. External assessment of the project work will be carried out by an external examiner (nominated by the Head/Chairperson of the Department) as per evaluation scheme.

- **For the Institutional Training/ Summer Internship /Survey /SWAYAM /MOOC /NPTEL courses:**

For Institutional Training/ Research Project/ Summer Internship /Survey /SWAYAM /MOOC /NPTEL courses, the list of topics will be provided by the Department/University. The students will pick the option, get registered and prepare the report. Each student has to register for online course after the permission/approval from concerned Department/University and has to pass the selected online course within the duration of running semester. Guidelines for the online courses from SWAYAM/MOOC/NPTEL may be taken after the registration through online portal/concerned Department as per required credits. The required weeks and course content for the concerned course may also be decided by the department head/Coordinator during Departmental meeting. The evaluation will be done on the basis of presentation/solving assignments and examination conducted by the Department (Department of Physics, HPTU) time to time as per the time table assigned. The students have to complete Institutional Training / Summer Internship / Survey / SWAYAM / MOOC /NPTEL under the guidance of the supervisor (taken from the same Department) allotted by Head/Coordinator of the concerned Department. The students may be given option to complete above tasks by choosing co-supervisor from the same Department/University or from any other institutions.

For research project, seminar and other (institutional training / summer internship /survey /SWAYAM /MOOC /NPTEL) courses, each lecture/contact hour per week will be considered as one credit as per the assigned time table. The duration of written and viva voce examination and other conditions (if any) shall be decided by the internal and external examiners appointed by the University authorities.

- **For paper setter- End Semester Examinations (ESE)**

In each theory paper (irrespective of credits) nine questions are to be set. The question paper will consist of five sections A, B, C, D & E. Sections A, B, C & D will have two questions of 12 or 8,4 each and section E will consist of six short answer type questions (covering whole syllabus), each of having 02 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and section E will be the compulsory question. The question paper may be expected to contain numerical problems with a minimum weightage of 20% of the total marks (60 marks).

In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover whole syllabus. The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

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6. Proposed Subject Code System

Each subject code is denoted by eight alpha-numerals, three alphabets before hyphen indicates course name and four numerals after hyphen indicates level, semester, and subject number respectively.

- **For Example: PHY-6101**

1. The first three alphabets "PHY" is course indicator.
2. The first number "6" defines Level 6 for first and second semesters and level 7 for third and fourth semesters.
3. Second number "1" defines the semester.
4. Third and fourth numbers are related to the subject number.

7. Assessment & Evaluation

Template for-Internal Examination (Theory)-Mid Semester

HIMACHAL PRADESH TECHNICAL UNIVERSITY
Department of Physics, School of Basic and Applied Sciences

AWARD SHEET THEORY (INTERNAL ASSESSMENT)

Name of the Institution:			**Distribution of Marks**				
Programme:			**Periodical Examinations**		**Teacher Assessment** (Assignment discussion/ presentation/Quizzes/ Overall behavior)	**Attendance**	**Total Marks**
Subject:		**Sub. Code:**					
Branch:		**Semester:**	1st Periodical Examination	2nd Periodical Examination			
MAX. MARKS:		**MIN. MARKS:**					
Sr. No.	**University Roll No.**	**Name of Student**	**10**	**10**	**15**	**05**	**40**

Name of Internal Examiner
Signature.....
Date.....

Head of Deptt.
Signature.....
Date.....

Head of the Institution
Signature.....
Date.....

Sr. No	Percentage of Lecture Attended	Marks Awarded
1	From 75% to 80%	01
2	Above 80% to 85%	02
3	Above 85% to 90%	03
4	Above 90% to 95%	04
5	Above 95%	05

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Template for-Internal Examination-Mid Semester (Practical/Project/Seminar/Viva-Voce)

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Department of Physics, School of Basic and Applied Sciences

AWARD SHEET (Practical/Project/Seminar/Viva-Voce)
Internal Examination

Name of the Institution:			Distribution of Marks				
Programme:			Periodical Examination		Teachers Assessment (Lab/Work performance/ Report/File work)	Attendance	Total Marks
Subject:		Sub. Code:					
Branch:		Semester:	Written/Presentation	Viva-voce			
MAX. MARKS:		MIN. MARKS:					
Sr. No.	**University Roll No.**	**Name of Student**	**10**	**10**	**15**	**05**	**40**

Name of Internal Examiner — Head of Deptt. — Head of the Institution

Signature…… Signature…… Signature……

Date…… Date…… Date……

Note: The distribution of marks for Institutional training, Internship, Survey, SWAYAM, MOOCs, NPTEL courses (if any) would be same as above.

Template for-External Examination (Practical/Project/Seminar/Viva-Voce)

HIMACHAL PRADESH TECHNICAL UNIVERSITY
Department of Physics, School of Basic and Applied Sciences
(Practical/Project/Seminar/Viva-Voce)

Name of the Institute: ……

Programme: ……

Subject Name:…… …… Subject Code:……

Branch: …… …… Semester ……

Max Marks …… Min. Marks:……

Sr. No.	University Roll No.	Name of Student	Marks in Figure	Marks in Words

Name of Internal Examiner: …… External Examiner……

Signature…… Signature……

Date…… Date……

Note: (i) The distribution of marks would be on the basis of Work done/Task performance (20 marks), Performance (written/presentation) (20 marks) and viva-voce (20 marks), total=60 marks.

(ii) The distribution of marks for Institutional training, Internship, Survey, SWAYAM, MOOCs, NPTEL courses (if any) would be same as above.

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8. Overall General Instructions

- Each paper will be of 100 marks (60 marks for external and 40 marks for internal) and the duration of paper will be 3 hours. The candidate shall be declared to have passed the examination if the candidate secures not less than 24 marks in the End Semester Examinations of each paper and secures not less than 16 marks in the Internal Assessment (IA) and overall aggregated marks is 40 in both the external and internal taken together.
- Each theory lecture per hour will be considered as one credit and two practical hours as one credit. For each theory course of 04 credits, there will be 4 lecture hours of teaching per week and for each theory course of 02 credits, there will be 2 lecture hours of teaching per week. For each practical course of 02 credits, there will be 04 lecture hours of teaching per week and for practical course of 04 credits, there will be 08 lecture hours of teaching per week. For the project work (major/minor)/seminar and other course categories, the lecture hours per credit would be same as those of having theory subjects.
- In each semester, the students are required to perform at least ten experiments out of the listed experiments.
- For Seminar, Industrial Training, Research Project, Summer Internship, Survey, SWAYAM, MOOC, NPTEL; the internal and external assessment shall be same as that of theory/practical courses i.e., 100 (60 % ESE & 40 % IA) marks.
- The distribution of internal & external assessment for Project work, Seminar and other course categories will be same as that of Core Compulsory course/Discipline Specific Courses and also as per the format mentioned above. (Read all the instructions mentioned in each course content semester-wise)
- Teaching hours per semester for each 04-credit theory course will be minimum 60 hours and of 02 credit theory course will be minimum 30 hours.
- For Research project, Seminar/SWAYAM/MOOC/NPTEL/Industrial Internship/Survey, the time frame for the duration of classes, examination, format for writing the report and evaluation system will be as per the format given as well as may be decided by the Department/University itself or organizing/host/collaborative institutions time to time after the approval from BoS.
- On the basis of the interest/availability of the students from other departments, any other relevant course for the Inter-departments Course (ID) may be offered at the spot after the approval from Authority/Department.
- Students having the attendance below 75% in each course will not be allowed to appear in the final examination. The students having attendance lying between 70-75% may be allowed to submit the examination form and finally to appear in the examinations only after the approval from the Dean/concerned authority. Similarly, the students having attendance lying between 65-70% may be allowed to submit the examination form and finally to appear in the examinations only after the approval from the Vice-Chancellor only on the request basis.
- For Theory examinations (Internals), two examinations; Periodical Examination-I and Periodical Examination-II will be conducted and for the practicals and other course categories, only one periodical examination will be conducted-as the internal examination along with other parameters as mentioned in the instructions (mentioned above).
- Both the periodical examinations are mandatory. If, in any case, the student is not able to appear in any of the above examinations, then the option of Make-up Examination will be given to t that, he/she has to report before that examination to the concerned teacher/head of t Within 3 days, he/she has to submit the documents related to the cause and finally get p

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the concerned Authority. After getting the permission, the student has to appear in the examination within 10 days with the weightage of 80% only. For example, if the student scoring 15 marks with the weightage of 100%, then he/she will be given 12 marks (80% weightage).

- Keeping in view the guidelines of NEP-2020, M.Sc. Physics is made inter- departmental in nature. It has been made mandatory by the university for the students at the PG level to opt at least one course of minimum 2 credits in first year.
- Duration: One year divided into two semesters. Total duration is of 02 years (04 semesters)
- Medium of instruction: English and Passing Standard: As mentioned in the Ordinance.
- In regard to maintain the record of the answer-sheets, after the completion of one year, all the used answer-sheets of internal examinations, project reports, practical note-books etc. would be allowed to disposed off.
- In regard to maintain the lab equipments, if any of the equipments not working properly may be allowed to send to the concerned companies (within and out-side the state) for repairing and may be allowed to disposed off/write off the damaged/old/not-in-use items like books, equipments, furniture and other appliances after the approval from the concerned authorities.

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THE DETAILS OF CREDITS DISTRIBUTION-COURSE CATEGORY WISE

Core Course (CC)-Theory and Laboratory (CC-LAB)	Discipline Specific Elective Course (DSE)	Value Added Course, Skill Enhancement Course and other Minor Elective Courses, Institutional Training/Summer Internship/Survey/SWAYAM MOOC/NPTEL	Inter-Departmental Elective Course (ID)	Research Project/ Seminar (RP)
Theory papers=14 Labs=03	Theory papers=03	Theory papers=03	Theory paper=01	Papers=02

Core Course (CC) (Theory)

Sem.	Papers	Cr.
I:	04	16
II:	04	16
III:	04	16
IV:	02	08

Core Course (LAB) (Practical)

Sem.	Papers	Cr.	Cr. hrs
I:	01	02	04
II:	01	02	04
III:	01	04	08

Sem.	Papers	Cr
III:	01	02
IV:	02	08

Value Added Course (VAC)

Sem.	Papers	Cr.
I:	01	02
II:	01	02

Skill Enhancement Elective Course (SEC)

Sem.	Papers	Cr.
I:	01	02

Sem.	Papers	Cr.
II:	01	02

Sem.	Papers	Cr.
III:	01	02
IV:	01	04

Credits=64	Credits=10	Credits=06	Credits=02	Credits=06

Total=88 credits **Total Marks=2600**

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Scheme of Teaching and Examination
Master of Science in Physics (M.Sc. Physics)

Semester-I

Subject Code	Course Category	Subject Title/ Subject Name	Periods			Credits	Evaluation Scheme					Total
							ESE	Internal Assessment				
			L	T	P			PE	TA	A	Total	
PHY-6101	CC	Mathematical Physics-I	04	00	00	04	60	20	15	05	40	100
PHY-6102	CC	Classical Mechanics	04	00	00	04	60	20	15	05	40	100
PHY-6103	CC	Quantum Mechanics-I	04	00	00	04	60	20	15	05	40	100
PHY-6104	CC	Classical Electrodynamics	04	00	00	04	60	20	15	05	40	100
PHY-6105	SEC	Skill Enhancement Course	02	00	00	02	60	20	15	05	40	100
UHV-6100	VAC	Universal Human Values and Professional Ethics	02	00	00	02	60	20	15	05	40	100
Lab Course												
PHY-6106P	CC-LAB	Physics Lab-I	00	00	04	02	60	20	15	05	40	100
Total			**20**	**00**	**04**	**22**	**420**	**140**	**105**	**35**	**280**	**700**

Skill Enhancement Course (PHY-6105) – Choose Any One
(i) Scientific Writing and Presentation
(ii) Institutional Training/Summer Internship/Survey
(iii) SWAYAM/MOOCs/ NPTEL

Legends:	**CC** - Core Course	**ESE**-End Semester Examination
	SEC - Skill Enhancement Course	**PE** - Periodical Examination
	VAC – Value Addition Course	**TA** - Teacher's Assessment
	CC-LAB- Core Course-Laboratory	**A** – Attendance
		L – Lecture
		T – Tutorial
		P – Practical

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Scheme of Teaching and Examination
Master of Science in Physics (M.Sc. Physics)

Semester-II

Subject Code	Course Category	Subject Title/ Subject Name	Periods			Credits	Evaluation Scheme					Total
							ESE	Internal Assessment				
			L	T	P			PE	TA	A	Total	
PHY-6201	CC	Mathematical Physics-II	04	00	00	04	60	20	15	05	40	100
PHY-6202	CC	Electronics	04	00	00	04	60	20	15	05	40	100
PHY-6203	CC	Statistical Physics	04	00	00	04	60	20	15	05	40	100
PHY-6204	CC	Atomic and Molecular Physics	04	00	00	04	60	20	15	05	40	100
PHY ID-6001	ID	Inter-Departmental Elective Course	02	00	00	02	60	20	15	05	40	100
IKS-6200	VAC	Indian Knowledge System	02	00	00	02	60	20	15	05	40	100
Lab Course												
PHY-6205P	CC-LAB	Physics Lab-II	00	00	04	02	60	20	15	05	40	100
Total			**20**	**00**	**04**	**22**	**420**	**140**	**105**	**35**	**280**	**700**

Inter-Departmental Elective Course (ID) - (PHY ID-6001) – Choose Any One (Only for the students of other Departments, e.g., the students of M.Sc. Physics will not opt the Inter-Departmental Elective Course offered by the same department)
(i) Radiation Safety
(ii) Physics for Everyone
(iii) Social Connect of Science and Technology
(iv) Any other course* *On the basis of the interest/availability of the students from other departments, any other relevant course from the basket may be offered at the spot after the approval from Authority.

Legends:	**CC** - Core Course	**ESE**-End Semester Examination
	ID – Inter Departmental Course	**PE** - Periodical Examination
	VAC – Value Addition Course	**TA** - Teacher's Assessment
	CC-LAB- Core Course-Laboratory	**A** – Attendance
		L – Lecture
		T – Tutorial
		P – Practical

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Scheme of Teaching and Examination
Master of Science in Physics (M.Sc. Physics)

Semester-III

Subject Code	Course Category	Subject Title/ Subject Name	Periods			Credits	Evaluation Scheme					Total
			L	T	P		ESE	Internal Assessment				
								PE	TA	A	Total	
PHY-7301	CC	Quantum Mechanics-II	04	00	00	04	60	20	15	05	40	100
PHY-7302	CC	Nuclear Physics	04	00	00	04	60	20	15	05	40	100
PHY-7303	CC	Condensed Matter Physics-I	04	00	00	04	60	20	15	05	40	100
PHY-7304	CC	Numerical Methods and Programming	04	00	00	04	60	20	15	05	40	100
PHY-7305	DSE	(Any of the Following as listed below)	02	00	00	02	60	20	15	05	40	100
PHY RP-7306	RP	Minor Research Project-I/ Seminar	02	00	00	02	60	20	15	05	40	100
Lab Course												
PHY-7307P	CC-LAB	Physics Lab-III & Computer Lab	00	00	08	04	60	20	15	05	40	100
Total			**20**	**00**	**08**	**24**	**420**	**140**	**105**	**35**	**280**	**700**

Discipline Specific Elective Course (DSE) - (PHY-7305) – Choose Any One
(i) Introduction to Nuclear Astrophysics
(ii) Renewable Energy Resources

Legends:	**CC** - Core Course	**ESE**-End Semester Examination
	DSE – Discipline Specific Elective Course	**PE** - Periodical Examination
	RP - Research Project/Seminar	**TA** - Teacher's Assessment
	CC-LAB- Core Course-Laboratory	**A** – Attendance
		L – Lecture
		T – Tutorial
		P – Practical

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Scheme of Teaching and Examination
Master of Science in Physics (M.Sc. Physics)

Semester-IV

Subject Code	Course Category	Subject Title/ Subject Name	Periods			Credits	Evaluation Scheme					Total
							ESE	Internal Assessment				
			L	T	P			PE	TA	A	Total	
PHY-7401	CC	Condensed Matter Physics-II	04	00	00	04	60	20	15	05	40	100
PHY-7402	CC	High Energy Physics	04	00	00	04	60	20	15	05	40	100
PHY-7403	DSE	Any one of the following as listed below	04	00	00	04	60	20	15	05	40	100
PHY-7404	DSE	Any one of the following as listed below	04	00	00	04	60	20	15	05	40	100
PHY RP-7405	RP	Research Project-II	04	00	00	04	60	20	15	05	40	100
Total			**20**	**00**	**00**	**20**	**300**	**100**	**75**	**25**	**200**	**500**

Choose Anyone (Discipline Specific Elective Course (DSE))	
PHY-7403	**PHY-7404**
(i) Nanophysics	(i) Experimental Techniques in Physics
(ii) Advanced Electronics	(ii) Opto-Electronics
(iii) Advanced Nuclear Physics	(iii) Nuclear Technology

Legends:	**CC** - Core Course	**ESE**-End Semester Examination
	DSE – Discipline Specific Elective Course	**PE** - Periodical Examination
	RP - Research Project	**TA** - Teacher's Assessment
		A – Attendance
		L – Lecture
		T – Tutorial
		P – Practical

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HIMACHAL PRADESH TECHNICAL UNIVERSITY
HAMIRPUR

Syllabus

for

M.Sc. Physics

(Semester-I)

As per National Education Policy (NEP-2020)

(w.e.f. the Academic Year 2023-2024)

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SEMESTER-I

PHY-6101 Mathematical Physics-I							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To impart knowledge about various mathematical tools employed to study physics problems.

Unit-I: Differential Equations	**15 Lectures**
Differential equations, First order differential equation, Second order differential equation with constant coefficients, Second order linear ODEs with variable coefficients, Partial differential equations-first order equations, Separation of variables, Ordinary and singular points, Series solutions and Frobenius method-Non-homogeneous partial differential equations, Green's functions. Introduction to probability theory, Binomial, Poisson and Normal distributions, Central limit theorem.	
Unit-II: Theory of Functions of a Complex variable	**15 Lectures**
Function of a Complex variable, Exponential functions, Logarithmic functions, Analyticity and Cauchy condition, Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, Harmonic functions, Cauchy's Integral Theorem, Cauchy's Integral Formula, Taylor's Series and Laurent's series and expansion, Singularities, Zeros, Poles and Residues, Cauchy's Residue Theorem, Jordon's Lemma, Evaluation of real definite integrals.	
Unit-III: Tensors	**15 Lectures**
Tensors in index notation, Kronecker and Levi Civita tensors, Einstein's summation convention-covariant and contravariant, mixed tensors, Inner and outer products, Contraction, Algebraic operations in tensors-symmetric and skew symmetric tensors, Quotient law, Metric tensors, Tensor calculus-Christoffel symbols, Applications.	
Unit-IV: Delta and Gamma Functions	**15 Lectures**
Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function, Relation with Gamma function, Evaluation of integrals.	

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Course Learning Outcome (CLO)

- Students will be familiar to understand and apply the mathematical skills to solve quantitative problems in the study of physics.

Books Recommended:

- A.K. Ghatak, Mathematical Method of Physics, Mc-Millan.
- H.K. Dass Mathematical Physics, S. Chand
- B.D. Gupta, Mathematical Physics, Vikas Publishing House.
- B.S. Rajput, Mathematical Physics, Pragati Prakashan
- R.K. Jain and SRK Iyengar, Advanced Engineering Mathematics, Narosa Publications.
- George B. Arfken and Hans-Jurgen Weber, Mathematical Methods for Physicists, Elsevier Science.
- J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics, Addison-Wesley
- M.R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6101
Mathematical Physics-I
Semester-I

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks. Simple calculator may be allowed to the students in the examination.

The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Derive Gauss's theorem, Green's Theorem and Stoke's Theorem. Show that divergence of curl of a vector is always zero. (12 or 8,4)

2. (a) Verify Cayley-Hamilton theorem for the matrix A and compute A^{-1}, where

$$A=\begin{bmatrix} 2 & 1 & 2 \\ 5 & 3 & 3 \\ -1 & 0 & -2 \end{bmatrix}$$

(b) Prove that the characteristic roots of a real symmetric matrix are all real. (12 or 8,4)

Section B

3. (a) Describe the characteristics of Binomial and Normal Distributions.
(b) It is known that from the experience that in a certain lab 3% items are defective. A sample of 100 items are taken at random. Find the probability that exactly 5 items are defective (Given: $e^{-3}=0.04979$) (12 or 8,4)

4. Give a general solution of Laplace equation and find the inverse Laplace transform of $1/s(s+2)$. (12 or 8,4)

Section C

5. (a) What do you understand by an analytic function? Highlight the condition for a function to be analytic.
(b) State and prove Jordan's Lemma. (12 or 8, 4)

6. State Cauchy's integral formula. Hence evaluate:

$\int_C \frac{x^3 dz}{z-2}$ Where C is the circle $|z|=3$. (12 or 8, 4)

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Section D

7. Define beta and gamma functions and derive the relation between the two. (12 or 8, 4)

8. Define Dirac delta function. State one situation where it finds application and explain the Guassian function function given by

$$f(x) = \left(\sqrt{a/\pi}\right) e^{-\alpha x 2}$$ (12 or 8, 4)

Section E (Compulsory)

9. (a) Eight coins are thrown simultaneously. Find the probability of getting at least six heads.

(b) Explain the physical significance of Curl of a vector field.

(c) Define (i) Isolated singularity, (ii) Pole

(d) Define Dirac delta function. State one situation where it finds application.

(e) Prove that curl of a vector is always solenoidal in nature.

(f) Starting from the first principle derive an expression for divergence of a vector in orthogonal curvilinear coordinates. (12 or 8, 4)

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SEMESTER-I

PHY-6102 Classical Mechanics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- The students will be equipped for advanced and specialized courses. The student learns to deal with particle mechanics at an advanced level and to learn the foundations of the classical theory of fields.

Unit-I: Lagrangian Formulation	**15 Lectures**
Mechanics of a system of particles, Constraints of motion, Generalized coordinates, D'Alembert's Principle and Lagrange's velocity – dependent force and the dissipation fuction, Application of Lagangian formulation. **Hamilton Principle**: Calculus of variations, Hamilton principle, Lagrange's equation from Hamilton's principle, Extension to non- holonomic systems, Advantages of variational principle formulation, Symmetry properties of space and time and conservation theorems.	
Unit–II: Rigid Body Motion	**15 Lectures**
Independent co-ordinates of rigid body, Orthogonal transformation, Euler's Angles and Euler's theorems, Infinitesimal rotation, Rate of change of vector, Coriolis force, 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 a symmetrical top.	
Unit–III: Small Oscillations	**15 Lectures**
Eigenvalue equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule. **Hamilton's Equations**: Legendre Transformations, Hamilton's equations of motion, Cyclic-co- ordinates, Hamilton's equations from variational principle, Principle of least action.	
Unit-IV: Canonical Transformation and Hamilton-Jacobi Theory	**15 Lectures**
Canonical transformation and its example, Poission brackets, Equations of motion, Angular momentum. Poission's Bracket relations, Infinitesimal canonical transformation, Conservation Theorems, Hamilton–Jacobi equations for principal and characteristic functions, Harmonic oscillator problem, Action and angle variables for system with one degree of freedom. **Special Theory of Relativity:** Preliminaries of special theory of relativity, Four vector notation. Energy. Momentum four-vector for a particle, Relativistic invariance of physical laws.	

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Course Learning Outcomes (CLOs)

- The students will be able to apply the Variational principles to real physical problems.
- The students will be able to model mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.

Books Recommended:

- H. Goldstein, Classical Mechanics, Narosa, New Delhi (1992).
- K.C.Gupta, Classical Mechanics of Particles and Rigid Bodies, Wiley Eastern, New Delhi (2006)
- L.N. Hand and J.D. Finch, Analytical Mechanics, Cambridge University Press, Cambridge (1998).
- V.D. Bargerand M.G. Olsson, Classical Mechanics, McGraw-Hill, New York,(1973).
- N.C. Rana and P.J .Joag, Classical Mechanics, Tata McGraw Hill, New Delhi(2004).
- J.C. Upadhyaya, Classical Mechanics, Himalaya Publishing House Pvt. Ltd., Mumbai (2019).

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6102
Classical Mechanics
Semester-I

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. (a) Define constraints of motion and discuss their classification with examples.
(b) What is velocity dependent potential? Obtain the equation of motion for a charged particles moving in an electromagnetic field. (12 or 8,4)
2. Explain symmetry of space and time and show their relations with different conservation laws. (12 or 8,4)

Section B

3. (a) Define Euler's angles as the generalized coordinate for a rigid body motion and obtain an expression for complete transformation matrix.
(b) Show that the K.E. of a rotating rigid body can be expressed as $T = {}^{1}/_{2}$. J.ω. Where ω is the angular velocity and J is the angular momentum. (12 or 8,4)
4. (a) Derive the Euler's equation of motion for a rotating rigid body with a fixed point.
(b) Define Inertia tensor. Give its physical significance. (12 or 8,4)

Section C

5. Define normal co-ordinates. Discuss the vibrations of a linear triatomic molecule. (12 or 8,4)
6. (a) State Hamilton's principle. Derive Hamilton canonical equations of motion from Hamilton's variational principle.
(b) State and prove the conditions under which Hamiltonian is a constant of motion. (12 or 8,4)

Section D

7. (a) Using Poisson brackets, show that the transformation defined by:
$q = \sqrt{2P}\sin Q$, $p = \sqrt{2P}\cos Q$is canonical. Show that Poisson bracket of two dynamical variables is invariant under canonical transformations.
(b) Explain Hamilton-Jacobi method. (12 or 8,4)
8. (a) What are four vectors? Express the velocity, energy, and momentum in terms of four vectors.
(b) Give the basic postulates of special theory of relativity. What do you understand by proper length and proper time interval? (12 or 8,4)

Section E (Compulsory)

9. (a) What are generalized coordinates? What is the advantage of using them?
(b) How Lagrangian mechanics is better than Newtonian mechanics?
(c) Discuss the nature of coriolis force with the help of examples.
(d) State the principle of least action.
(e) Differentiate between point and canonical transformations.
(f) Evaluate the Poisson bracket [J*x*, P*y*].

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SEMESTER-I

PHY-6103 Quantum Mechanics-I							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- The primary goal of this course is to develop an understanding of some of the more advanced topics and techniques used in quantum mechanics.

Unit-I: General Formalism of Quantum Mechanics	**15 Lectures**
Linear vector spaces-Linear operator, Eigen functions and Eigen values, Hermitian operators and their properties, Postulates of quantum mechanics, Simultaneous measurability of observables, Derivation of uncertainty relation through operators, Dirac's notation, Equations of motion; Schrodinger, Heisenberg and Dirac representation, momentum representation, Density matrix and its properties.	
Unit-II: Energy Eigenvalue Problems	**15 Lectures**
Particle in a three-dimensional box, Linear harmonic oscillator, Tunneling through a barrier, particle moving in a spherically symmetric potential, System of two interacting particles, Rigid rotator and energy eigen values of (a) plane rigid rotator (b) 3-D rigid rotator, Hydrogen atom: Separation of the center of mass motion, Solution to radial equation.	
Unit-III: Angular Momentum	**15 Lectures**
Orbital angular momentum, Spin angular momentum, Total angular momentum operators, Commutation relations of total angular momentum with components, Ladder operators, Commutation relation of J_z with J^+ and J^-, Eigen values of J^2, J_z, Matrix representation of J^2, J_z, J^+ and J^-, Addition of angular momenta- Clebsch-Gordon Coefficients (j =1/2, 1/2; 1/2,1; 1,1), Selection rules– recursion relations-computation of Clebsch-Gordon Coefficients.	
Unit-IV: Approximate Methods	**15 Lectures**
Time independent perturbation theory in non-degenerate case, Degenerate case, Stark effect in hydrogen atom, Formulation of variational approximation method, Application of variational method: Ground state of helium atom, Zero point energy of simple harmonic oscillator, The WKB approximation and its validity, Application of WKB approximation: Connection formulas for penetration though a barrier, Bound energy levels in a potential well, Variation method, Born-Oppenheimer approximation.	

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Course Learning Outcomes (CLOs)

- Students will be able to understand the need for quantum mechanical formalism and basic principles.
- Students will be able to understand the importance and implication of vector spaces, Dirac notations, eigen value problems and mathematical foundations of angular momentum of a system of particles.
- Students will be able to apply various approximation methods in solving the Schrodinger equation as well as perturbation theory to scattering matrix and partial wave analysis.

Books Recommended:

- L.I Schiff, Quantum Mechanics, McGraw Hill.
- N. Zettili, Wiley, Quantum Mechanics - Concepts and Applications.
- V. Devanathan, Quantum Mechanics, Alpha Science Intl Ltd.
- Ghatak and Loknathan, Quantum Mechanics, 1st Edition, MacMillan India.
- Agrawal, Quantum Mechanics & Field Theory, Lokbharti Prakashan Pvt Ltd, 2003.
- Pauling and Wilson, Introduction to quantum mechanics, Dover Publication, 1985.
- P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata Mc Graw Hill G. Aruldhas, Quantum Mechanics, Prentice Hall of India.
- David J. Griffiths, Introduction to Quantum Mechanics, Cambridge University Press.
- J.L. Powell and Crasemann, Quantum Mechanics, Dover Publication, 2015.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6103
Quantum Mechanics-I
Semester-I

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. List the postulates of quantum mechanics and explain them. (12 or 8,4)

2. (a) Explain momentum representation. What are the operators for position in the momentum representation?
   (b) A and B are Hermitian operators, show that (AB+BA) is Hermitian and (AB-BA) is not Hermitian. (12 or 8,4)

Section B

3. (a) Calculate the energy eigen values for a particle in a box. Also explain the zero-point energy for a particle in a box. . (12 or 8,4)
   (b) Obtain the angular part of the Schrodinger equation for a moving particle under spherical symmetric potential.
4. What do you mean by tunnelling through a barrier? A particle travelling through a barrier with energy E along X-axis, has potential barrier defined as

$$U(x) = \begin{cases} 0, & \text{when } x < 0 \\ U_0, & \text{when } 0 \leq x \leq L \\ 0, & \text{when } x > L \end{cases}$$

Drive the expression for the expression for reflection and transmission coefficient of a particle.(12 or 8, 4)

Section C

5. (a) Determine the eigenvalue of L^2 and L_Z.
   (b) Apply commutator algebra to find the uncertainty relation between any two operators. (12 or 8, 4)

6. Discuss the formal theory of addition of angular momentum. Discuss the relevant commutation relations. (12 or 8, 4)

Section D

7. Discuss the time independent perturbation theory for non-degenerate stationary state. Obtain the corrected eigenfunctions and Eigen values. (12 or 8, 4)
8. Evaluate the ground state energy of the Hydrogen atom using Variational method. (12 or 8,4)

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SEMESTER-I

PHY-6104 Classical Electrodynamics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs)

- To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific methods.
- To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.

Unit-I: Electrostatics	**15 Lectures**
Introduction, Work and Energy in electrostatics, Polarization, Laws of electrostatic field in the presence of dielectrics, Energy of the field in the presence of a dielectric, Boundary condition, Poisson and Laplace equations, Earnshaw's theorem, Boundary conditions and Uniqueness theorem, Multipole expansion, Method of electrostatic images. **Magnetostatics:** Introduction, Laws of magnetostatics, Magnetic scalar and vector potentials, Magnetic media, magnetization, magnetic field vector, Boundary conditions.	
Unit-II: Time Varying Fields	**15 Lectures**
Maxwell's equations, Displacement current, Electromagnetic potential, Vector and Scalar potential, Gauge transformations; Lorentz and Coulomb Gauge, Poynting theorem, Conservation laws for a system of charged particles and electromagnetic field, Continuity equation.	
Unit-III: Electromagnetic Waves	**15 Lectures**
Plane waves in Non-conducting and conducting media, Polarization-linear and circular polarization, Skin effect, Reflection and refraction of electromagnetic waves across a dielectric interface at a plane surface between dielectrics, Total internal reflection, Polarization by reflection, Reflection from the surface of a metal.	
Unit-IV: Electromagnetic Radiation	**15 Lectures**
Retarded Potentials, Radiation from an oscillating dipole, Lienard-Wiechert potentials, Potentials for a charge in uniform motion-Lorentz Formula, Fields of an accelerated charge, Transmission lines and wave guides-TE, TM and TEM modes, rectangular and cylindrical waveguides, Resonant cavities, Energy dissipation, Q of a cavity. Dispersion relations in plasma, Plasma oscillations, Debye shielding, Plasma parameters, magneto plasma. Plasma confinement.	

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Section E (Compulsory)

9. (a) What are ladder operators? Why are they called so?
   (b) Find the Eigen values for angular momentum operators J^2 and J_Z.
   (c) Define Hermitian operator and its properties.
   (d) What are the properties needed of a wavefunction to be well-behaved?
   (e) Write the expression of the unperturbed Hamiltonian of the hydrogen atom in the absence of electric field.
   (f) Write the expression for time dependent Schrodinger equation. (6x2=12)

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SEMESTER-I

PHY-6105(i) Scientific Writing and Presentation							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- This course aims to train the students in high level theoretical knowledge enabling them totackle practical complex problems in industrial fields.

Unit-I: Latex	**08 Lectures**
Introduction to Latex, Creating an article with title, author and date, Important parts of a scientific paper, Structure the content as Abstract, Sections, Sub-sections and the use of list environments, Text formatting and page setting, Generating tables of different styles, Inserting different types of graphs and pictures in different ways and sizes, Understand the graphics environment by inserting different types and sizes of graphs, Typesetting equations of varying complexity, Single line equations and multiple line equations using tabular environment.	
Unit-II: Bibliography	**08 Lectures**
Referencing and Bibliography, Preparing reports and book, How to cross reference figures, Tables, Equations and references and create list of figures and table of contents, How to use Beamer in Latex for creating presentations, Creating Title Slide, Outline of Presentation, Making Bullets, Enumeration, etc, Splitting the slide into multiple columns.	
Unit-III: Microsoft Power point Presentation	**08 Lectures**
Open a Presentation, Outlines, Slide Structure, Fonts, Colour, Background, Graphs, Spelling and Grammar, Open a New Presentation, Save a Slide Show, Create a New Slide, Add Slides, Insert Pictures, Insert Clip Art, Format Pictures, Crop Images, Format Fonts, Header and Footer, Hyperlinks, Tables, Charts, Slide Themes, Slide Transitions, Rearrange Slides, Preview Presentations, View Outline, tips to make power point presentation more effective, From scratch, Templates, Adding and formatting graphics, Slide Master, Creating and setting up a custom show, Adding slide transitions & animations, Using more than one theme, Handout, Notes and Prints.	
Unit-IV: Excel Spreadsheets	**06 Lectures**
Understanding the basic concepts of a spreadsheet: Templates cells, rows and columns, Cell coordinates, Entering data into a spreadsheet cell, Setting up labels: setting column widths, Aligning data in cells, entering column and row labels, Creating and copying formulas, Making changes in a spreadsheet, inserting rows and columns, deleting rows and columns, Producing a printed copy of the contents of a document, Saving a backup copy of your work, Navigate a worksheet, Edit Data in a Worksh Appreciating the power of spreadsheet templates.	

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Course Learning Outcomes (CLOs)

- Having successfully completed this course work, students will be able to communicate the results of a review of the scientific literature relevant to course content in writing, using appropriate scientific terminology and formatting.
- Students will be able to analyse the data from a variety of sources as well as to work independently towards achieving well defined objectives.
- Students will be able to identify key elements of the scientific domain that are relevant to a research area.

Books Recommended:

- Open Software and standard Open and Licensed software.
- Andre Heck, Learning Latex by doing, AMSTEL Institute, 2002.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6105(i)
Scientific Writing and Presentation
Semester-I

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. How to generate a table in latex? Explain with example. What are the different ways of inserting graph and picture in latex document? Give example to create a table of content for latex document. (12 or 8,4)
2. How to insert reference and bibliography in latex? Explain with example. (12 or 8,4)

Section B

3. How to create hyperlinks in Power point presentation? Explain the steps of inserting a clip art or picture in Power Point presentation with example. (12 or 8,4)
4. What are the steps for adding slide transition and animations in Power Point presentation? (12 or 8,4)

Section C

5. How many data formats are available in excel? Name some of them. How to delete and insert columnsin excel spreadsheet? (12 or 8,4)
6. Explain spreadsheet and its basics. How can you wrap the text within a cell? (12 or 8,4)

Section D

7. Explain beamer in details. How can you format the slides? (12 or 8,4)
8. Explain, handouts, prints and notes. (12 or 8,4)

Section E (Compulsory)

9. (a) How to cross reference figure in latex?
   (b) What is the quick way to return to a retinacular area of a worksheet in excel?
   (c) How to split slides in multiple columns in latex?
   (d) Explain the various font formats in Power Point.
   (e) What are three report formats that are available in excel.
   (f) How is cell reference useful in calculation in excel? (6×2=12)

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SEMESTER-I

PHY-6105(ii) Institutional Training/Summer Internship/Survey (Optional)

PHY 6105(iii) SWAYAM/MOOCs/ NPTEL (Optional)

Teaching Scheme			Credit	Marks			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Instructions: INTERNAL ASSESSMENT

Name of the Institution:			Distribution of Marks					
Programme:			Periodical Examination		Teacher's Assessment		Attendance	Total Marks
Subject:		Sub. Code:						
Branch:		Semester:	Written	Viva-voce	Lab/work performance	Report/File work		
MAX. MARKS:		MIN. MARKS:						
Sr. No.	University Roll No.	Name of Student	10	10	10	05	05	40

For the External Examination:

The distribution of marks would be on the basis of work done (20 marks), performance (written/presentation) (20 marks) and viva-voce (20 marks), total=60 marks.

Guidelines for Institutional Training/Summer Internship/Survey/SWAYAM/MOOCs/NPTEL courses

For Institutional Training/ Summer Internship /Survey /SWAYAM /MOOC /NPTEL courses, the list of topics will be provided by the Department/University. The students will pick the option, get registered and prepare the report. Each student has to register for online course after the permission/approval from concerned Department/University and has to pass the selected online course within the duration of running semester. Guidelines for the online courses from SWAYAM/MOOC/NPTEL may be taken after the registration through online portal/concerned Department. The evaluation will be done on the basis of presentation/solving assignments and examination conducted by the Department (Department of Physics, HPTU).

The students have to complete Institutional Training / Summer Internship / Survey / SWAYAM / MOOC / NPTEL under the guidance of the supervisor (taken from the same Department) allotted by Head/Coordinator of the concerned Department. The students may be given option to complete above tasks by choosing co-supervisor from the same Department/University or from any other institutions. The Department may offer more than one optional/elective courses depending upon the specialization and strength of the faculty members. The final decision will be taken by the Head/Coordinator of the Department.

For institutional training / summer internship /survey /SWAYAM /MOOC /NPTEL) courses, each lecture/contact hour per week will be considered as one credit. The duration of written and viva voce examination and other conditions (if any) shall be decided by the internal and externc[illegible] appointed by the University authorities.

Internal and external examiners appointed by the University authorities.

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SEMESTER-I

UHV-6100 Universal Human Values and Professional Ethics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LOs)

- To help students distinguish between values and skills and understand the need basic guidelines, content and progress of value education.
- To enable the students to imbibe, internalize the values and ethical behavior in the personal and Professional lives.

Unit-I: Introduction to Value Education	**08 Lectures**
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness, and Prosperity – the Basic Human Aspirations Exploring Human Consciousness, Happiness and Prosperity-Current Scenario, Method to Fulfil the Basic Human Aspirations, Exploring Natural Acceptance.	
Unit–II: Harmony in the Human Being	**08 Lectures**
Understanding Human being as the Co-existence of the Self and the Body Distinguishing between the Needs of the Self and the Body, Exploring the difference of Needs of Self and Body. The Body as an Instrument of the Self Understanding Harmony in the Self Program to ensure self-regulation and Health Exploring Harmony of Self with the Body.	
Unit–III: Harmony in the Family and Society	**08 Lectures**
Harmony in the Family-the Basic Unit of Human Interaction, 'Trust'–the Foundational Value in Relationship, Exploring the Feeling of Trust, 'Respect'–as the Right Evaluation, Exploring the Feeling of Respect, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order, Exploring Systems to fulfil Human Goal.	
Unit-IV: Ethics	**06 Lectures**
Ethics-definitional aspects, Nature of ethics, Scope of ethics, The philosophical basis of ethics, Family ethics, Ethics at the workplace and professions, Relevance of ethics in society.	

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Course Learning Outcomes (CLOs)

- Students will be able to relate ethical concepts and materials to ethical problems in specific professions and professionalism.
- Students will be made available to aware about the types of ethical challenges.

Books Recommended:

- R. R. Gaur, RAsthana, G P Bagaria, The Textbook A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN978-93-87034-47-1.
- R. R. Gaur, R Asthana, GP Bagaria, The Teacher's Manual Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN978-93-87034-53
- R. R.Gaur, R.Sangal,G.P. Bhagaria, A Foundation Course in Value Education.
- A. Nagaraj, Jeevan Vidya: Ek Parichaya, , Jeevan Vidya Prakashan, Amar Kantak,1999.
- A.N. Tripathi, Human Values, New Age Intl. Publishers, NewDelhi, 2004.
- Mohandas Karamchand Gandhi, The Story of My Experiments with Truth.
- E. .F Schumacher, Small is Beautiful.
- Cecile Andrews, Slow is Beautiful.
- J. C. Kumarappa, Economy of Permanence.
- Pandit Sunder Lal, Bharat Mein Angreji Raj.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
UHV-6100
Universal Human Values and Professional Ethics
Semester-I

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Self-exploration is a process of dialogue between 'What you are' and 'What you really want to be'. Explain and illustrate. (12 or 8, 4)
2. What do you mean by values and human values? Explain the basic guidelines and process for value education? (12 or 8, 4)

Section B

3. How does the feeling of *Sanyam* ensure health of the body? List two programs of *Sanyam*. (12 or 8,4)
4. Distinguish between the needs of self and need of body. The needs of the body are quantitative support your answers with examples. (12 or 8, 4)

Section C

5. There are four orders in Nature. How do each other participate in the harmony in Nature? Give a few examples. (12 or 8, 4)
6. What is the meaning of justice in human relationships? How does it follow from family to world family? (12 or 8, 4)

Section D

7. What do you understand by competence in professional ethics? Give two examples of its implications in Industry. (12 or 8, 4)
8. What do you mean by competence in professional ethics? Elaborate with examples. (12 or 8, 4)

Section E (Compulsory)

9. Write short notes on the following:
   (a) Value Education.
   (b) Self-regulation.
   (c) Sensations and preconditioning.
   (d) Happiness and prosperity.
   (e) What do you mean by human relationship?
   (f) How to build trust in the relationship? (6x2=12)

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SEMESTER-I

PHY-6106P Physics Lab-I							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
0	0	4	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Learning Objectives (LO)

- To impart knowledge among the students to perform scientific experiments, accurately record and analyze the results of experiments.

List of Experiments	15 Lectures

Note: Students are required to perform at least Eight experiments.

1. To determine Planck's constant using photocell/LED.
2. To determine the wavelength of sodium light & also determine resolving power of using a diffraction grating.
3. Diode laser diffraction experiment.
4. To study the characteristics of phototransistor.
5. Solar cell characteristics.
6. Ionization potential of mercury/Neon.
7. To find conductivity of given semiconductor crystal using four probe method.
8. To determine the Hall coefficient for given semi-conductor and study its field dependence.
9. To study the characteristics of a LED and determine activation energy.
10. Characteristics of Photo Devices.
11. Magnetic susceptibility of Para-magnetic liquids.
12. Velocity of light determination experiment
13. To study Zeeman effect by using Na lamp.
14. To study the law of conservation of momentum, energy and dependency of mass ratio to kinetic energy using Linear Air track apparatus.
15. Frank Hertz Experiment

Note: The additional/other experiments may also be performed and asked in the examination depending on the availability of the equipments.

Course Learning Outcome (CLO)

- Students will be familiar to understand and apply the mathematical skills to solve quantitative problems in the study of physics.

Books Recommended:

- C.L. Arora Practical Physics S. Chand & company Ltd, 2009.
- S.P. Singh, Advanced Practical Physics Vol I & II, Pragati Prakashan, 15thEd,2017.
- S.S. Kapoor and V.S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi,1986.
- R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons1974.
- Lab Manuals

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HIMACHAL PRADESH TECHNICAL UNIVERSITY
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Syllabus

for

M.Sc. Physics

(Semester-II)

As per National Education Policy (NEP-2020)

(w.e.f. the Academic Year 2023-2024)

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SEMESTER-II

PHY-6201 Mathematical Physics-II							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs)

- To impart knowledge about various mathematical tools employed to study physics problems.
- To develop mathematical skills to solve quantitative problems in the study of physics.

Unit I: Special Functions	**15 Lectures**
Bessel Functions: Bessel functions of the first kind Jn(x), Generating function, Recurrence relations, Expansion of Jn(x) when n is half an odd integer, Integral representation; Legendre Polynomials Pn(x): Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of Pn(x); Hermite and Laguerre Polynomials: generating function & recurrence relations only.	
Unit II: Laplace Transforms	**15 Lectures**
Laplace Transforms, Transform of some Elementary Functions, Properties of Laplace transform, Transform of Derivatives, Transform of Integrals, Convolution theorem, and its applications, Inverse Laplace Transform, Applications of Laplace transform to differential equations and boundary value problems.	
Unit III: Fourier Series and Integral Transforms	**15 Lectures**
Fourier series, Dirichlet conditions, General properties of Fourier series, Fourier sine and cosine series, Fourier integral, Fourier integral theorem, Fourier Sine, Cosine and Complex transforms with examples, Properties of Fourier transform, Fourier transforms of Derivatives, Convolution theorem, Fourier transform of Integrals, Inverse Fourier transform and related problems.	
Unit-IV: Group Theory	**15 Lectures**
Definition of a Group, Multiplication table, Conjugate elements and classes, Subgroups, Isomorphism and Homomorphism, permutation group, Definition of representation and its properties, Reducible and irreducible representations, Characters of a representation, Cyclic groups, Matrix diagonalization, Lie groups, Three dimensional rotation group, Special unitary groups SU(2) and SU(3).	

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Course Outcomes (CLOs)

- Students will be able to use various techniques to solve differential equations, special functions and other mathematical problems of interest in Physics.
- Students will be able to understand the applications of group theory, Fourier series in all the branches of Physics problems.

Books Recommended:

- George B. Arfken and Hans-Jurgen Weber, Mathematical Methods for Physicists.
- J. Mathews and R. I. Walker (Benjamin), Mathematical Methods of Physics.
- A.K. Ghatak, Mathematical Method of Physics.
- M. R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables
- H.K. Dass Mathematical Physics, S. Chand Publisher
- A.W. Joshi, Matrices and Tensors in Physics, , New Age Publishers
- Erwin Kreyszig, Advanced Engineering Mathematics, John Willey & Sons, Inc.
- B.D. Gupta, Mathematical Physics, Vikas Publishing House.
- R.K. Jain and SRK Iyengar, Advanced Engineering Mathematics, Narosa Publications.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6201
Mathematical Physics-II
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks. Simple calculator may be allowed to the students in the examination.

The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. (a) Write Generating function for Hermite Polynomial.
   (b) State and prove Rodrigue's formula for $L_n(x)$ (Laguerre polynomial). (12 or 8,4)
2. Derive an expression for Recurrence formulae (any four) for Bessel's Polynomial $J_n(x)$. (12 or 8,4)

Section B

3. Find the Laplace transform of (i) (1+cos2t), (ii) (e^{at} sinbt). (12 or 8,4)
4. Prove that f(t) has the transform F(s) then the shifted function: (12 or 8,4)

$$f(t)=f(t-a)u(t-a)=\begin{cases}0 & if \quad t<a\\ f(t-a) & if \quad t>a\end{cases}$$

Section C

5. Derive expression for Fourier integral starting from Fourier series, also write Fourier cosine and Fourier sine integrals for $f(x)=e^{-kx}$ where $x>0$ and $k>0$. (12 or 8,4)

6. A sinusoidal voltage E sinωt, where t is time, is passed through a half wave rectifier that clips the negative portion of the wave. Find the Fourier series of the resulting periodic function: (12 or 8,4)

$$U(t)=\begin{cases}0 & \text{if} \quad -L<t<0\\ E\sin\omega t & \text{if} \quad 0<t<L\end{cases}$$

Section D

7. (a) Prove that:
   (i) Every tensor can be written as the sum of a symmetric tensor and a skew symmetric tensor.
   (ii) The symmetry of the tensor is an invariant property.
   (b) State and explain the quotient law for tensors. (12 or 8,4)

8. Let G be a subgroup of some dihedral group. For each x in G, define:

$$\phi(x)=\begin{cases}+1 \text{ if } x \text{ is rotation}\\ -1 \text{ if } x \text{ is a reflection}\end{cases}$$

Prove that Φ is a homomorphism from G to the multiplicative group {+1,-1}. What is the kern

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Section E (Compulsory)

9. (a) Write general expression of Rodrigue's formula in Bessel's Differential Equation.
   (b) Define First shifting property of Laplace Transform.
   (c) What is Homomorphism?
   (d) Prove that the covariant derivative of the metric tensor is zero.
   (e) What is Dirichlet's condition in Fourier series? State the monotonic and bounded conditions.
   (f) What is the value of Laplace Transform of Sinh x? (6x2=12)

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SEMESTER-II

PHY-6202 Electronics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
4	0	0	4	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs)

- To gain a deeper understanding of linear and digital electronic circuits, to be able to conceptualize, implement and actualize both linear and digital electronics circuits.
- The course will enable students to study the design and implementation of digital circuits and also the microprocessor architecture as a basis for computers.

Unit-I: Operational Amplifier	**15 Lectures**
Differential amplifier, Inverting and non-inverting inputs, Analysis of inverting and non-Inverting amplifier, Effect of negative feedback on input resistance, Output resistance, Band width; closed loop gain and offset voltage, Voltage follower, Input bias current, Input off-set current, Total output offset voltage, CMRR. DC and AC amplifier, Summing, Scaling, Instrumentation amplifier, Integrator and differentiator, log & antilog Amplifiers, Comparators, Waveform generators and Regenerative comparator (Schmitt Trigger) using 741 op amp. Oscillator principles, Oscillator types, Frequency stability, Frequency response, Phase shift oscillator.	
Unit-II: Sequential Logic	**15 Lectures**
Flip-Flop: Al-Bit memory- RS Flip-Flop, JK- Flip-Flop, JK master slave-Flip-Flop, T Flip- Flop, D- Flip-Flop-Shift Registers, Synchronous and Asynchronous Counter, Cascade Counters, A/D and D/A Converters.	
Unit-III: Microprocessors	**15 Lectures**
Introduction to microcomputers, Input/output- interfacing devices, 8085 CPU – Architecture- BUS timings, Demultiplexing the address bus generating control signals, Instruction Set, Addressing Modes, Illustrative Programmes, Writing Assembly Language Programmes, Looping, Counting and Indexing, Counters and Timing Delays, Stack and Subroutine. Microprocessor Applications, Recent trends in microprocessor technology.	
Unit-IV: Modulation & Communication Systems	**15 Lectures**
Basic concepts of communication systems, Need for modulation, Amplitude Modulation, Generation of AM waves, Demodulation of AM waves. Frequency modulation, Block diagram of transmitter and super hytrodyne receiver, Digital communication, Basic idea about delta modulation, PCM, PPM a BSC modulation, Generation of DSBSC waves, Coherent detection DSBSC wave, SSE Generation and detection of SSB waves, Vestigial sideband modulation, Frequency division multipl	

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Course Learning Outcomes (CLOs)

- Students will be able to use techniques for analyzing analogue and digital electronic circuits.
- Students will be able to formulate the concepts of operational amplifier, identify major properties of op-amps circuits.
- Students will be able to provide theoretical knowledge and develop the practical skill in digital systems, logic systems and Microprocessor.

Books Recommended:

- MiIlman & Halkias. Integrated electronics, McGraw Hill Education, 2nd edition 2017.
- D. V. Hall, Microprocessor and Interfacing, McGraw Hill Education, 3rd edition 2017.
- Millman & Grabel, Micro Electronics, McGraw Hill Education, 2nd edition 2017.
- AP. Malvino and A. Brown, Digital Computer Electronics.
- R. P. Jain, Modern digital electronics, McGraw Hill Education,4th edition 2009.
- R. S. Gaonkar, Microprocessor Architecture, Programming and Applications, Prentice-Hall.
- A.P. Mathur, Introduction to Microprocessors, McGraw-Hill Publishing Co.
- Kennedy, Electronic communication system, McGraw Hill Education, 3rd edition 2017.
- S. Gaonkar, Microprocessor Architecture Prog. & Appls. Wiley-Estern.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6202
Electronics
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is comparator? Explain the working of comparator. What are its important characteristics? (12 or 8,4)
2. What is the principle of Phase shift oscillator? Derive an expression for frequency of oscillation of phase shift oscillator. (12 or 8,4)

Section B

3. What is the difference between counter and a shift registers? Discuss the various kinds of shift registers. (12 or 8,4)
4. What is Flip Flop? Explain working of NOR and NAND latch. Also explain the circuit diagram, truth table, excitation table and k-map of J-K flip flop. (12 or 8,4)

Section C

5. What are the functions of an accumulator? Explain in brief the recent trends in microprocessors. (12 or 8,4)
6. What is the principle and application of microprocessors? Draw and explain the architecture of 8085 microprocessor. (12 or 8,4)

Section D

7. What is the difference between AM and demodulation of AM waves? An audio frequency signal $10\sin(2\pi \times 10^3 t)$ is used to modulate amplitude of a carrier of $20\sin(2\pi \times 104t)$. Calculate (i) Modulation index (ii) Side band frequencies (iii) percentage modulation (iv)Total power delivered to the load of 600Ω. (12 or 8,4)
8. What do you mean by DSBSC and SSC waves? Explain the generation and coherent detection of DSBSC waves. (12 or 8,4)

Section E (Compulsory)

9. (a) What is the difference between a CPU and a microprocessor?
   (b) What is the use of shift register?
   (c) What is the common mode rejection ratio?
   (d) Draw the block diagram of communication system.
   (e) What are the advantages of FDM?
   (f) What do you mean by frequency response? (6x2=12)

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SEMESTER II

PHY-6203 Statistical Physics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
4	0	0	4	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs):

- The students will be able to work out equations of state and thermodynamic potentials for elementary systems of particles.
- The students will be able to use ensemble theory and develop mean field theory for first and second order phase transitions.

Unit-I: Thermodynamics	**15 Lectures**
Basic ideas about heat, Temperature, Work done, Laws of thermodynamics and their significance, Specific heats, Thermodynamic potentials, Maxwell relations significance of entropy, Chemical potentials, Phase equilibrium, Entropy of mixing and Gibb's paradox.	
Unit–II: Ensembles	**15 Lectures**
Concepts of phase space, Microstates, Macro states, Equal priori probability, Ensemble of particles, Micro canonical ensemble, Macro canonical ensemble, Grand canonical ensemble. Derivation of partition function, Derivation of thermodynamic quantities from each ensemble, Free energy and its connection with thermodynamic quantities.	
Unit–III: Classical Statistical Mechanics	**15 Lectures**
Link between entropy and probability, Boltzmann's equation, Elementary ideas about three different statistics, Classical statistics – Maxwell & Boltzmann statistics, Classical ideal gas equation, Equipartition theorem. Bose-Einstein Statistics: Bose-Einstein statistics, Black body radiation, Rayleigh Jeans formula, Wien's law, Planck radiation law, Bose Einstein condensation, Einstein model of lattice vibrations, Phonons, Debye's theory of specific heats of solids.	
Unit-IV: Fermi-Dirac Statistics	**15 Lectures**
Basics for quantum statistics, System of identical indistinguishable particles, Symmetry of Wave functions, Bosons, Fermions, Fermi & Dirac statistics, Fermi free electron theory, Pauli Para magnetism, Phase transitions and fluctuations: Type of phase transitions, First and second order phase transitions, Diamagnetism, Paramagnetism and ferromagnetism, Ising model, Mean-field theories of the Ising model, Thermodynamic fluctuations, and Brownian motion, Introduction to non-equilibrium processes, Diffusion equation.	

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Course Outcome

- On completion of the course students will understand Physics of equilibrium systems, Fermi and Bose systems, Bose-Einstein condensation and Phase transitions, magnetism and super fluids, and critical phenomena.

Books Recommended:

- R.K. Patharia, Statistical Mechanics, (Butterworth-Heinemann, Oxford), 2nd edition (2005).
- K. Huang, Statistical Mechanics, (Wiley Eastern, New Delhi) 2011,
- B.K. Agarwal and M. Eisner, Statistical Mechanics, (Wiley Eastern, New Delhi) (1988).
- C. Kittel, Elementary Statistical Physics, (Wiley, New York) (1958).
- F. Reif, Fundamentals of Statistical and Thermal Physics, International Students Edition,
- Tata McGraw-Hill (1988).
- B. B. Laud, Fundamentals of Statistical Mechanics, New Age.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6203
Statistical Physics
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Derive Maxwell relations used in thermodynamics. (12 or 8,4)
2. Explain Gibb's paradox. Discuss how it avoided using ensemble theory. (12or 8,4)

Section B

3. Discuss the need for three different types of statistics and compare them.
4. Write the names of ensemble mostly used. Find the expression for partition function for grand canonical ensemble.

Section C

5. Explain Einstein model of lattice vibrations. (12 or 8,4)
6. Discuss the black body radiation using Planck's law and derive Rayleigh Jeans law. (12 or 8,4)

Section D

7. What are first order and second order phase transitions? (12 or 8,4)
8. Derive expression for energy and fluctuation in energy and pressure using canonical ensemble. (12 or 8,4)

Section E (Compulsory)

9. (a) What is Sterling approximation?
   (b) Calculate change in the entropy of 1kg water if it is from zero degree centigrade to 100 degree centigrade. Given $= 4.180$.
   (c) What is the effect of Pauli's exclusion principle on total number of microstates?
   (d) Define Curie temperature. What is the order of phase transition which occurs at this point?
   (e) Write the expression for Wein's law and draw appropriate diagram.
   (f) Draw the variation of Fermi distribution function at T=0 and T>0. (6×2=12)

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SEMESTER II

PHY-6204 Atomic and Molecular Physics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
4	0	0	4	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To impart the knowledge about the fundamentals of atomic and molecular Physics of the systems and to describe the structure of atoms and molecules on the basis of quantum mechanics.

Unit-I: Atomic Physics	**15 Lectures**
Quantum states of one electron atom, atomic orbitals, Hydrogen spectrum, Spectra of alkali elements, Spin-orbit interaction and fine structure of alkali spectra, Normal and anomalous Zeeman effect, Paschen-Back effect, Stark effect, Two electron system, Equivalent and non-equivalent electron, Pauli exclusion principle, Interaction energy, LS and JJ coupling, Hyperfine structure, Lande interval rule and Auger effect.	
Unit-II: Rotational Spectra	**15 Lectures**
Types of molecules: Linear, Non-linear, Symmetric top, Asymmetric top and spherical top, Born Oppenheimer Approximation, Rotational Spectra of diatomic molecules as a rigid rotator, Energy level diagram and spectra, Rotational spectra of non rigid rotator, Energy level diagram and spectra, Isotope effect, Intensity of rotational lines, Application of rotational spectra and Pure rotational Raman spectra.	
Unit-III: Vibrational and Vibrational- Rotational Spectra	**15 Lectures**
Vibrational energy of a diatomic molecules, Diatomic molecule as a simple harmonic oscillator, its energy level diagram and spectrum, Morse potential energy curve, Molecules as vibrating rotator, Vibration spectrum of diatomic molecule, PQR branches, Vibration-rotation spectra, Vibrational Raman Spectroscopy, Electronic spectra of diatomic molecules- vibrational structure of electronic transitions, Rotational structure of electronic bands, Intensities in electronic bands-The Franck-Condon principle.	
Unit-IV: Laser Spectroscopy	**15 Lectures**
Transition probability and life time of an atom in an exited state, Population inversion, Laser rate equation for two and three level systems, Line broadening mechanism, shape and width of spectral line, Optical resonator; Quality factor, Losses inside the cavity, threshold condition, Laser systems; Solid State laser, He-Ne laser, CO_2 laser, Semiconductor lasers.	

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Course Learning Outcomes (CLOs)

- Students will be able to learn Atomic Physics with problem solving approach towards spectroscopy.
- Students will be able to understand the static properties of nuclei, nuclear force and nuclear models.
- Students will apply the knowledge gained in atomic and molecular spectroscopy as well as to understand classical/Quantum description of electronic, vibrational and rotational spectra.

Books Recommended:

- B. H. Bransden and C. J. Jochain, Physics of Atoms and Molecules, 2nd Ed., Pearson Education (2003).
- G. Herzberg, Atomic Spectra and Atomic Structure, Dover Publications (2003).
- G. Herzberg, Molecular Spectra and Molecular Structure, Van Nostrand (1950).
- W. Demtroder, Atoms, Molecules and Photons, Springer (2006).
- C. N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill (1983).
- J. M. Hollas, Basic atomic & Molecular Spectrocopy, Royal Society of Chemistry (2002).
- N. Levine, Quantum Chemistry.
- P Atkins & R. Friedman, Molecular Quantum Mechanics, Oxford Univ. Press, (2005).
- W. Demtroder, Laser Spectroscopy, 3rd Ed., Springer (2003).
- O. Svelto, Principles of Lasers, 5th Ed., Springer (2010).

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6204
Atomic and Molecular Physics
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is Normal Zeeman effect? How it differs from anomalous Zeeman effect? Find the effect of magnetic field on energy level and frequency of spectral lines? (12 or 8,4)
2. Explain the following terms: (i) Stark effect, (ii) spin orbit Interaction, (iii) Lande interval rule (12 or 8,4)

Section B

3. Discuss Born-Oppenheimer approximation for diatomic molecules. (12 or 8,4)
4. What is the difference between homonuclear and heteronuclear molecules? Explain the Molecular Orbital Treatment of Hydrogen Molecule Ion ($^{+}$ion). (12 or 8,4)

Section C

5. Discuss the theory of diatomic molecule as anharmonic oscillator. Obtain the expression for the Vibrational energy and explain Morse Curve. Discuss various selection rules and different types of transitions. (12 or 8,4)
6. Discuss the principal features of electronic spectrum of a diatomic molecule. (12 or 8,4)

Section D

7. What is LASER? Explain its main components for lasing action. Also explain principle, constructionand working of He-Ne laser. (12 or 8,4)
8. What do you mean by population inversion? Explain the principle, construction and working of any one solid state laser. (12 or 8,4)

Section E (Compulsory)

9. (a) What is the difference between the spontaneous and stimulated emission?
   (b) Write the equations for multilevel rate equations?
   (c) Explain Franck-Condon principle?
   (d) What do you mean by dissociation energy?
   (e) Find the bond order of O_2 molecule?
   (f) What is the difference between LS and JJ coupling schemes? (6 x 2 = 12)

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SEMESTER-II

PHY ID-6001(i) Radiation Safety							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs)

- This course focuses on the applications of nuclear techniques and radiation protection.
- It will not only enhance the skills towards the basic understanding of the radiation but will also provide the knowledge about the protective measures against radiation exposure.
- It imparts all the skills required by a radiation safety officer or any job dealing with radiation such as X-ray operators, jobs dealing with nuclear medicine: operators of PET, MRI, CT scan, gamma camera etc.

Unit 1: Radiation and its Interaction with Matter	**08 Lectures**
Basic idea of different types of radiation electromagnetic (X-ray, gamma rays, cosmic rays etc.), nuclear radiation and their origin. **Nuclear Radiation:** Basic idea of Alpha, Beta, Gamma neutron radiation and their sources (sealed and unsealed sources). **Interaction of Charged Particles (including alpha particles):** Heavy charged particles (e.g. accelerated ions)-Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, and Straggling. **Interaction of Beta Particles:** Collision and Radiation loss (Bremsstrahlung). **Interaction of Photons:** Linear and Mass Attenuation Coefficients. **Interaction of Neutrons:** Collision, slowing down and Moderation.	
Unit II: Radiation Detection and Monitoring Devices	**08 Lectures**
Basic concepts and working principle of gas detectors, Scintillation Detectors, Solid State Detectors and Neutron Detectors, Thermo luminescent Dosimetry. **Radiation Quantities and Units:** Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, annual limit of intake (ALI) and derived air concentration (DAC).	
Unit III: Radiation Safety Management	**08 Lectures**
Biological effects of ionizing radiation, Operational limits and basics of radiation hazards, its evaluation and control: radiation protection standards. International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation.	
Unit IV: Application of Radiation as a Technique	**06 Lectures**
Application in medical science (e.g., basic principles of X-rays, MRI, PET, CT scan, Projection Imaging Gamma Camera, Radiation therapy), Archaeology, Art, Crime detection, Mining and oil. **Industrial Uses:** Tracing, Gauging, Material Modification, Sterilization, Food preservation.	

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Course Learning Outcomes (CLOs)

- Awareness and understanding the hazards of radiation and the safety measures to guard against these hazards.
- Knowing about the units of radiations and their safety limits, the devices to detect and measure radiation.
- Learning radiation safety management, biological effects of ionizing radiation, operational limits and basics of radiation hazards evaluation and control, radiation protection standards.
- Learning about the devices which apply radiations in medical sciences, such as X-r a y, MRI, PET, CT-scan.

Books Recommended:

- K Heyde, Nuclear Physics: An introductory approach, third edition, IOP Publication, 1999.
- S N Ghoshal, Nuclear Physics, First edition, S. Chand Publication, 2010.
- J Lilley, Nuclear Physics: Principles and Applications, Wiley Publication, 2006.
- A Martin and S A Harbisor, An Introduction to Radiation Protection, John Willey and Sons, Inc. NewYork, 1981.
- W J Meredith and B Massey, Fundamental Physics of Radiology, John Wright and Sons, UK, 1989.
- G F Knoll, Radiation detection and measurement, 4th Edition, Wiley Publications, 2010.
- W R Leo, Techniques for Nuclear and Particle Physics experiments, Springer, 1994.
- A F Mcknlay, Bristol, Adam Hilger, Thermoluminescence dosimetry, Medical Physics Hand book.
- W R Hendee, Medical Radiation Physics, Year book Medical Publishers, Inc., London, 1981.
- S N Ahmed, Physics and Engineering of Radiation Detection, Academic Press Elsevier, 2007.
- IAEA Publications: (a) General safety requirements Part 1, No. GSR Part 1 (2010), Part 3 No. GSR Part 3 (Interium) (2010); (b) Safety Standards Series No. RS-G-1.5 (2002), Rs-G-1.9 (2005), Safety Series No. 120 (1996); (c) Safety Guide GS-G-2.1 (2007).

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY ID-6001(i)
Radiation Safety
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Discuss interaction of heavy charged particle with matter. Obtain the Bethe-Bloch formula and hence obtain result of the range of the charged particle. (12 or 8,4)

2. Explain the basic idea about different types of radiation electromagnetic and nuclear radiation and their origin. (12or8,4)

Section B

3. Discuss the principle, construction and working of scintillation detectors. Give its main advantages. (12 or 8,4)

4. Explain the terms absorbed dose, effective dose and equivalent dose. (12 or 8,4)

Section C

5. What do you mean by biological effects of ionizing radiation? Discuss them in detail. (12 or 8,4)

6. What is ICRP? Explain its different principles. (12 or 8,4)

Section D

7. Explain principle, construction and working of Positron Emission Tomography (PET). (12or 8,4)

8. Explain the terms: Tracing, Gauging, and Material Modification. (12or 8,4)

Section E (Compulsory)

9. (a) Write short note on sealed and unsealed source of radiation.
   (b) Define linear and mass attenuation coefficient.
   (c) What is Radiation Therapy?
   (d) Explain the concept of Bremsstrahlung.
   (e) Annual limit of intake
   (f) Explain KERMA (6×2=12)

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SEMESTER II

PHY ID-6001(ii) Physics for Everyone							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
2	0	0	2	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- Every student will be able to study physics on a deeper level and to uses basic physics concepts to navigate everyday life.

Unit-I: Physics in Earth's Atmosphere	**08 Lectures**
Sun, Earth's atmosphere as an ideal gas; Pressure, temperature and density, Pascal's Law and Archimedes' Principle, Coriolis acceleration and weather systems, Rayleigh scattering, the red sunset, Reflection, refraction and dispersion of light, Total internal reflection, Rainbow.	
Unit-II: Physics in Human Body and Sports	**08 Lectures**
The eyes as an optical instrument, Vision defects, Rayleigh criterion and resolving power, Sound waves and hearing, Sound intensity, Decibel scale, Energy budget and temperature control.	
Unit-III: Physics in Sports	**08 Lectures**
The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Motion of a spinning ball, Continuity and Bernoulli equations, Turbulence and drag.	
Unit IV: Physics in Technology	**06 Lectures**
Microwave ovens, Lorentz force, Global Positioning System, CCDs, Lasers, Displays, Optical recording, CD, DVD Player, Tape records, Electric motors, Hybrid car, Telescope, Microscope, Projector etc.	

Course Learning Outcome (CLO)

- Every student will be able to build essential scientific knowledge and skills for life-long learning.

Books Recommended:

- F. W. Sears, M. Zemansky, R. A. Freedman, and H. D. Young, University Physics, Pearson Education.
- D. Halliday, R. Resnick, J. Walker, Fundamentals of Physics, John Wiley & Sons.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY ID-6001(ii)
Physics for Everyone
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is Coriolis effect? How does the Coriolis Effect affect weather patterns? (12 or 4,8)
2. Explain the following:
   (i) Rayleigh scattering with the help of example.
   (ii) Total internal reflection with the help of example. (12 or 4,8)

Section B

3. Explain each part of eye with the help of diagram? Also explain the types of vision defect. (12 or 4,8)
4. Explain the following:
   (i) Earth's energy budget
   (ii) Temperature control (12 or 4,8)

Section C

5. What is Bernoulli's theorem? Derive an expression for it. Also explain its one application. (12 or 4,8)
6. What do you mean by sweet spot? Discuss the concept of Dynamics of rotating objects. (12 or 4,8)

Section D

7. What is Lorentz force? Discuss the components of Global Positioning System? How does GPS work? Explain in brief. (12 or 4,8)
8. Explain the following:
   (i) Telescope and microscope
   (ii) CD and DVD player (12 or 4,8)

Section E (Compulsory)

9. (a) State Pascal's law?
   (b) Define Presbyopia?
   (c) What are the laws of physics used in sports?
   (d) How is a microwave related to physics?
   (e) What hybrid car means?
   (f) What is the difference between longitudinal and transversal waves? (6x2=12)

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SEMESTER-II

PHY ID-6001(iii) Social Connect of Science and Technology							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Note: In each theory paper, nine questions are to be set. The question paper will consist of five sections A, B, C, D & E. Sections A, B, C & D will have two questions of 12 or 8, 4 each and section E will consist of six short answer type questions (covering whole syllabus), each of having 02 marks. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and section E will be the compulsory question.

In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover whole syllabus.

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Learning Objectives (LOs)

- To enable the student to understand the character and functions of science and technology and their inter-relationships with society from a historical perspective.
- To enable the student to anticipate and comprehend the impacts, implications, and limitations of the new developments in science and technology.
- To familiarize the student with the sociological, cultural, ethical, environmental, economic and ideological aspects of science and technology.

Unit 1: History of Science and Technology	**8 Lectures**
Introduction to Science, Technology, Culture and Traditions. Introduction to Bharatiya Civilization, Babylonia, Egypt, Greek and Roman Civilizations of the World.	
Unit II: Science, Technology and Society in Ancient Times	**8 Lectures**
Ancient to Modern Bharat: Vedic and Post-Vedic Era till 18th Century and 19th Century to Modern Times, Contribution of Babylonia, Egypt, Greeks, Romans and Bharatiya civilization to Modern Science and World Trade.	
Unit III: Impact of Science and Technology in Modern Times	**7 Lectures**
Technology as Knowledge and Information Society, Computers & Information Technology, Automation, Robotic Technology, Manufacturing and Energy Technologies, Medical and Agricultural Technologies, Construction, Transport and Space Technologies.	
Unit IV: Impacts and Recent Developments	**7 Lectures**
Environmental Impact (on energy, water and global warming) and their effect on Science and Technology and Society, Role of Innovation and R&D Strategies in Bharat, Industry-Academia Interaction to Enhance Standard of Living. Recent Developments in Science and Technology and their influence on Society, Other Integrating Issues and their possible solutions.	

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Course Learning Outcomes (CLOs)

- This paper is interdisciplinary in nature and would provide students with basic exposure to scientific methods, technologies and developments that have played a significant role in the evolution of human society from ancient to modern times.
- Students would also be made aware of the scientific rationale of technological developments that would enable them to make informed decisions about their potential impact on society.

Books Recommended:

- Sal Restivo, Science, Technology and Society: An Encyclopedia, Oxford University Press (2005).
- Wenda K. Bauchspies, Jennifer Croissant, Sal P. Restivo, Science, Technology and Society: A Sociological Appraoach, Wiley-Blackwell, (2008).
- Stephan H. Cutcliffe, Carl Mitcham, Vision of STS: Counterpoints in Science Technology and Society Studies by, Sunny Press (2012)
- Basu and Khan, Marching Ahead with Science. National Book Trust (2001).
- Gopalakrishnan, Inventors who revolutionized our Lives, National Book Trust, India (2006).
- Hakob Barseghyan, Nicholas Overgaard, and Gregory Rupik, Introduction to History and Philosophy of Science.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY ID-6001(iii)
Social Connect of Science and Technology
Semester-II

Time : 3 Hours **Max. Marks : 60**

The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

The question paper consists of five sections A, B, C, D and E. Sections A, B, C and D have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from the sections A, B, C, D and the compulsory question from section E.

Section A

1. What is culture heritage? Explain its general characteristics and importance in human life. (12 or 8,4)
2. Identify the social, economic, legal and religious structure for Bharatiya, Egypt, Greek and Roman civilization of the world. (12 or 8,4)

Section B

3. Explain the Bharatiya, Egypt, Greek and Roman historical contribution to Modern science and world trade. (12 or 8,4)
4. Distinguish between the Vedic and Post-Vedic Era till 18th Century and 19th century to modern times. (12 or 8,4)

Section C

5. How Give the recent development in science and technology. Also explain how it influence our society? (12 or 8,4)
6. Explain in detail the impact of science and Technology on society in Modern Times. (12 or 8,4)

Section D

7. Give the recent development in science and technology. Also explain how it influence our society? (12 or 8,4)
8. Explain in detail the environmental impact of energy, water and global warming. Give their possible solutions. (12 or 8,4)

Section E (Compulsory)

9. (a) Explain how science and technology plays a very important role in today's world?

(b) How you can say that culture is dynamic?

(c) The first e-waste clinic of India was recently opened in which city?

(d) What do you mean by Science and Technology? How they contribute to each other?

(e) Give the impact and solutions of global warming

(f) India's first supercomputer is known as? (6 x 2 = 12)

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SEMESTER II

IKS-6200 Indian Knowledge System							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
2	0	0	2	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs)

- To equip the students with the knowledge and understanding related to Indian knowledge systems, origin, evolution and the approaches used in ancient and modern times.
- To promote the youths to do research in the various fields of Bhāratīya knowledge system.

Unit-I: Bhāratīya Civilization and Development of Knowledge System.	**08 Lectures**
Genesis of the land, On the trail of the Lost River, Discovery of the Saraswatī River, The Saraswatī-Sindhu civilization, Traditional knowledge system, The introduction to Vedas, Main Schools of Philosophy (6+3), Ancient education system, The Takṣaśilā University, The Nālandā University, Alumni, Knowledge export from Bhārata.	
Unit-II: Arts, Literature and Scholars	**08 Lectures**
Art, Music, and Dance, Naṭarāja– A masterpiece of Bhāratīya Art, Literature, Life and works of Agastya, Lopāmudrā, Ghoṣā, Vālmīki, Patañjali, Vedavyāsa, Yājňavalkya, Gārgī, Maitreyī, Bodhāyana, Caraka, Suśruta, Jīvaka, Kaṇāda, Patañjali, Kauṭīlya, Pāṇini, Thiruvalluvar, Āryabhaṭa, Varāhamihira, Bhāskarācārya, Mādhavācārya.	
Unit-III: Engineering, Science and Management	**08 Lectures**
Engineering, science and technology in the Vedic Age, Post-Vedic period and Saraswatī-Sindhu civilization, Concept of matter, life and universe, Bhāratīya Kāla-gaṇanā, Concepts of Zero, Pi and number system, Vedic Mathematics, Āyurveda, Astronomy in India, Agriculture in India, Water Management in India, Trades in Ancient India, Seals, Coins and Marine Technology.	
Unit-IV: Cultural Heritage and Indian Traditional Practices	**06 Lectures**
Temple architecture in ancient India, Sculptures, Theatre, Drama and Martial arts traditions, Fairs and festivals, Yoga, Integrated approach to healthcare, Approaches and strategies to the protection and conservation of environment. .	

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Course Learning Outcomes (CLOs)

- The students will be able to understand and appreciate the rich heritage that resides in our traditions.
- The students will be able to improve mindfulness and more maturity leading to effective process of learning.

Books Recommended:

- Bhag Chand Chauhan, IKS: The Knowledge of Bharata, Garuda Prakashan, 2023.
- Pradeep Kohle et. Al. Pride of India- A Glimpse of India's Scientific Heritage edited by Sanskrit Bharati, 2006.
- Keshav Dev Verma, Vedic Physics, Motilal Banarsi dass Publishers, 2012.
- Suresh Soni, India's Glorious Scientific Tradition, Ocean Books Pvt. Ltd., 2010.
- Sibaji Raha, et al, History of Science in India Volume-1, Part-I, Part-II, Volume VIII, National Academy of Sciences, India and The Ramkrishna Mission Institute of Culture, Kolkata, 2014.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-6200
Indian Knowledge System
Semester-II

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What are Vedas? How many types of Vedas? Explain. (12or 8, 4)
2. What was the ancient system of education in India? (12 or 8, 4)

Section B

3. Write a short note on the Life and works of Agastya. (12 or 8, 4)

4. Write a short note on:
   (1) Āryabhaṭa
   (2) Kauṭīlya (12 or 8, 4)

Section C

5. What was science and technology during the Vedic period? (12 or 8, 4)
6. Write a brief note on the trading communities in ancient India? (12 or 8, 4)

Section D

7. Explain briefly on Temple architecture in ancient India. (12 or 8, 4)
8. Write a short note on:
   (a) Fairs and festivals in India
   (b) Yoga (12 or 8, 4)

Section E (Compulsory)

9. (a) Which of the following Vedic literature contains Gayatri Mantra?
   (b) What is Agastya Rishi famous for?
   (c) Who invented Zero?
   (d) How important are Aryabhatta's discoveries to the modern world?
   (e) Agriculture in ancient India.
   (f) Who destroyed Takshila University? (6×2=12)

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SEMESTER-II

PHY-6205P Physics Lab-II							
Teaching Scheme			Credit	Marks			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
0	0	4	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Learning Objective (LO)

- To impart knowledge among the students to perform scientific experiments, accurately record and analyze the results of experiments.

List of Experiments:

Note: Students are required to perform at least Eight experiments.

1. P-N Junctions-Study of the energy band-gap and diffusion potential of P-N Junctions.
2. Zener diode: Characteristics and voltage regulation.
3. Experiment on Uni-Junction Transistor and its applications.
4. To study the characteristics of Junction Field Effect Transistor (FET/MOSFET.
5. Application of op-amp as inverting and non-inverting Amplifier.
6. To use the op-amp as summing, scaling, averaging amplifier, differentiator and integrator.
7. To study Registors/Counters
8. Basic Logic Gates, NAND and NOR, XOR, XNOR, combinational Logic
9. Flip-Flops: RS, JK/JK master slave, T and D.
10. Network Analysis-Thevenin and Norton's equivalent circuits
11. Study of clipping and clamping circuits.
12. A/D and D/A conversion
13. To Study the Half and full adder of binary numbers.
14. Design 2:1, 4:1 MUX circuit using basic gates and verify.
15. Addition, Subtraction, Multiplication & Division using 8085/8086.
16. BCD to Seven Segment display
17. Fibre optics communication
18. Modulation and demodulation: AM, FM, PAM.
19. Characteristics of Semiconductors Diodes.
20. Study of Digital-to-Analog Converter (with CRO)

Note: The additional/other experiments may also be performed and asked in the examination depending on the availability of the equipments.

Course Learning Outcomes (CLOs)

- Students will be able to acquire hands on experience of handling different instruments.
- Students will be familiar with the various components to be used in various circuits.
- Students will be able to design and perform scientific experiments as well as accurately analyze the results of experiments.

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Books Recommended:

- C.L. Arora Practical Physics S. Chand & company Ltd (2009).
- S. P. Singh,_Advanced Practical Physics Vol I & II, Pragati Prakashan, 15th Ed (2017).
- S.S. Kapoor and V.S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi (1986).
- R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons (1974).
- R.C. Verma, P.K. Ahluwalia & K.C Sharma, Computational Physics: An Introduction, , New Age Pub.
- Lab manuals

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HIMACHAL PRADESH TECHNICAL UNIVERSITY
HAMIRPUR

Syllabus

for

M.Sc. Physics

(Semester-III)

As per National Education Policy (NEP-2020)

(w.e.f. the Academic Year 2023-2024)

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SEMESTER-III

PHY-7301 Quantum Mechanics-II							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objectives (LOs)

- The primary objective is to teach the students the concept of commutation relations of angular momentum and symmetry along with relativistic Quantum mechanics.
- The important topic of non-relativistic scattering is also dealt with.

Unit-I: Time Dependent Perturbation Theory	**15 Lectures**
The First and second order transitions, Transition to continuum of states, Fermi Golden-rule, Constant and harmonic perturbation, A charged particle in an electromagnetic Field.	
Unit-II: Scattering Theory	**15 Lectures**
Scattering amplitude, Expression in terms of Green's function, Born approximation and its validity, Partial wave analysis, Phase shifts, Asymptotic behavior of partial waves, The scattering amplitude in terms of phase shift, Scattering by Coulomb potential and Yukawa potential.	
Unit-III: Identical Particles	**15 Lectures**
Brief introduction to identical particles in quantum mechanics, The Schrodinger equation for a system consisting of identical particles, Symmetric and anti-symmetric wave functions, Elementary theory of the ground state of two electron atoms, Ortho-and para-helium, Spin and statistics connection, Scattering of identical particles.	
Unit IV: Relativistic Wave-Equation	**15 Lectures**
Klein-Gordon equation, Plane wave equation, Charge and current density, Application to the study of Hydrogen like atom, Dirac relativistic equation for a free particle, Dirac matrices, Dirac equation in electromagnetic field, Negative energy states. Quantum Field Theory: Quantization of wave fields, Field quantization of the non-relativistic Schrodinger equation, Creation, destruction and number operators, Anti commutation relations, Quantization of electromagnetic, Field energy and momentum.	

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Course Learning Outcomes (CLOs)

- To give exposure about the various tools employed to analyze the quantum mechanical problems.
- At the end of the course, the student will be able to understand relativistic effects in quantum mechanics and its need.

Books Recommended:

- P.M. Mathews & K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill., 2017.
- G. Aruldhas, Quantum Mechanics, Prentice Hall of India, 2008.
- David J. Griffiths, Introduction to Quantum Mechanics, Cambridge University Press, 2018.
- L.I. Schiff, Quantum Mechanics, McGraw Hill, 1968.
- N. Zettili. Quantum Mechanics - Concepts and Applications, Wiley, 2023.
- V. Devanathan, Quantum Mechanics, Alpha Science Intl Ltd, 2019.
- Ghatak & Loknathan, Quantum Mechanic 1st Edition, MacMillan India, 2004.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7301
Quantum Mechanics-II
Semester-III

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is harmonic perturbation? Calculate transition probability per unit radiation of intensity of harmonic perturbation.
2. Describe a charged particle in an electromagnetic field. (12 or 8,4)

Section B

3. What do you mean by partial wave? Obtain the partial wave shift for scattering from square wellpotential.
4. For the Yukawa potential obtain the scattering amplitude using Born's approximation. (12 or 8,4)

Section C

5. Derive the Slator's determinant for N electron system.
6. Describe symmetric and anti-symmetric wave functions. (12 or 8,4)

Section D

7. Write Dirac equation in electromagnetic field.
8. Describe quantization of wave field and quantization of Schrodinger equation. (12 or 8,4)

Section E (Compulsory)

9. (a) Discuss the condition for validity of Born approximation.
   (b) Write a note on sudden approximation.
   (c) Write short notes on Dirac matrices.
   (d) Write the consequence of negative energy states.
   (e) Give brief introduction of identical particles.
   (f) Deduce an expression for scattering by screened coulomb potential. (6×2=12)

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SEMESTER-III

PHY-7302 Nuclear Physics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.

Unit-I: Nucleus and its Properties	**15 Lectures**
The constitution of the nucleus and its general properties: Proton-electron hypothesis, Nucleus as a quantum system, Proton-neutron hypothesis, Nuclear mass, Basic components of mass spectroscopy, Mirror nuclei and isotopic spin (introductory), Packing fraction and binding energies, Nuclear radius- its determination and interpretation of results (experimental details not required), Natural radioactivity, Successive radioactive transformation, Radioactive equilibrium, Gamow theory of alpha decay, Nuclear spin, Parity, Magnetic moments, Electric dipole and quadrupole moments (experimental details not required), Deuteron problem.	
Unit-II: Nucleon-Nucleon Interaction	**15 Lectures**
Exchange forces and tensor forces, Meson theory of nuclear forces, Nucleon-Nucleon scattering, Spin dependences of nuclear forces, Effective range theory, Symmetry and nuclear force, Isospin invariance and Operator general form of the nuclear potential, Yukawa theory of nuclear interaction.	
Unit-III: Nuclear Models	**15 Lectures**
Liquid drop model, Semi empirical mass formula, Isobaric mass parabola, Nuclear fission, The mass and energy distributions of the fission products, The energy release in fission, Application of liquid drop model to fission, Nuclear Shell model; Magic numbers, Single particle model of the nucleus, Spin-orbit coupling, Application to prediction of spin and magnetic moments (Schmidt values), Collective model: Nuclear collective vibrations, Nuclear collective rotation.	
Unit-IV: Nuclear Reaction	**15 Lectures**
Types of nuclear reactions, Wave function and scattered waves, Differential cross-sections, Scattered potential, Partial waves, Total differential cross-sections and Optical theorem,-Conservation laws for nuclear reactions, Q-value, The compound nucleus, Independence hypothesis, Resonances, Single Wigner formula, Direct reaction (introductory ideas about stripping and pick-up reactions).	

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Course Learning Outcome (CLO)

- Students will be able to analyze the basics of nuclear physics, properties and nuclear models for their use in various applications.

Books Recommended:

- B.L. Cohen, Concepts of Nuclear Physics, TMH.
- K.S. Krane, Introductory Nuclear Physics, John Wiley & Sons.
- S.S.M. Wong, Introductory Nuclear Physics, Printice Hall of India.
- R.R. Roy and B.P. Nigam, Nuclear Physics, New Age International (2000).
- H.S. Hans, Nuclear Physics: Experimental and Theoretical, New Academic Science Ltd., Second revised edition (2010).
- D.C. Tayal, Nuclear Physics, Himalaya Publishing House (2011).
- V.K. Mittal, R.C. Verma & S.C. Gupta, Introduction to Nuclear and Particle Physics, Prenice Hall of India 3rd edition (2013).

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7302
Nuclear Physics
Semester-III

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. List the postulates of quantum mechanics and explain them. (12 or 8,4)
2. (a) Explain momentum representation. What are the operators for position in the momentum representation?
   (b) Solve Schrodinger wave equation for deuteron and plot the radial wave functions. (12 or 8,4)

Section B

3. (a) What is the effective range theory of nuclear physics?
   (b) What is Nucleon-Nucleon scattering? (12 or 8,4)
4. What is Yukawa theory of nuclear forces? Discuss Yukawa potential and other key features of this theory. (12 or 8,4)

Section C

5. (a) Describe the nuclear shell model. Show how the magic numbers are obtained in the nuclear shell model.
   (b) What is Spin-Orbit coupling? (12 or 8,4)
6. Discuss the need for a collective model of atomic nucleus. Also elaborate on the nuclear properties which cannot be explained without assuming collective behavior of nucleons. How these properties are explained using collective model. (12 or 8,4)

Section D

7. What do you understand by partial waves? Using this concept drives the expression for the total differential cross-section. (12 or 8,4)
8. Explain compound resonances and derive Berit-Wigner formula. (12 or 8,4)

Section E (Compulsory)

9. (a) What is Isotopic Spin?
   (b) Why we need tensor force in nuclear force.
   (c) Estimate the mass of meson using uncertainty principle.
   (d) What are the properties of nuclei having neutron (proton) number as magic number?
   (e) What can one learn about nucleus by measuring nuclear vibrations?
   (f) What are Direct Nuclear Reactions? (6x2=12)

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SEMESTER III

PHY-7303 Condensed Matter Physics-I							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
4	0	0	4	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- This course aims to study the basic properties of the condensed phase of matter.

Unit-I: Crystal Physics	**15 Lectures**
Classification of condensed matter-crystalline and non-crystalline solids, Bonding and internal structure of solids - Ionic, Covalent and metallic solids, The vander waals interaction, Hydrogen bonding, Crystal symmetry, Point groups, Space groups, Lattices and basis, Typical crystal structures, Reciprocal lattice, Bragg's law of diffraction, X-ray, neutron and electron diffraction, Brillouin zone, Structure factor.	
Unit-II: Lattice Vibrations and Thermal Properties	**15 Lectures**
Monoatomic and diatomic lattices, normal modes of lattice vibration, phonons and density of states, dispersion curves, Specific heat–Classical, Einstein and Debye models, Thermal expansion, Thermal conductivity, Normal and umklapp processes.	
Unit-III: Free Electron Theory	**15 Lectures**
Drude-Lorentz's Classical Theory (Free electron theory of metals), Sommerfold quantum theory (free electron gas in one dimensional box), Thermal and electrical transport properties, Electronic specific heat, Fermi surface, Motion in a magnetic field: cyclotron resonance and Hall effect, Thermionic emission, Failures of free electron theory.	
Unit-IV: Energy Band Theory	**15 Lectures**
Energy spectra of atoms, molecules and solids-formation of energy bands, Bloch theorem, Kronig-penny model, E-K diagram, Construction of brillouin zones, extended, reduced and periodic zone schemes, Velocity and effective mass of an electron, Nearly free electron model, Tight binding approximation, Orthogonalized plane wave method, Pseudo-potential method, Insulators, conductors and semiconductors.	

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Course Learning Outcomes (CLOs)

- The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.
- The students will be able to develop an understanding of relation between band structure and the electrical/optical properties of a material.

Books Recommended:

- C. Kittel, Introduction to Solid State Physics, Wiley (2007).
- Ashcroft and Mermin, Solid state Physics, Thomson (2007).
- Ali Omar, Elementary Solid State Physics, Addison-Wesley (2005).
- M A Wahab, Solid State Physics-Structure and Properties of Materials, Narosa (2005).
- S. L. Kakani and C Hemrajajani, Solid State Physics: Theory, Applications & Problems (Sultan Chand & Sons, Delhi) (2014).
- J M Ziman, Principles of the theory of solids (2nd edition, Cambridge Univ. press).
- J. P. Srivastava, Elements of Solid State Physics, Prentice-Hall of India.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7303
Condensed Matter Physics-I
Semester-III

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What do you mean by reciprocal lattice? Show that the reciprocal lattice for body centered cubic is face centred cubic. (12or 8,4)
2. (a) A beam of X-radiation is incident on a crystal at a glancing angle of 8^0 , when the first order Bragg's diffraction occurs. Calculate the glancing angle for second order diffraction if the wavelength of the radiation is 0.85 Å.
   (b) What are Brillouin Zones? Draw the first three Brillouin zones of a two-dimensional square. (12or 8,4)

Section B

3. (a) What are phonons? Express the law of conservation of energy and momentum in the case of inelastic scattering of a photon by a phonon.
   (b) What is Debye temperature? What are the limitations of Debye theory? (12or 8,4)
4. Discuss Einstein's theory of lattice specific heat of solids. Discuss success and failure of this model. (12 or 8,4)

Section C

5. (a) What is Hall Effect? What is the application of it?
   (b) Explain the free electron theory of electrical conductivity in metals. (12or 8,4)
6. Discuss Free Electron theory of metals. Discuss the success and failure of free electron theory. (12 or 8,4)

Section D

7. On the basis of the TB electron approximation, considering only nearest neighbor interaction drive an expression for energy. Find out energy broadening of the S-band in simple cubic crystal. (12or 8,4)
8. Discuss Kronig-Penny model for electron energy in solids and show how it explains the forbidden bands. (12 or 8,4)

Section E (Compulsory)

9. (a) State and explain Bragg's law of x-ray diffraction.
   (b) Difference between ionic and covalent bond.
   (c)What do you mean by effective mass of an electron?
   (d) What is the cause of failure of free electron theory?
   (e) What do you mean by density of states?
   (f) Discuss the physical meaning of Fermi energy. (6x2=12)

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SEMESTER-III

PHY-7304 Numerical Methods and Programming							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus. Scientific calculator may be allowed to the students during the examination.

Learning Objective (LO)

- This course aims to develop skilled students, both theoretically and practically; in computer programming, able to solve numerical problems that are frequently used in physics using computer programs.
- The students will be able to simulate the problem with the help of programming.

Unit-I: Roots of Equations	**15 Lectures**
Non-linear equation: Approximate values of roots, Bisection Method, Regula-Falsi Method, Newton-Raphson method, Solution of set of non-linear equations, Solution of Simultaneous Linear equation: Direct Method: Gauss elimination, Pivoting, Gauss-Jordon method, Matrix inversion, Iterative methods: Jacobi iteration method, Gauss Seidel iteration method, Precision and accuracy, Error analysis, Propagation of errors, Linear and non-linear curve fitting–least squares fitting, Chi-square test.	
Unit-II: Curve Fitting and Interpolation	**15 Lectures**
Straight line, Parabola and Weighted least squares approximation, Method of least squares for continuous functions, Interpolation, Newton's formula for forward and backward interpolation, Divided difference, Symmetry of divided differences, Newton's general interpolation formula, Lagrange's interpolation formula, Cubic splines, Interpolation in multi dimension. Eigenvectors and Eigenvalues: Homogeneous equations, Characteristic equation, Secant method, Order of convergence in different Power method, Jacobi method, Applications.	
Unit-III: Integration	**15 Lectures**
Newton – cotes formula – Trapezoidal rule, Simpson's rule, Simpson's 3/8 rule, Error estimates in trapezoidal and Simpson's rule, Gauss quadrature, Numerical evaluation of singular integrals, Numerical calculation of Fourier integrals. Differential Equations: Ordinary differential equation: Euler's method, Modified Euler's method, Runge-Kutta Method, System of coupled first order ordinary differential equations, Shooting method, Partial differential equations, Solution of Laplace equation, Poission Equation, and heat equation.	

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Unit-IV: Programming With C^{++}	15 Lectures
Representation of constant, Variables and functions, Arithmetic expressions and their evaluation. Assignment statements, Logical constants variables and expression, Input and output statements, Control statements, Ternary Operator, Go to Statement, Switch Statement, Unconditional and Conditional Looping, While Loop, Do-while Loop, For Loop, Break and Continue Statements. Nested Loops, Sequencing alternation, Arrays, Manipulating vectors and matrices. Programming with MATLAB: Basic features of MATLAB: Variables, Comments, MATLAB workspace, Simple math, Complex numbers, Mathematical function, Operation on vectors and matrices, Logical arrays, Control structure: For loops, While loops, If-else, Switch-case statements, Optimization tools in MATLAB.	

Course Learning Outcome (CLO)

- Students will be able to learn Numerical Analysis such as solutions of nonlinear equations in one variable, interpolation, approximation numerical differentiation, integration, direct methods for solving linear systems, numerical and solution of ordinary differential equations.

Books Recommended:

- S. S. M. Wong, Computational Methods in Physics and Engineering, World Scientific.
- V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India.
- V. Rajaraman, Computer Programming in FORTRAN 90/95.
- Joe D. Hoffman, Numerical methods for scientist and engineers, Marcel Dekker Inc, 14 New York.
- Steven C. Chapra and Raymond P Canale, Numerical Methods for Engineers, Tata McGraw-Hill Education.
- Srimanta Pal, Numerical Methods: Principles, Analysis and Algorithms, Oxford University Press.
- Scarbrough James B, Numerical Mathematical Analysis, Oxford and IBH Publishing Company, New Delhi, 1966.
- S.D. Conte, Elementary Numerical Analysis, Tata McGraw Hill Publishing Company, New Delhi.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)

M.Sc. Physics Examination

PHY-7304

Numerical Methods & Programming

Semester-III

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks. Scientific calculator may be allowed to the students in the examination.

The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Solve the following system of equations using Gauss-Seidel Method.

   $20x + y - 2z = 17$,

   $2x - 3y + 20z = 25$ and

   $3x + 20y - z = -18$ (12 or 8,4)

2. Find the root of given equation $f(x) = x^3 - x - 4 = 0$ using Regula-Falsi Method. (12 or 8,4)

Section B

3. Solve the following system of equations correct up to 3 significant digits.

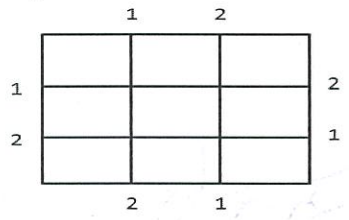
   $2x + y + z = 5$, $3x + 5y + 2z = 15$, $2x + y + 4z = 8$ (12 or 8,4)

4. Use Newton's backward difference formula to construct polynomial of degree 3 for the data: $f(-0.75) = -0.07181250$, $f(-0.50) = -0.024750$, $f(-0.25) = 0.33493750$, $f(0)=1.10100$. Hence find $f(-1/3)$. (12 or 8,4)

Section C

5. Estimate $y(0.4)$ using Modified Euler's formula, when $y'(x) = x^2 + y^2$ with $y(0) = 0$, assume $h = 0.2$. (12 or 8,4)

6. Solve $\frac{\partial^2}{\partial}$ + $\frac{\partial^2}{\partial}$ = 0 numerically for the following mesh with boundary values as in the figure below.



(12 or 8,4)

Section D

7. (a) Explain the structure of the C^{++} program.
   (b) Explain the features of MATLAB. (12 or 8,4)

8. (a) Explain different decision-making statements used in C++ language.
   (b) Write a program in MATLAB to multiply two matrices of same order. (12 or 8,4)

Section E (Compulsory)

9. (a) What do you mean by propagation of errors?
   (b) What approximation is used in deriving Simpson's rule of Integration?
   (c) When does the special Gauss elimination method fail?
   (d) State Newton's formula to find $f'(x)$ using the forward difference.
   (e) Write a note on Chi-square test.
   (f) How will you find the smallest eigen value of a square matrix X?

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SEMESTER-III

PHY-7305(i) Introduction to Nuclear Astrophysics							
Teaching Scheme			Credit	Marks			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To provide a basic knowledge of the universe outside the solar system and to prepare students for more advanced astronomy courses.

Unit-I: Evolution of matter in the Universe	**08 Lectures**
A Brief Description of the Observed Universe, A Historical Introduction to Galaxies in the Universe, The Origin of the Universe: The Hadron Era, The Lepton Era, The Radiation Era; The Stellar Era: Stellar Evolution: The Hertzsprung-Russel Diagram, Evolution of Stars: The Chemical Composition of the Observable Universe.	
Unit-II: Chemical compositions in nuclear reactions	**06 Lectures**
The Abundances of Elements in the Universe, the main Sequence Stars, The Life and Times of a (low-mass) Star, Hydrogen burning, The CNO Cycle, Helium burning, Supernovae.	
Unit-III: Formation of heavy elements: s, r and p processes	**08 Lectures**
The s-process, The s-process Nucleosynthesis; The r-process; The p- process: Weak Interaction Mechanism Spallation Reaction, thermonuclear reactions of the heavy Elements, Abundances of the Heavy elements- Processes of Neutron Capture.	
Unit-IV: Nucleosynthesis	**08 Lectures**
Nucleosynthesis of Light Elements, The Abundances of Light Elements, Light Element Production in Stellar interiors and Supernovae explosions Big Bang Nucleosynthesis, The Standard Model of the Universe, The Cosmological principle and the expansion of the Universe, thermal Equilibrium.	

Course Learning Outcome (CLO)

- After gaining the elementary knowledge of Atmosphere and Space related concepts impart his wisdom further to some major organizations like NARL & ISRO etc.

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Books Recommended:

- Jean Audouze and Sylvte Vaudair, An Introduction to Nuclear Astrophysics.
- E.W. Kolb and M.S. Turner, The Early Universe, (Addision – Wesley).
- D.A. Ostlie and B.W. Carroll, An Introduction to Modern Stellar Astrophysics, Addision Wesley 2007.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7305(i)
Introduction to Astrophysics
Semester-III

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What are the four components of a galaxy? Distinguish between stars of population I and II. (12or 8,4)
2. (a) What is stellar evolution? Explain the evolution of a star from its birth up to the red giant stage.
   (b) Explain Hadron Era? (12 or 8,4)

Section B

3. What do you mean by main sequence stars? Write down the spectral classes of stars. In which class the Sun belongs to? Name the layers of solar atmosphere. Why is the temperature of the sunspots lower than their surroundings? (12 or 8,4)
4. Write a short note on:
   (a) CNO Cycle
   (b) Hydrogen burning (12 or 8,4)

Section C

5. What is the difference between r-process and s-process? (12 or 8,4)
6. Explain thermonuclear reaction of the heavy elements. (12 or 8,4)

Section D

7. What are the abundances of Big- Bang Nucleosynthesis? (12 or 8,4)
8. Write a short note on:
   (a) Thermal Equilibrium
   (b) Supernovae explosion (12 or 8,4)

Section E (Compulsory)

9. (a) What happened in lepton epoch?
   (b) What is stellar evolution? Explain the evolution of a star from its birth up to the red giant stage.
   (c) What is abundance of light elements in Big Bang theory?
   (d) What are supernovas made of?
   (e) What is a solar system made of?
   (f) What are the processes of neutron capture? (6×2=12)

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SEMESTER-III

PHY-7305(ii) Renewable Energy Resources							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- The aim and objective of this course is to teach the students about renewable sources of energy, solar energy, wind energy, biomass energy, Small Hydropower, Ocean Energy, Geothermal Energy & Fuel Cells, their types and applications.

Unit-I: Introduction	**08 Lectures**
Energy: Past, Today and Future, A brief history of energy consumption, Energy & Environment, Non-renewable energies, Production and reserves of energy sources, India, eed for alternatives, Renewable energy sources, Need of renewable energy.	
Unit-II: Solar Energy	**08 Lectures**
Basics of Solar Energy; its importance, Merits & demerits of solar energy, Radiation measuring instrument, Basics of Flat plate collectors, Solar water heater, solar distillation, Solar cooker, Solar green houses and solar cell-brief discussion of each, Need and characteristics of photovoltaic (PV) systems, Application of solar energy. **Wind Energy:** Characteristics and measurement, Wind energy conversion principles, Types and classification of WECS, Wind Turbines and Environmental Impact.	
Unit-III: Biomass Energy	**06 Lectures**
Classification of biomass, Physicochemical characteristics of biomass as fuel, Biomass conversion routes. **Small Hydropower:** Overview of micro, mini and small hydro system, Types of hydro turbine, Environmental impact of hydropower sources.	
Unit-IV: Ocean Energy	**08 Lectures**
Principle of ocean thermal energy conversion system, Principles of Wave and Tidal energy conversion. **Geothermal Energy & Fuel Cell:** Origin of geothermal resources, Type of geothermal energy deposits. **Fuel Cell:** Hydrogen as a source of energy, Design and principle of operation of a Fuel Cell (H_2, O_2 cell), Classification of Fuel Cells, Types of Fuel Cells, Advantages and Disadvantages of Conversion efficiency of Fuel Cells, Applications of Fuel Cells-Hydrogen Energy.	

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Course Learning Outcomes (CLOs)

- The student can learn about the various types of natural energy resources such as solar energy, wind energy, biomass energy, small hydropower, ocean energy, geothermal energy & fuel cells, their functions, uses, exploitation and their applications.
- Gain knowledge about design and principle of operation of a fuel cell (H_2, O_2 cell), classification of fuel cells, types of fuel cells, advantages and disadvantages of fuel cells etc.

Books Recommended:

- Aldo V. da Rosa, Fundamentals of Renewable Energy Processes, Academic Press (2005).
- S.P. Sukhatme, Solar Energy, Tata McGraw-Hill, New Delhi (2008).
- J.P Navani., Sapra Sonal, Conventional Energy Resources, S Chand & Company.
- M.A. Kettani, Direct energy conversion, Addision Wesley Reading (1970).
- Linden, Handbook of Batteries and fuel cells, McGraw Hill.
- G.D Rai-Khanna, Non-conventional energy sources, Publishers: New Delhi M P Agarwal – S. Chand.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7305(ii)
Renewable Energy Resources
Semester-III

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Explain energy and energy consumption in details.
2. Why is there a great demand of renewable energy resources? (12 or 8,4)

Section B

3. Describe the principle of solar energy, its significance, merits and demerits in detail.
4. What is wind energy? Explain its principle and types. (12 or 8,4)

Section C

5. Explain the process of gasification of solid biomass. What is the general composition of the gas produced and what is its heating value? What are its applications?
6. Explain micro, mini and small hydro systems in details. (12 or 8,4)

Section D

7. Explain design and operation of a fuel cell.
8. Explain in detail about hydrogen as a source of energy. (12 or 8,4)

Section E (Compulsory)

9. (a) What are conventional sources of energy?
   (b) State any four limitations of solar energy.
   (c) State photovoltaic principle.
   (d) What are the contents of biomass?
   (e) Define maximum energy conversion.
   (f) Write two factors affecting bio digestion. (6x2=12)

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SEMESTER-III

PHY RP-7306 Minor Research Project-I/ Seminar							
Teaching Scheme			Credit	Marks			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
2	0	0	2	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

For the External Examination:

The distribution of marks would be on the basis of Work done/Task performance (20 marks), Performance (written/presentation) (20 marks) and viva-voce (20 marks), total=60 marks.

Guidelines for the Preparation of Report (Research Project/Seminar):

The purpose of introducing the above courses is to introduce new methodologies to the students for the learning enhancement. It may consist of review of some research papers, development of a laboratory experiment,fabrication of a device, working out some problem related to Physics, participation in some ongoing research activity, analysis of data, etc. The work can be carried out in any thrust areas of Physics (Experimental or Theoretical Physics) under the guidance of faculty members of the department. A smallproject report or review article submission of any one topic related to the concerned branch of interest will be submitted as per the instructions.

The project report/seminar report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, methodology, result and discussion conclusion and references etc. The paper size to be used should be A-4 size. The font size should be 12 with Times Roman font. The text of the report may be typed in 1.5 (one and a half) space. The printout of the report shall be done on both sides of the paper (instead of single side printing). The candidate shall be required to submit two soft bound copies of the report along with a CD in the department as per the date announced.

The list of topics will be provided by the Department/University and the students will choose the area of his/her interest and get registered under the concerned faculty after appearing in an interview and final approval from the Head of the Department. The candidate shall be required to maintain his/her project diary (logbook) of work in the organization or under the Guide/Supervisor. The student has to formulate the project problem / research problem with the help of her/his Guide and submit the project proposal / research proposal within 10 days at the starting of Minor Project for further approval.

The report will be evaluated internally by the supervisor allotted to the student during the semester and the candidate will present his/her work through presentation/viva before the External examiner at the end of semester and will be awarded marks. The candidate is required to submit the three final copies of the report in hard bound within two weeks after the viva -voce/presentation as discussed in the presence of internal as well as external examiners.

The students must submit their project work/seminar report in the Department as per the date announced for the submission. Internal assessment of the project work/seminar will be carried out by respective faculty members assigned to them as mentor/supervisor as per evaluation scheme. External assessment of the project work will be carried out by an external examiner (nominated by the Head/Chairperson of the Department) as per evaluation scheme.

For research project/seminar, each lecture/contact hour per week will be considered as one credit. The duration of the written and viva voce examination and other conditions (if any) shall be deci... internal and external examiners appointed by the University authorities.

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SEMESTER-III

PHY-7307P Physics Lab-III & Computer Lab							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
0	0	8	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Learning Objective (LO)

- To impart knowledge among the students to perform scientific experiments and to analyze the results.

List of Experiments:

(Section-A)

Note: Students are required to perform at least Eight experiments.

1. Kelvin double bridge: determination of low resistance.
2. Anderson bridge: determination of self-inductance by AC and DC balancing.
3. Holography experiment and related studies
4. Millikan's oil drop experiment.
5. Determination of wavelength and difference in wavelengths of sodium lines, and thickness of mica sheet using Michelson Interferometer.
6. To find the wavelength of monochromatic light using Febry Perot Interferometer.
7. e/m of electron by helical method.
8. B-H curve of a given material and to determine its parameters.
9. Stefan's constant determination.
10. G. M. Counter (a) characteristics, (b) dead time (c) absorption coefficient of given material.
11. Determining thickness of a thin wire by diffraction using laser beam.
12. To study gamma ray spectrometer and related parameters-
13. Superconductivity experiment kit and related studies
14. Magnetic Hysteresis Loop Tracer (BH Curve)

Note: The additional/other experiments may also be performed and asked in the examination depending on the availability of the equipments. 06 hours for Physics Lab practicals and 02 hours for Computer Lab per week.

(Section-B)

Computer based experiments using C++/Mathematica/MATLAB

Note: Students are required to perform at least Four experiments.

1. Statistical and error analysis of (a) given data (b) error estimation in computation.
2. (a) Roots of a quadratic/ cubic equation (b) summation of a series.
3. Numerical differentiation and integration of simple functions.
4. Operations on a matrix (a) inversion (b) diagonalisation (3x3 matrix) (c) solution of simultaneous equations.
5. Plotting and interpolation of a function.
6. Finding the value of Pi using monte-carlo method
7. Computer Simulation of Problems by Mathematica: dealing with algebra, differentia calculus and powerful graphics tool.

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Course Learning Outcomes (CLOs)

- Students will be able to acquire hands on experience of handling different instruments.
- Students will be familiar with the various components to be used in various circuits.
- Students will be able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.

Books Recommended:

- C.L. Arora Practical Physics S. Chand & company Ltd (2009).
- S. P. Singh, Advanced Practical Physics Vol I & II, Pragati Prakashan, 15th Ed (2017).
- S.S. Kapoor and V.S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi (1986).
- R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons (1974).
- Open Software and standard Open and Licensed software.
- Lab manuals

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HIMACHAL PRADESH TECHNICAL UNIVERSITY
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Syllabus

for

M.Sc. Physics

(Semester-IV)

As per National Education Policy (NEP-2020)

(w.e.f. the Academic Year 2023-2024)

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SEMESTER IV

PHY-7401 Condensed Matter Physics-II							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- It aims to introduce the students to the advanced topics in condensed matter physics.

Unit I: Semiconductors	**15 Lectures**
Semiconductor materials, Typical band structure of a semiconductor, Number of carriers in thermal equilibrium, Intrinsic (non-degenerate) semiconductors, Extrinsic semiconductors, Effect of doping, Impurity levels, Density of states, Intrinsic carrier concentration, Donors and acceptors, Effective mass, Carrier drift, Mobility effects, Hall effect in semiconductors, Dielectric properties: Local electric field at an atom, Clausius-Mossotti equation, Dielectric constant and polarizability- Classical theory of electronic polarizability, Dipolar polarizability, Piezo-, pyro- and ferroelectric crystals, Ferroelectricity, Ferroelectric domains, Anti-ferroelectricity and Ferrielectricity.	
Unit II: Magnetism	**15 Lectures**
Classification of magnetic materials, Origin of permanent magnetic moments, Langevin"s classical theory of diamagnetism, Quantum theory of paramagnetism, Ferromagnetism, Weiss molecular field, Ferromagnetic domains, Anti-ferromagnetism, Ferrimagnetism and ferrites, Magnon and magnon dispersion relation.	
Unit III: Superconductivity	**15 Lectures**
Meissner effect, London equation, Type I and II superconductors, Thermodynamics, Superconducting band gap, Cooper pairs, Flux quantization, BCS theory (qualitative), Josephson Effect, SQUIDS, High temperature superconductors. **Physics of Nanomaterials:** Mesoscopic physics, Quantum wire, Well and dot, Size and interference effects, Quantum confinement and coulomb blockade, Imaging techniques for nanostructures-electron microscopy, Scanning tunnelling microscopy and atomic force microscopy.	
Unit IV: Defects in Crystals	**15 Lectures**
Point defects-Frenkel and Schottky defects, Colour centres, Excitons, Dislocations-models of screw and edge dislocations, Burgers vector, Surface imperfections – grain boundaries, tilt bou boundaries and stacking faults, Volume defects.	

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Course Learning Outcome (CLO)

- The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials; and develop an understanding of relation between band structure and the electrical/optical properties of a material.

Books Recommended:

- C. Kittle, Introduction to Solid State Physics, Wiley (2007).
- Ashcroft and Mermin, Solid state Physics, Thomson (2007).
- Ali Omar, Elementary SolidState Physics, Addison-Wesley (2005).
- M A Wahab, Solid State Physics: Structure and Properties of Materials, Narosa (2005).
- S.M. Sze, Semiconductor Devices: Physics and Technology, John Wiley and Sons (2002)
- S. L. Kakani and C. Hemrajajani, Solid State Physics: Theory, Applications & Problems, Sultan Chand & Sons, Delhi, (2014).

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7401
Condensed Matter Physics-II
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is meant by polarization of a dielectric? Write the different types of polarization. Discuss atomic polarization in detail and find the expression for atomic polariziability. (12 or 8,4)
2. (a) What is meant by local field in a solid dielectric? Deduce an expression for the local field in a solid dielectric and hence obtain the Clausius–Mosotti relation.
   (b)What is meant by energy bands? Discuss the formation of energy bands in solids. (12 or 8,4)

Section B

3. (a) Explain the details of the quantum theory of Paramagnetism.
   (b) Compare the origin of paramagnetic and diamagnetic behavior in solids. (12 or 8,4)
4. Discuss the temperature effect on magnetic properties of ferrites and their applications. (12 or 8,4)

Section C

5. (a) Distinguish between type-I and type-II superconductors.
   (b) Write the silent features of BCS theory and discuss how it explains the phenomena of superconductivity. (12 or 8,4)
6. What is the need of atomic force microscopy? Explain it in detail. (12 or 8,4)

Section D

7. Does the burger vector change with the size of the burgers circuit? Explain, using sketches, show how two edge dislocations on the same slip plane with burgers vectors of the equal magnitude can come together and annihilate each other. (12 or 8,4)
8. Make two neat sketches to show the climbing up and the climbing down of an edge dislocation. (12 or 8,4)

Section E (Compulsory)

9. (a) Define effective mass?
   (b) What is a domain in a ferroelectric material?
   (c) Write a short note on magnons?
   (d) Why a superconductivity a low temperature phenomenon?
   (e) What is the use of scanning tunneling microscopy?
   (f) Explain the term quantum confinement? (6x2=12)

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SEMESTER IV

PHY-7402 High Energy Physics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
				Maximum Marks: 40	Maximum Marks: 60	100	
4	0	0	4	Minimum Marks: 16	Minimum Marks: 24	40	3 Hours

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To provide students with coherent theoretical and experimental training in high energy physics addressing a broad spectrum of fields and applications: particle physics, conservation laws, electromagnetic interactions, standard model of electroweak interactions and its extensions, strong interactions and quantum chromo dynamics, gauge invariance, unification schemes and Higgs theory.

Unit-I: Introduction and Overview	**15 Lectures**
Historical development, Particle classification: Bosons, Fermions, Particles and Antiparticles, Quarks and Leptons; Basic ideas about the interactions and fields in Particle Physics, Types of interactions: Electromagnetic, Weak, Strong and Gravitational, Natural System of Units in High Energy Physics.	
Unit-II: Invariance Principles and Conservation Laws	**15 Lectures**
Conservation of electric charge, Baryon number, Lepton number, Continuous symmetry transformations: translation and rotation; Parity, Pion parity, Charge conjugation, Strangeness and Isospin, Two Nucleon System, Pion-Nucleon System, G-parity, Time reversal invariance, Associated production of particles and Gell-Mann Nishijima scheme, K0-K0 doublet, CP violation in K- decay, CPT theorem.	
Unit-III: Electromagnetic Interactions	**15 Lectures**
Form factors of nucleons. Parton model and Deep inelastic scattering structure functions, Cross Section and Decay Rates. QCD and Quark Model: Asymptotic freedom and Infrared slavery, confinement hypothesis, Classification of hadrons by flavor symmetry: SU(2) and SU(3) multiplets of Mesons and Baryons, The Baryon Octet and Decuplet, Pseudoscalar mesons and Vector mesons.	
Unit-IV: Weak Interactions	**15 Lectures**
Classification of weak processes, Fermi theory of β-decay, Parity non conservation in β -decay, two component theory of neutrino and determination of helicity, V-A interaction, Strangeness changing and non-changing decays, Cabibbo's theory. Gauge invariance and Unification schemes: Global and Local invariance of the Action, Noeth Spontaneous breaking of symmetry and Goldstone theorem. Abelian and Non-Abelian gauge t	

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Course Learning Outcomes (CLOs)

- Students will be able to learn standard model of particle physics and its limitations and the properties.
- Students will be able to learn various global and local gauge symmetries of system, invariance of action, symmetry breaking and Physics beyond the Standard Model Physics etc.

Books Recommended:

- D.H. Perkins, Introduction to High Energy Physics, 4th Edition, Cambridge University Press (2000).
- M.P. Khanna, Introduction to Particle Physics, Prentice Hall India Learning Pvt. Ltd (1999).
- D. Griffiths, Introduction to Elementary Particles, 2nd Edition, Wiley VCH (2008).
- F.E. Close, Introduction to Quarks and Partons, Academic Press.
- F. Halzen and A.D. Martin, Quarks and Leptons: An Introductory Course in Modern Particle Physics.
- Martin and Shaw, Particle Physics, 3rd Edition, John Wileys Sons (2008).

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7402
High Energy Physics
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Describe the historical development of particle physics. (12 or 8,4)
2. Write a brief note on different types of interactions which the elementary particles can undergo. Give an example. (12 or 8,4)

Section B

3. Explain the following:
(a) strangeness, (b) time reversal invariance, (c) CP violation in K-decay. (d) CPT theorem. (12 or 8,4)
4. Define kinematics of high energy collisions relativistically. Explain threshold energy. (12 or 8,4)

Section C

5. Explain SU (2) and SU (3) symmetry. Also discuss deep inelastic scattering. (12 or 8,4)
6. Explain the following: (a) Baryon Octet and Decuplet. (b)asymptotic freedom and Infrared slavery. (12 or 8,4)

Section D

7. What is spontaneous symmetry breaking? Derive the expression for Goldstone theorem. (12 or 8,4)
8. Define Cabibbo theory? Derive an expression for it. (12 or 8,4)

Section E (Compulsory)

9. (a) Define decay rate?
(b) Define D meson and write Gell - Mann Nishijima formula?
(c) Define Goldstone Boson?
(d) what is the nature of interaction potential V® between two quarks inside a nuclei?
(e) What gauge invariance? Explain with the help of an example.
(f) How is baryon number conserved in beta decay? (6x2=12)

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SEMESTER IV

PHY-7403(i) Nanophysics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

The objectives of this course are to know about the Nanomaterials, synthesis and characterization of nanostructure materials, their properties and applications of Nanomaterials.

Unit-I: Introduction to Nanomaterials	**15 Lectures**
Overview of Nano Science and Nano Technology, Size dependence properties (Optical, Mechanical, Magnetic, Dielectric, Chemical reactivity, Photo catalytic properties etc.) and electronic structure from bulk to quantum dot. Nanostructures: 0D, 1D, 2D and 3D (nano dots, nanowires, nanorods, thin films), Band structure and density of states of materials at nanoscale.	
Unit-II: Synthesis processes of Nanomaterials	**15 Lectures**
Top down and bottom-up approach, Physical and chemical methods for the synthesis of nanomaterials (Mechanical milling, Gas phase Condensation, Vacuum deposition, Physical vapour deposition (PVD), Thermal evaporation, Pulsed laser deposition, Chemical vapour deposition (CVD), Sputter deposition, Spray pyrolysis, Molecular beam epitaxy, Lithography technique, Self assembly, Sol-gel method, Hydrothermal synthesis, Micro-emulsion, Langmuir Blodgett (L-B), Prepation through colloidal route). Study of texture and microstructure, Increase in X-ray diffraction peaks; Shift in photoluminescence peaks; variation in Raman spectra; Magnetic resonance and photoemission in nanomaterials.	
Unit-III: Quantum Nanostructures	**15 Lectures**
Quantum confinement and its consequences, Size and dimensionality effects: Size effects, Conduction electrons and Dimensionality, Potential wells, Partial confinement, Properties dependent on density of states, Surface passivation and Core/shell nanoparticles, Single electron tunneling; Nanomaterials Devices: Quantum dots hetrostructure lasers, Optical switching and optical data storage, Magnetic quantum well, Magnetic dots- magnetic data storage, Infrared detectors.	
Unit-IV: Carbon Nanostructures	**15 Lectures**
Carbon nanostructures, Carbon clusters, Structure and properties C60, Alkali doped C60, Carbon nanotubes and nanofibres: fabrication, structure and its properties, Application of carbo Field emission and shielding, Computers, Fuel cells, Chemical sensors and Catalysis.	

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Course Learning Outcome (CLO)

- Students will understand the various concepts of nano sized materials, their properties and classifications along with different physical and chemical approaches used for their synthesis as well as their applications.

Books Recommended:

- C. Kittel, Introduction to Solid State Physics, Wiley, 2007.
- C.P. Poole, Introduction to Nanotechnology, Wiley, 2006.
- Goswami, Thin Film fundamentals, New age International, 2007.
- K.P. Jain, Physics of Semiconductor Nanostructures, Narosa, 1997.
- C.N. Rao and A. Govindaraj, Nanotubes and Nanowires, Royal Society of Chemistry, 2005.
- T. Pradeep, Nano-The Essentials, McGraw Hill Companies, 2007.
- K. Kulkarni, Nanotechnology: Principles and practices, Capital Publishing Company, 2015.
- Kasturi L. Chopra, Thin Films Device Applications, McGraw-Hill Book Company, 2011.
- Kasturi L. Chopra, Thin Films Phenomena, McGraw-Hill Book Company, 1979.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7403(i)
Nanophysics
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Explain in detail CVD method of nano-materials synthesis. Also give their merits, demerits and applications. (12 or 8,4)
2. Discuss in detail the various properties of material that can be tuned by playing with matter at low dimensions. (12 or 8,4)

Section B

3. (a) With graphical representation, distinguish between textures and amorphous materials.
   (b) Compare the principles of Scanning probe microscopy (SPM) and Electron microscopy. Discuss the particle size determination from XRD. (12 or 8,4)
4. (a) "XRD is non-destructive technique". Comment. Also explain the essential components of XRD with suitable diagram.
   (b) Explain the peak shift in photoluminescence spectra. (12 or 8,4)

Section C

5. What do you mean by DOS (Density of states)? Compare the DOS (Density of states) of 3D, 2D, 1D and 0D materials. (12 or 8,4)
6. What do you understand by the word Lithography? Discuss advancements in lithography technique from ancient times to modern world. (12 or 8,4)

Section D

7. What is carbon nanotube (CNT)? Give its different types. How is it related to graphene? Discuss its different properties and applications. (12 or 8,4)
8. (a) CNTs are believed to have high strength for the future technological world. Explain. (b) CNTs are potential materials for catalysis, field emission and fuel cells. Explain. (12 or 8,4)

Section E (Compulsory)

9. (a) What are Nanomaterials? Define the size range of nanomaterials.
   (b) Differentiate between PVD and CVD techniques for nano synthesis.
   (c) What are the conditions of quantum confinement?
   (d) What is fullerene? How it is different from core-shell nano particles?
   (e) With diagram explain "surface area is deciding factor in nano materials".
   (f) How do melting point, photoluminescence peaks and Raman spectra vary with particle size? (6x2=12)

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SEMESTER IV

PHY-7403(ii) Advanced Electronics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- The course content covers basic analog and digital systems, digital communications, Pulse-Modulation Systems, Digital Modulation techniques, Microwave Devices and Communications, Fabrication of integrated devices, Physical vapours deposition methods etc.

Unit I: Analog to Digital System	**15 Lectures**
Analog Computation, Active Filters, Comparators, Logarithmic and Anti–Logarithmic Amplifiers, Sample and Hold Amplifiers, Waveform Generators, Square and Triangular Wave Generators, Pulse Generators, Read only Memory (ROM) and Applications, Random Access Memory (RAM) and applications, Digital to Analog Converters, Ladder and weighted type Analog to Digital Converters, Counter type, Successive Approximation and Dual Slope Converters, Application of Digital to Analog converter (DACs) and Analog to Digital Converters (ADCs).	
Unit II: Digital Communications	**15 Lectures**
Pulse-Modulation Systems: Sampling theorem- Low pass and Band pass Signals, PAM, Channel Bandwidth for a PAM signal, Natural sampling, Flat-Top sampling, Signal recovery through Holding, Quantization of signal, Quantization, Differential PCM, delta Modulation, Adaptive Delta Modulation, CVSD, Digital Modulation techniques: BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK.	
Unit III: Microwave Devices and Communications	**15 Lectures**
Klystron amplifiers, Velocity Modulation, Basic principle of two Cavity Klystron, Reflex klystron, Traveling Wave Tubes (TWT), Transferred Electron Devices (Gunn Diode), Tunnel Diode, IMPATT Diode, TRAPATT Diode. **Microwave Communications:** Advantages and Disadvantages of Microwave Transmission, Propagation of microwaves, Atmospheric effects on propagation, Fresnel zone problem, Ground reflection. Fading sources, Detectors, Components, Antennas used in MW Communication Systems.	

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Unit IV: Fabrication of Integrated Devices	15 Lectures
Thin Film Deposition Techniques; Vacuum pumps and gauges pumping speed, throughout Effective conductance control chemical vapor Deposition (CVD), MOCVD, PEMOCVD (plasma enhanced chemical vapour deposition) **Physical Vapor Deposition:** Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering and Laser Ablation, Lithography, Etching and Micro-Machining of Silicon, Fabrication of integrated circuits and integrated micro-electro-mechanical-systems (MEMS).	

Course Learning Outcomes (CLOs)

- Illustrate working principles of different electronic circuits and their applications in real life.
- Students will be able to learn the concept of Pulse-Modulation Systems and different digital modulation techniques.
- To know about the Fabrication of integrated Devices and Physical Vapour Deposition methods.

Books Recommended:

- MuIlman & Halkias, Integrated Electronics.
- D. V Hall, Micro processor and Interfacing.
- S.K. Gandhi, Theory and Application of Micro Electronics.
- Millman & Grabel, Micro Electronics.
- P. Malvino, Digital Computer Electronics.
- Atwater, Introduction to Microwave Theory, McGraw Hill,1962.
- M.L. Sisodia and G.S. Raghuvanshi, Microwave Circuits & Passive Devices, New Age International,
- H.A. Watson, Microwave Semiconductor Devices and Their Circuit Applications, 1969.
- R.E. Collin, Foundations of Microwave Engineering, McGraw Hill, 2001.

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Format of Question Paper for the End Semester Examination

Roll No:..... ..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7403(ii)
Advanced Electronics
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. Explain the following
   (i) Waveform Generators (Square and Triangular)
   (ii) Random Access Memory (RAM) and applications.
   (12 or 8,4)
2. What is the difference between digital to analog converter (DACs) and analog to digital Converters (ADCs)? Also discuss one application of DAC. (12 or 8,4)

Section B

3. Explain the following:
   (i) Pulse Modulation System (PMS)
   (ii) Channel Bandwidth for a PAM signal (12 or 8,4)
4. Explain the following:
   (i) Adaptive Delta Modulation
   (ii) Binary Phase Shift Keying (BPSK) And Quadrature Phase Shift Keying (QPSK). (12 or 8,4)

Section C

5. What is Klystron amplifiers? Explain the basic principle and theory of two Cavity Klystron in detail? (12 or 8,4)
6. Explain microwave communications? Also discuss the Advantages and Disadvantages of Microwave Transmission? (12 or 8,4)

Section D

7. What is thin film technology? How does Plasma Enhanced Chemical Vapor Deposition Work? Also discuss its advantages and disadvantages. (12 or 8,4)

8. Explain the following techniques:
   (i) Molecular Beam Epitaxy (MBE), (ii) Fabrication of integrated circuits (12 or 8,4)

Section E (Compulsory)

9. (a) Explain delta Modulation?
   (b) Differentiate Sample and Hold Amplifiers?
   (c) What do you mean by Analog Computation?
   (d) What is the principle of IMPATT diode?
   (e) How do you calculate Fresnel number?
   (f) What are the factors affecting lithography?

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SEMESTER IV

PHY-7403(iii) Advanced Nuclear Physics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To impart knowledge about nuclear deformations, properties and nuclear models for understanding of related reaction dynamics.
- To realize about the latest nuclear detectors, accelerators for their practical applications

Unit-I: Angular Momentum Theory	**15 Lectures**
Angular momentum coupling: coupling of two angular momenta, coupling of three angular momenta, coupling of four angular momenta Racah coefficients, Tensors and reduced matrix elements of irreducible operators, Product of tensor operators, Application: Spherical harmonics between orbital angular momentum states, Spin operator between spin states, Angular momentum J between momentum states, Matrix elements element of compounded states and Matrix elements between angular momentum coupled state.	
Unit-II: Nuclear Decays	**15 Lectures**
Decay widths and lifetimes, Alpha Decay: General Properties and theory of alpha decay, Barrier penetration of alpha decay, alpha decay spectroscopy Spontaneous fission decay, **Beta Decay**: General Properties, Neutrinos and Antineutrinos, the Fermi theory of beta decay, Angular momentum and selection rules of beta decay, electron capture, beta spectroscopy, Gamma decay, Reduced transition probabilities for gamma decay, Weisskopf units for gamma decay.	
Unit–III: Independent Particle Model	**15 Lectures**
The Fermi gas model, The one body potential General properties, The harmonic oscillator potential separation of intrinsic and centre-of-mass motion, the kinetic energy and the harmonic oscillator, Conserved quantum numbers, angular momentum, parity and isospin, Quantum number for the two nucleon system, two proton or two neutron, and proton and neutron, The Hartree Fock Approximation, Properties of single Slater determinants, Derivation of the Hartree-Fock equations, examples of single particle energies, Results with Skyrme Hamiltonian: Binding energy, single particle energies, RMS charge radii and charge densities.	

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Unit-IV: The Shell Model	15 Lectures
Ground state spin of nuclei, Static electromagnetic moments of nuclei, Electromagnetic transition probability on shell model, Exact treatment of two-nucleons by shall model, two- nucleon wave function, matrix elements of one-body operator and two-body potential, Shell model diagonalization, Configuration mixing, relationship between hole state and particle state, State of hole-particle excitation and core polarization, Seniority and fractional percentage by second-quantization technique.	

Course Learning Outcomes (CLOs)

- Students will be able to understand the structure and properties of nuclei, radioactive decay and different types of nuclear reactions.
- Students will be able to understand quantum behavior of atoms in external electric and magnetic fields.
- Students will be able to compare various nuclear models and properties of the nucleus.

Books Recommended:

- M.K. Pal Theory of Nuclear Structure, Affiliated East-West, Madras-1992.
- Y. R. Waghmare, Introductory Nuclear Physics, Oxford-IBH, Bombay, 1981.
- K. L. G. Heyde, The Nuclear Shell Model, (Springer-Verlag, 1994)
- R. D. Lawson, Theory of the Nuclear Shell Model, (Clarendon Press, 1980).
- A. R. Edmonds, Angular Momentum in Quantum Mechanics, (Princeton University Press, 1957
- D. M. Brink and G. R. Satchler, Angular Momentum, (Clarendon Press, Oxford, 1968.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7403(iii)
Advanced Nuclear Physics
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is coupling of Angular Momentum? Explain the coupling of three angular momenta? (12 or 8,4)
2. What is the relationship between J, L and S? What is the matrix representation of angular momentum? (12 or 8,4)

Section B

3. What is Alpha Decay? How would you briefly explain the nuclear potential barrier of alpha decay? (12 or 8,4)
4. What is Beta Decay? How many types of Beta Decay. Explain Fermi's Theory of Beta decay. (12 or 8,4)

Section C

5. What is the Fermi gas model? What is the potential of a harmonic oscillator? (12 or 8,4)
6. What are the approximations in Hartree-Fock? Write the derivation of the Hartree-Fock equations. (12 or 8,4)

Section D

7. What are the predictions of the shell model in nuclear physics? Explain the electromagnetic transition probability on the shell model. (12 or 8,4)

8. What is configuration mixing? What is the relationship between hole state and particle state? (12 or 8,4)

Section E (Compulsory)

9. (a) What is the spin operator?
   (b) What is the irreducible tensor operator?
   (c) What is neutrino and antineutrino in beta decay?
   (d) What is the difference between Hartree and Hartree fock approximation?
   (e) What is the relationship between parity and angular momentum?
   (f) What is angular momentum of a particle? (6x2 =12)

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SEMESTER IV

PHY-7404(i) Experimental Techniques in Physics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To enhance the practical skill among the students by characterizing and analyzing the data using various techniques.

Unit I: Thin Film Deposition Technology	**15 Lectures**
Basics of thin films and role of thin films in Devices, General introduction to physical and chemical deposition methods (Thermal evaporation, Cathodic sputtering, Molecular beam epitaxy, Laser ablation methods and Chemical vapor deposition, Properties and applications of thin films. Vacuum technology: different pumps, leakage and contamination detection, construction of vacuum systems.	
Unit II: Diffraction Techniques	**15 Lectures**
Principal, Instrumentation, Working and applications of X-ray diffraction, Electron diffraction, Diffraction data analysis. **Thermal Analysis:** Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Universal Tensile Testing.	
Unit III: Microscopic Techniques	**15 Lectures**
Basic concepts, Instrumentation, Working and Applications of Optical Microscopy, Scanning Electron Microscopy (SEM) with EDAX, Transmission Electron Microscopy (TEM), Scanning Probe Microscopy; (a) Scanning Tunneling Microscopy (STM), (b) Atomic Force Microscopy (AFM).	
Unit IV: Spectroscopy Techniques	**15 Lectures**
Basic concepts, Instrumentation & working, Applications: UV-Visible absorption spectroscopy, X-ray photoelectron spectroscopy, Raman spectroscopy, Infrared spectroscopy, Fourier Transform Infrared spectroscopy, Luminescence spectroscopy, Atomic absorption spectroscopy, Impedance spectroscopy, Dielectric Spectroscopy, Mass spectroscopy, Mossbauer spectroscopy.	

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Course Learning Outcomes (CLOs)

- Students will be able to identify the strength and limitation of each technique and hence to make suitable characterization techniques.
- Upon completion, students should be able to describe and explain the working principles of the various techniques.

Books Recommended:

- K. L. Chopra, Thin Film Phenomena, Robert E. Krieger publishing, 1969
- S.Zhang, L. Li , A. Kumar, Materials Characterization Techniques1st Edition, Kindle Edition, CRC Press.
- Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Wiley.
- C.S. Rangan, G.R. Sarmaand V. S. V. Mani, Instrumentation: Devices and Systems, Tata Mc Graw Hill Publishing Co. Ltd.
- G. Chatwaland, S. Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House.
- J. B. Wachtman & Zwi. H. Kalman, Characterization of Materials, Pub. Butterworth Heinemann (1992).
- B. Dennis Cullity, R. S. Stuart, Elements of X-ray diffraction, (Printice Hall, 2001-Science - 664pages).
- V.V. Rao, T.B. Gosh, K.L. Chopra, Vacuum Science and Technology, Allied Publishers.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7404(i)
Experimental Techniques in Physics
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is sputtering? discuss advantages of sputter deposition. Describe thermal evaporation method of thin film growth. (12 or 8,4)
2. (a) Describe evaporation technique of thin films deposition. Discuss different evaporation methods of thin film deposition.
   (b) Write the short note on (i) Chemical vapour deposition and (ii) Physical vapour deposition. (12 or 8,4)

Section B

3. (a) Describe the principle and working of scanning tunneling electron microscopy.
   (b) Derive Bragg's law of X-Ray diffraction. Discuss how it is used to identify crystalline nature of solids. (12 or 8,4)
4. Discuss the universal tensile testing techniques. Describe the principle and working of differential scanning calorimetry techniques. (12 or 8,4)

Section C

5. (a) Explain the principle, working and construction of energy dispersive x-ray spectroscopy. (12 or 8,4)
   (b) Discuss the principle of electron diffraction. Explain the working of transmission electron microscope.
6. (a) Differentiate between scanning electron microscope and field emission scanning electron microscope.
   (b) Explain the principle and working of atomic force microscope. (12 or 8,4)

Section D

7. (a) Describe the UV-Visible absorption spectroscopy in terms of basic concepts and instrumentation.
   (b) Explain the working of Raman spectroscopy. (12 or 8,4)
8. Explain the working of Mossbauer spectroscopy technique. What information about the material we can extract from this technique? (12 or 8,4)

Section E (Compulsory)

9. (a) Name one technique to estimate energy band gap of the semiconductor.
   (b)What is the application of Mossbauer spectroscopy?
   (c) What is the use of Fourier Transform Infrared spectroscopy?
   (d) Which technique requires a continues wavelength source for analysis?
   (e) Name the technique which is used to study optical properties of solids.
   (f)Which technique can be used to find out the melting point of solids?

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SEMESTER IV

PHY-7404(ii) Opto-Electronics							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- The main objective of this course is to make the students not only understand and perform the Optics and Electronics experiments but also suitably correlate them with the corresponding theory, through the standard set of experiments.

Unit I: Injection Luminescence	**15 Lectures**
Recombination, Luminescence and their processes, The spectrum of recombination radiations, High Injection approximations for recombination rates, Carrier Recombination, Direct and Indirect band gap Semiconductors, The Semiconductor Injection Laser, The Internal Quantum Efficiency, The External Quantum Efficiency.	
Unit II: Theory of Laser Action in Semiconductors	**15 Lectures**
Condition for gain, The threshold conditions for oscillations, Rates of spontaneous and stimulated emission, Effect of refractive index, Calculation of the gain coefficients, Relation of the gain coefficient to current density. **Semiconductor Injection Laser:** Efficiency, Stripe geometry LED materials, Commercial LED materials, LED construction, Response time of LED's, LED derive circuitry.	
Unit III: Optical Detectors	**15 Lectures**
Introduction, Device types, Optical Detection, Principles, Absorption, quantum efficiency, Responsively, Long wavelength cut off, Photoconductive Detectors, Characteristics of particular photoconductive materials, Solar cell, Holography and its applications, Liquid crystal displays The Optical Fiber, Multimode and Single Mode Fibers, Glass Fibers, Plastic Optical Fibers, Fiber-Optic Bundle, Fabrication of Optical Fibers, Perform fabrication, Fiber Fabrication, Free Space Optics.	
Unit IV: Junction Detectors	**15 Lectures**
Detectors performance parameters Semiconductors p-i-n diodes, General Principle, Quantum efficiency, Materials and design for p-i-n photodiodes, Impulse & frequency response of p-i-n photodiodes, Avalanche photodiodes detectors, The multiplication process, Avalanche photodiodes (APD) design, AP Phototransistors.	

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Course Learning Outcomes (CLOs)

- After the completion of course knowledge about modulation of light, LEDs, Lasers and Photo detectors will be imparted for fiber-optic communication.
- Students will be able to explain key concepts in quantum and statistical mechanics relevant to physical, electrical and optoelectronic properties of materials.

Books Recommended:

- John Gowar, Optical Communication Systems, Prentice Hall of India Pvt. Ltd. New Delhi.
- J. M. Senior, Optical Fiber communications- Principles and practice, Prentice Hall International.
- J. Wilson, Opto-electronics-An Introduction (Second edition), J.F. B. Hawkes Prentice Hall International.
- S. M. Sze, Physics of the Semiconductor Devices, 2nd edition, Wiley Eastern Ltd. (1983).
- Ghatak and K. Thyagarajan, Fiber Optics and Lasers -The Two Revolutions.
- O. Svelto, Principle of Lasers, Springer.
- B B Laud, Lasers and non-linear optics, New Age International (P) Limited Publishers.
- K. Thyagarajan, Laser, Theory and Applications.
- Anchal Srivastava, Introduction to Optics, etc, New Age International Publishers, New Delhi.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7404(ii)
Opto-electronics
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is Spectrum of recombination radiation? Give high Injection approximations for recombination rates and Carrier Recombination. (12 or 8,4)

2. Explain Semiconductor Injection Laser. What is internal quantum efficiency and external quantum efficiency? (12 or 8,4)

Section B

3. What are the threshold conditions for oscillations? Calculate rate of spontaneous and stimulated emission. (12 or 8,4)
4. What is the basic principle of laser action? What are its types? Explain semiconductor Laser. (12 or 8,4)

Section C

5. What do you mean by Liquid crystal display? Draw the structure and discuss the working of LCD. Where are they used? (12 or 8,4)
6. What do you mean by optic Fiber? Discuss multimode and single mode fibers. What are Fiber optic bundle? (12 or 8,4)

Section D

7. Discuss junction detector performance parameters. Discuss the semiconductor p-i-n diode in detail. (12 or 8,4)
8. (a) What do you mean by multiplication process?
   (b) Explain phototransistors in detail. (12 or 8,4)

Section E (Compulsory)

9. (a) What are indirect band gap semiconductors? Give one application for this.
   (b) What are optical detectors?
   (c) When is the response time for LED?
   (d) Why are sharp bending is avoided in optical fibers.
   (e) What are Solar cell? Calculate its efficiency.
   (f) Explain holography and give its application. (6x2=12)

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SEMESTER IV

PHY-7404(iii) Nuclear Technology							
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
4	0	0	4	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Guidelines for setting Question Paper: Question paper of end semester examination will be of 60 marks. The question paper will consist of five sections A, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answer type questions consisting of six parts of 02 marks each. The candidates will attempt five questions in all, i.e. one question each from sections A, B, C, D and the compulsory question from section E. In the question paper, the questions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and Section-E will cover the whole syllabus.

Learning Objective (LO)

- To accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.

Unit I: Detection and Instrumentation	**15 Lectures**
Introduction, Gas detectors: Ionization chamber, Proportional counter and Geiger-Mueller counter, Scintillation counters, Semiconductor detectors, Neutrons detectors. **Particle Accelerators** Classification and performance characteristics of accelerators, Ion sources, Electrostatics accelerators, Cockcroft – Walton generator, Cyclotron, Synchrocyclotron, Betatron, Electron and proton synchrotron, Microtron, Linear accelerator.	
Unit II: Biological Effects Radiation	**15 Lectures**
Initial interactions, Dose, Dose rate and dose distribution, Damage to critical tissue, Human exposure to radiation and risk assessment. **Industrial and Analytical Applications** Industrial uses: -Tracing, Gauging, Material modification sterilization, Food preservation, Neutron activation analysis, Rutherford backscattering, Particle induced X-ray emission accelerator mass spectroscopy.	
Unit III: Nuclear Medicine Projection Imaging	**15 Lectures**
X-Radiography and the gamma camera, Computed tomography, Positron emission tomography (PET), Magnetic resonance imaging (MRI), Radiation therapy. **Mossbauer Spectroscopy:** Resonant absorption of gamma rays, The Mossbauer effect, Application: Nano material spectroscopy and nuclear spectroscopy.	
Unit IV: Nuclear Energy Power	**15 Lectures**
Characteristic of fission, The chain reaction in a thermal fission reactor, Reactor operation, Commercial thermal reactions, The breeder reactor technology, Accelerator driven systems, Indian nuclear energy program. Thermonuclear reaction and energy production, Fusion in hot medium, Progress towards fusion power, Fusion in early universe, Stellar burning, The pp chains, Beyond hydrogen burning and nucleosynthesis: Production of light elements (up to Fe), Lawson Production of the heavy elements supernovae criteria, Fundamentals of inertial confinement fusion, Fundamentals of magnetic method and current status.	

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Course Learning Outcomes (CLOs)

- Upon completion of the course, students can define the basic elements of nuclear power production and technology.
- Students can also describe different elements of nuclear power technology deployment such as safety.

Books Recommended:

- Krane, Introductory Nuclear Physics. Wiley (2008).
- W. R. Leo, Techniques for Nuclear and Particle Physics Experiments. Springer (1994).
- R. L. Murray, K. E. Holbert, Nuclear Energy, Elsevier (2015).
- Bowers & Deeming, Astrophysics I (Stars), Jones and Barlett Publishers (1984).
- Roth & Poty - Nuclear Methods of Dating, Springer (1990).
- Webb - The Physics of Medical Imaging, 1988.

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Format of Question Paper for the End Semester Examination

Roll No:..... **Total Pages:.....**

(Month-Year)
M.Sc. Physics Examination
PHY-7404(iii)
Nuclear Technology
Semester-IV

Time: 3 Hours **Max. Marks: 60**

Note: Attempt five questions in all, selecting one question from each section A, B, C and D and section E is compulsory. All questions carry equal marks.
The candidates shall limit their answers precisely within the answer book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Section A

1. What is the principle of Cyclotron? Explain the construction, working and limitations of Cyclotron. (12 or 8,4)

2. What is the principle of Geiger-Mueller counter? Explain the theory and applications of GM counter. (12 or 8,4)

Section B

3. What is radiation and how are people exposed to it? Also differentiate Dose rate and dose distribution? (12 or 8,4)

4. Explain the following:
   (i) Neutron activation analysis
   (ii) Rutherford backscattering (12 or 8,4)

Section C

5. What is the principle of Positron emission tomography (PET)? Explain the theory and applications of PET. (12 or 8,4)
6. What is the principle of Magnetic resonance imaging (MRI)? Explain the working and applications of MRI. (12 or 8,4)

Section D

7. What is the difference between thermal and fast reaction? Explain the different type of chain reaction in a thermal fission reactor. (12 or 8,4)

8. What is thermonuclear reaction? Explain the Lawson Production of the heavy elements. (12 or 8,4)

Section E (Compulsory)

9. (a) What is the most common risk of radiation exposure?
   (b) How many types of radiation biological effect are there?
   (c) How much energy can you get from nuclear fission?
   (d) What are the two forms of energy produced in thermonuclear reactions?
   (e) What is the principle of operation of proportional counter?
   (f) What is the principle of linear accelerator? (6x2=12)

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Format of the Project Report

A PROJECT REPORT
on
Title

SUBMITTED
in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE IN PHYSICS

Supervised by

Submitted by

DEPARTMENT OF PHYSICS

SCHOOL OF BASIC AND APPLIED SCIENCES
UNIVERSITY SCHOOLS OF STUDIES
Himachal Pradesh Technical University, Hamirpur

Session:

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DECLARATION

I hereby declare that the project work entitled " " submitted to the HP Technical University, Hamirpur, is a record of an original work done by me under the guidance of Dr._____Department of Physics, School of Basic and Applied Sciences and this project work is submitted in the partial fulfilment of the requirements for the award of the degree of Master of Science in Physics. The results embodied in this report have not been submitted to any other university or institute for the award of any degree or diploma.

Signature and Name of the Student

CERTIFICATE

This is to certify that the Project work entitled "------Title-----" was carried out by ---------- under my supervisor ---------- at Physics laboratory in the Department of Physics, School of Basic and Applied Sciences, Himachal Pradesh Technical University, Hamirpur.

It is certified that this project work has been done by the team and has not been submitted for any other degree.

Supervisor

Head/Coordinator

Dean, University Schools of Studies

Other Main Contents

ACKNOWLEDGEMENT
PREFACE
LIST OF TABLES
LIST OF FIGURES
CONTENTS
CHAPTERS
SUMMARY AND CONCLUSION
REFERENCES

Note: The above format may also be considered for the submission of Seminar, Institutional Tra Internship/Survey/Online course report with the minor amendments.

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Below is the Open Elective subject to be offered by the Physics Department for B.Tech. and other UG students (Introduction to Quantum Computing), 7th Semester

PHYOE-711(i) Introduction to Quantum Computing							Semester-VII
Teaching Scheme			Credit	Marks Distribution			Duration of End Semester Examination
L	T	P	C	Internal Assessment	End Semester Examination	Total	
3	0	0	3	Maximum Marks: 40	Maximum Marks: 60	100	3 Hours
				Minimum Marks: 16	Minimum Marks: 24	40	

Instructions to the question paper setter:

Question paper of end semester examination will be of 60 marks. The question paper will consist of five sectionsA, B, C, D and E. Sections A, B, C and D will have 2 questions of 12 marks each and section E has short answertype questions consisting of six parts of 02 marks each. The candidate will attempt five questions in all, i.e onequestion each from sections A, B, C, D and the compulsory question from section E. In the question paper, thequestions available in sections A, B, C and D will be covered from Unit-I, Unit-II, Unit-III and Unit-IV respectively and section-E will cover whole syllabus.

Learning Objectives (LOs):

- To introduce the fundamentals of Vector spaces and quantum mechanics.
- To understand linear algebra which is a strong prerequisite for quantum computing.
- To understand the problem-solving approach in the context of the qubits and multi-qubit Hilbert space and operators.

Unit-I
Fundamental of Quantum Mechanics: Vector Spaces, Linear Dependence and Independence of Vectors, Basis, Projection Operator and Completeness Relation, Orthonormal Basis and Completeness Relation, Projection Operators, Gram-Schmidt Ortho-normalization, Linear Operators and Matrices, Hermitian operators, Eigen value Problems, Pauli Matrices.
Unit-II
Linear Algebra for Quantum Computation: Linear transformations, Matrix multiplication, Non-commutativity, Diagonalization, Inversion, Hermitian and Unitary operators, Spectral Decomposition, Singular Value Decomposition, Trace and partial trace, Tensor Product and its properties, Postulates of quantum mechanics in density matrix formulism.
Unit–III
Classical Information Theory and Quantum Bits: Basics of bits, Gates, Communication, Randomness and statistics Quantum bits, Superposition states, Measurements and the Born rule, Single-qubit, Hilbert space: linear operators, Dirac notation, Orthonormal bases, Qubit rotations and the Bloch sphere, Expectation values and variance of measurement results.
Unit–IV
Quantum Gates: Unitary operator, Single qubit gate, Universal quantum gates, CNOT gate, Toffoli gate and circuit model of computation, Bell states and non-classical correlations, Quantum dense coding and Concept of entanglement and its measure, The no-cloning theorem and Quantum state teleportation.

Learning Outcomes:

- To understand the basics of quantum theory in context with quantum computing.
- To solve the problems of 1 or 2 qubits analytically.
- To build quantum computation from basic elements (gates) along with concerned outcor

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Text Books:

- D. A. Miller, Quantum mechanics for scientists and engineers. Cambridge University Press, 2008.
- M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information: 10th Anniversary Edition. Cambridge University Press, 2011.
- Chuck Easttom, Quantum Computing Fundamentals, Published by Addison Wesley, 2021.
- Phillip Kaye, Raymond Laflamme and Michele Mosca, An introduction to Quantum Computing, Oxford University press, 2007.
- David McMahon, Quantum Computing Explained, John Wiley & Sons, 2008.
- Pathak, Elements of Quantum Computation and Information, Publication by CRC Press, 2013.

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