NEW COURSE STRUCTURE

in accordance with NEP-2020

for

B.Sc. (Physics Hons.)
&
I.M.Sc. (Physics)

(Effective from Academic Year 2023-24)

Department of Physics
B.I.T. Mesra, Ranchi

NEP-based 4-Years B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) continuable to 5-Year Integrated M.Sc. Physics Program

Important Notes:

- The essential guidelines from UGC dated 07 Dec 2022 have been followed in the preparation of the course structure of this programme.
- Candidates having passed Class 12 (or equivalent examination) with Physics, Mathematics, English, Chemistry (or Biology/ Biotechnology/ Technical Vocational subject) with minimum 75% (65% for SC/ST and PwD) aggregate marks in five subjects, will be eligible for admission to B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research). The seat allocation will be done through CSAB (Central Seat Allocation Board) / JoSAA (Joint Seat Allocation Authority) Based on AIR in JEE (Main).
- Students will obtain B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) after completing the 4th year upon fulfilling the academic requirements.
- The multiple entry-exit options will be available on successful completion of stipulated year-wise academic requirements to obtain 1 Year - UG Certificate, 2 Year - UG Diploma, and 3 Year - B.Sc. Physics (Major).
- Lateral entry at each level is allowed in MO sessions as per eligibility and qualifying admission test.

Department Vision

To become an internationally recognized centre of excellence in academics and research in the area of Physics and related interdisciplinary fields.

Department Mission

- To impart high quality science education in a multidisciplinary vibrant academic ambience, nurture young talents and prepare them to take up challenges in diverse areas of science and technology.
- To inculcate professional ethics, integrity, and appreciation for diversity in students and incumbents.
- To provide an environment for collaborative cutting edge research leading to innovations, while maintaining focus on social responsibilities.
- To create proactive performers to take up initiatives, leading to creation of new knowledge.
- Strive towards achieving satisfaction of all stakeholders.

Educational objectives

1. To impart high quality education in Physical Sciences.
2. To prepare students for taking up challenges as globally competitive physicists & researchers in diverse areas of theoretical and experimental physics.
3. To make students technically and analytically skilled.
4. To provide opportunity of pursuing cutting-edge research as project work.
5. To give exposure to a vibrant academic ambience.
6. To create a sense of academic and social ethics among the students.
7. To prepare them to take up higher studies of interdisciplinary nature.

Program Outcomes:

a) They will be prepared to take up challenges as globally competitive physicists & researchers in diverse areas of theoretical and experimental physics.
b) The students will obtain good knowledge in Physical Sciences. They will be trained to compete for national level tests like, UGC-CSIR NET, JEST, GATE, etc., successfully.
c) They will be technically and analytically skilled to pursue their further studies.
d) They will have a sense of academic and social ethics.
e) They will gain knowledge of other allied disciplines and be capable of taking up jobs and higher studies in interdisciplinary areas.
f) They will be able to recognize the need for continuous learning and develop throughout their professional career.

The contents of laboratory papers are designed to meet their respective theory papers' course objectives and outcomes.

Chapter 1: Introduction

The program is designed to provide a broad interdisciplinary experience to the students.

The **B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research)** is a 4-year programme organized into eight semesters. For a well-balanced and well-rounded learning experience, each student is required to take a minimum number of courses in other disciplines as well.
Students who complete all requirements for the award of **B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research)** can continue their study leading to **5-Year Integrated M.Sc. Physics.**

As per NEP-2020 guidelines, the following levels will be given to the candidates to opt for entry and exit the programme:

- ***1-Year Programme: UG Certificate***
- ***2 Year Programme: UG Diploma Physics***
- ***3-Year Programme: B.Sc. Physics (Major)***
- ***4-Year Programme: B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) with minor in Computer Science / Electronics and Communication / Electrical and Electronics / Mathematics and Computing.***

Chapter 2: Academic Details

The NEP-2020 guidelines for awarding Certificate, Diploma, and Degree

1-Year UG Certificate: Students who opt to exit after completing the first year and have secured a minimum of 40 credits will be awarded a UG certificate provided they complete a 4 credit summer vocational program.
2-Year UG Diploma: Students who opt to exit after completing the second year and have secured a minimum of 80 credits will be awarded the UG diploma provided they have completed a 4-credit summer vocational program.
3-Year UG Degree: Students who opt to exit after 3-years will be awarded a ***B.Sc. Physics Degree***, provided they have earned a minimum of 120 credits as per Table-1.
4-Year UG Degree (Honours): A four-year ***B.Sc. Physics (Honours) Degree*** will be awarded upon completion of a minimum of 160 credits as per Table-1.
4-Year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream during the fourth year. They will be required to undertake a research project or dissertation under the guidance of a faculty member of the University / College. The research project / dissertation will have to be in the major discipline. The students who secure 160 credits, including 12 credits from a research project/dissertation, are awarded UG Degree (Honours with Research).

Table 1: Minimum Credit Requirements to Award UG Degree as per NEP guidelines:

S.No.	Broad Category of Course		
		3-year UG	4-year UG
1.	Major (Core)	60	80
2.	Minor Stream	24	32
3.	Multidisciplinary	09	09
4.	Ability Enhancement Courses (AEC)	08	08
5.	Skill Enhancement Courses (SEC)	09	09
6.	Value Added Courses common for all UG	06-08	06-08
7.	Summer Internship	02-04	02-04
8.	Research Project / Dissertation	-	12
	Total (up to 4-Year)	**120**	**160**

Systematic exposure to the pillars of scientific, mathematical, and engineering principles takes place during the first three semesters. In each of these semesters, the students will take courses from chemistry, mathematics, biology, engineering, data sciences, humanities, etc., other than major courses. The teaching of the compulsory major courses will include substantial components of laboratory demonstrations and hands-on experiments.

The 4-Year B.Sc. program will focus primarily on the core papers of Major discipline (Physics) like, Mechanics, Mathematical Physics, Electrodynamics, Quantum Mechanics, Statistical Mechanics, Nuclear and Particle Physics, Solid State Physics, etc. In addition to the Major discipline, a student will also have an option to choose a Minor discipline. Students eligible and opting for B.Sc. (Honours with Research) will have to undertake Research Project of 12-credits, starting after the seventh semester, along with other required courses. The Research Project should be in the chosen Major discipline (Physics) or an interdisciplinary topic that substantially overlaps with Physics.

While students specialize in the major discipline, they will also broaden their knowledge and enhance their skills by opting courses from other disciplines. Students who take courses fulfilling the credit requirements in a specific discipline other than the major will qualify for a Minor in that discipline.

Students who complete all requirements for the award of the B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) may continue their studies into fifth year for a 5-Year Integrated M.Sc. Physics degree.

Chapter 3: The Selection Process

- Candidates must have a valid JEE (Main) score.
- Candidates must have passed Class 12 (or equivalent examination) with Physics, Mathematics, English,
- Chemistry (or Biology/ Biotechnology/ Technical Vocational subject) with a minimum of 75% (65% for SC/ST and PwD) aggregate marks in five subjects.
- Seat allocation will be done through CSAB (Central Seat Allocation Board) / JoSAA (Joint Seat Allocation Authority) Based on AIR in JEE (Main).
- Based on the availability of seats, lateral entry at every level will be allowed to the eligible candidates provided they qualify the admission test.

NOTE ON THE COURSE STRUCTURE

- The first year of the program will be common with the B.Tech. programs of the institute wherein the students would study courses from a variety of disciplines like, Chemistry, Mathematics, Computer Science, Electrical Engineering, Electronics and Communication Engineering, Mechanical Engineering, etc., gaining a broad exposure.
- Students will choose minor from a pool of courses.
- Students will obtain B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) after successfully completing the four years of study.
- Students who take Minor courses from a particular discipline fulfilling the specified credit requirements will qualify for a Minor in that discipline.
- Students who complete all requirements for the award of the B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) may continue their studies into the fifth year to obtain a 5-Year Integrated M.Sc. Physics degree.

FIRST YEAR						
FIRST SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major	PH113	Physics	3	1	0	4
	PH114	Physics Lab	0	0	3	1.5
Minor	CS101	Programming for Problem Solving	3	1	0	4
	CS102	Programming for Problem Solving Lab	0	0	3	1.5
	EE101	Basic Electrical Engineering	3	1	0	4
	MA103	Mathematics - I	3	1	0	4
Multidisciplinary	BE101	Biological Science for Engineers	2	0	0	2
Ability Enhancement	MT132	Communication Skills - I	0	0	3	1.5
Skill Enhancement	PE101	Workshop Practice	0	0	3	1.5
Value Added	MC101/102/ 103/104/109	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	1
		Total Credits in First Semester				**25**
SECOND SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Minor	EC101	Basics of Electronics and Communication Engineering	3	1	0	4
	EC102	Electronics and Communication Lab	0	0	3	1.5
	MA107	Mathematics - II	3	1	0	4
Multidisciplinary	CH101	Chemistry	3	1	0	4
	CH102	Chemistry Lab	0	0	3	1.5
	ME101	Basics of Mechanical Engineering	3	1	0	4
Skill Enhancement	ME102	Engineering Graphics	0	0	4	2
Value Added	MC105/106/ 107/108/110	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	1
	CE101	Environmental Science	2	0	0	2
Vocational Summer Internship		Hands on training on Vacuum Systems				4
		Total Credits in Second Semester				**24**
		Total Credits in First Year				**49**
		Total Credits for Students exiting with Certificate				**53**

SECOND YEAR						
THIRD SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major	PH101R1	Mechanics	3	0	0	3
	PH103R1	Mechanics Lab	0	0	3	1.5
	PH102R1	Electricity and Magnetism	3	0	0	3
	PH104R1	Electricity and Magnetism Lab	0	0	3	1.5
	PH105R2	Mathematical Physics-I	3	0	0	3
	PH106R1	Waves and Optics	3	0	0	3
	PH108R1	Waves and Optics Lab	0	0	3	1.5
Ability Enhancement	MT133	Communication Skills - II	0	0	3	1.5
		Group Discussion / MOOC				2
Skill Enhancement		SEC-1 **(Annexure-I)**	2	0	0	1.5
Value Added	MC201/202/ 203/204/209	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	1
					Total Credits in Third Semester	**22.5**
FOURTH SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major	PH213R1	Mathematical Physics-II	3	1	0	4
	PH214R1	Mathematical Physics Lab	0	0	3	1.5
	PH201R1	Thermal Physics	3	0	0	3
	PH204R1	Thermal Physics Lab	0	0	3	1.5
	PH202R1	Digital Systems & Applications	3	0	0	3
	PH205R1	Digital Systems & Applications Lab	0	0	3	1.5
Ability Enhancement	MT417/MT418	Foreign Language French/German MOOC	0	0	0	3
Skill Enhancement		SEC-2 **(Annexure-II)**	2	0	0	2
		SEC-3 **(Annexure-III)**	2	0	0	2
Value Added	MC205/206/ 207/208/210	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)/Entrepreneurship	0	0	2	1
Vocational Summer Internship		Hands on training on 3-D printing and designing (AICTE IDEA Lab)				4
					Total Credits in Fourth Semester	**22.5**
					Total Credits in Second Year	**94**
					Total Credits for Students exiting with Diploma	**98**

THIRD YEAR						
FIFTH SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major	PH301R1	Quantum Physics and Applications	3	0	0	3
	PH302R1	Solid State Physics	3	0	0	3
	PH309R1	Solid State Physics Lab	0	0	3	1.5
		DSE-1 **(Annexure-IV)**	3	0	0	3
		DSE-1 Lab **(Annexure-IV)**	0	0	3	1.5
Minor		ME-1 **(Annexure-V)**				4.5
					Total Credits in Fifth Semester	**16.5**
SIXTH SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major	PH316R1	Statistical Mechanics	3	0	0	3
	PH323R1	Statistical Mechanics Lab	0	0	3	1.5
		DSE-2 **(Annexure-VI)**	3	1	0	4
		DSE-2 Lab **(Annexure-VI)**	0	0	3	1.5
		DSE-3 **(Annexure-VII)**	3	1	0	4
		DSE-3 Lab **(Annexure-VII)**	0	0	3	1.5
Vocational Summer Internship		Summer Internship (Industry/Institute)	1	0	3	2
					Total Credits in Sixth Semester	**17.5**
					Total Credits in Third Year	**34**
					Total Credits for Students exiting with B.Sc. Physics	**128**

<table>
<tr><th colspan="7">FOURTH YEAR</th></tr>
<tr><td colspan="7">SEVENTH SEMESTER</td></tr>
<tr><td>Course Category</td><td>Course code</td><td>Course Name</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Major</td><td>PH401R1</td><td>Mathematical Methods in Physics</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>PH402</td><td>Electrodynamics</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>PH403</td><td>Classical Mechanics</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>PH404R1</td><td>Quantum Mechanics</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>PH405R2</td><td>Modern Computational Techniques and Programming</td><td>2</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td></td><td>PH406R1</td><td>Modern Computational Techniques and Programming Lab</td><td>0</td><td>0</td><td>3</td><td>1.5</td></tr>
<tr><td>Minor</td><td></td><td>ME-2 (Annexure-VIII)</td><td></td><td></td><td></td><td>4 - 4.5</td></tr>
<tr><td>Value Added</td><td>MT204</td><td>Constitution of India</td><td>2</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="6" align="right">Total Credits in Seventh Semester</td><td>19.5 - 20</td></tr>
<tr><td colspan="7">EIGHTH SEMESTER</td></tr>
<tr><td>Course Category</td><td>Course code</td><td>Course Name</td><td>L</td><td>T</td><td>P</td><td>Credit</td></tr>
<tr><td>Major</td><td>PH409</td><td>Atomic and Molecular Spectroscopy</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td></td><td></td><td>(Research Project/ Dissertation)</td><td></td><td></td><td></td><td>12</td></tr>
<tr><td></td><td colspan="6" align="center">OR</td></tr>
<tr><td></td><td>PH410</td><td>Electronic Devices and Circuits</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>PH412R1</td><td>Electronics Lab</td><td>0</td><td>0</td><td>3</td><td>1</td></tr>
<tr><td></td><td>PH502R1</td><td>Advanced Quantum Mechanics</td><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td></td><td>PH503R1</td><td>Laser Physics and Applications</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td></td><td>PH513R1</td><td>Laser Physics Lab</td><td>0</td><td>0</td><td>3</td><td>1</td></tr>
<tr><td>Minor</td><td></td><td>ME-3 (Annexure-IX)</td><td></td><td></td><td></td><td>4 - 5.5</td></tr>
<tr><td colspan="6" align="right">Total Credits in Eighth Semester</td><td>20 - 21.5</td></tr>
<tr><td colspan="6" align="right">Total Credits in Fourth Year</td><td>40-41</td></tr>
<tr><td colspan="6" align="right">Total Credits for Students exiting with B.Sc. Physics (Honours) / B.Sc. Physics (Honours with Research) with Minor in chosen discipline</td><td>168-169</td></tr>
</table>

FIFTH YEAR						
NINTH SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major	PH501	Nuclear and Particle Physics	3	1	0	4
	PH418	Spectroscopy Lab	0	0	4	2
	PH408R1	Advanced Statistical Mechanics	3	1	0	4
	PH411R2	Condensed Matter Physics	3	1	0	4
	PH413	Condensed Matter Physics Lab	0	0	4	2
		PE-I **(ANNEXURE-X)**	4	0	0	4
Total Credits in Ninth Semester						**20**
TENTH SEMESTER						
Course Category	**Course code**	**Course Name**	**L**	**T**	**P**	**Credit**
Major		PE-II **(ANNEXURE-XI)**	4	0	0	4
		PE-III **(ANNEXURE-XI)**	4	0	0	4
	PH550	Project				12
Total Credits in Tenth Semester						**20**
Total Credits in Fifth Year						**40**
Total Credits for I.M.Sc. Physics						**208-209**

ANNEXURE-I (Skill Enhancement Courses - I)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	SEC301R1	PHYSICS WORKSHOP SKILLS	1.5
2	SEC305R1	ELECTRICAL CIRCUITS AND NETWORK SKILLS	1.5

ANNEXURE-II (Skill Enhancement Courses - II)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	SEC401	RADIATION SAFETY	2
2	SEC405	WEATHER FORECASTING	2
3	SEC407	BASIC INSTRUMENTATION SKILLS	2

ANNEXURE-III (Skill Enhancement Courses - III)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	SEC303	COMPUTATIONAL PHYSICS SKILLS	2
2	SEC307	RENEWABLE ENERGY AND ENERGY HARVESTING	2
3	SEC403	APPLIED OPTICS	2

ANNEXURE-IV (Discipline Specific Elective - I)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	PH307	EXPERIMENTAL TECHNIQUES	3
2	PH314R1	EXPERIMENTAL TECHNIQUES LAB	1.5
3	PH306	MATERIALS SCIENCE AND NANOTECHNOLOGY	3
4	PH313R1	MATERIALS SCIENCE AND NANOTECHNOLOGY LAB	1.5
5	PH320R1	ATMOSPHERIC PHYSICS	3
6	PH325R1	ATMOSPHERIC PHYSICS LAB	1.5

ANNEXURE-V (Minor Elective - I)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	CS263	Data Structures and Algorithm	3
2	CS264	Data Structures and Algorithm Lab	1.5
3	EC303R1	Microprocessor and Microcontroller	3
4	EC304R1	Microprocessor and Microcontroller Lab	1.5
5	EE102	Basic Electrical Engineering Lab	1.5
6	EE201	Electrical Measurement and Instrumentation	3

ANNEXURE-VI (Discipline Specific Elective - II)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	PH318R1	INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS	4
2	PH327R1	NUCLEAR AND PARTICLE PHYSICS LAB	1.5
3	PH203R1	CLASSICAL DYNAMICS	4
4	PH206R1	CLASSICAL DYNAMICS LAB	1.5
5	PH208	ELEMENTS OF MODERN PHYSICS	4
6	PH211R1	ELEMENTS OF MODERN PHYSICS LAB	1.5

ANNEXURE-VII (Discipline Specific Elective - III)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	PH304R1	NANO MATERIALS AND APPLICATIONS	4
2	PH311R1	NANO MATERIALS AND APPLICATIONS LAB	1.5
3	PH321	ADVANCED EXPERIMENTAL TECHNIQUES	4
4	PH326R1	ADVANCED EXPERIMENTAL TECHNIQUES LAB	1.5
5	PH328	BIOPHYSICS	4
6	PH329R1	BIOPHYSICS LAB	1.5

ANNEXURE-VIII (Minor Elective - II)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	CS450	Mini Project	4
2	EC331	Communication System	3
3	EC332	Communication System Lab	1
4	EE205	Circuit Theory	4
5	CS206	Design and Analysis of Algorithm	3
6	CS207	Design and Analysis of Algorithm Lab	1.5

ANNEXURE-IX (Minor Elective - III)			
S. No.	**Course Code**	**Course Name**	**Credits**
1	IT263	Object Oriented Programming	3
2	IT264	Object Oriented Programming Lab	1.5
3	EC355R1	Fiber Optic Communication	3
4	EC356	Fiber Optic Communication Lab	1.5
5	EE261	Principles of Electrical Machines	4
6	EE252	Electrical Machine Laboratory - I	1.5
7	MA311	Numerical Techniques	4

ANNEXURE-X (Specialization Elective - I)

S. No.	Course Code	Course Name	Credits
GROUP-A (Theoretical Physics)			
1	PH535	Advanced mathematical methods	4
2	PH504	NUMERICAL METHODS FOR PHYSICISTS	4
GROUP-B (Condensed Matter Physics)			
3	PH505	THEORY OF SOLIDS	4
4	PH506	FUNCTIONAL MATERIALS	4
GROUP-C (Photonics)			
5	PH507	FIBER AND INTEGRATED OPTICS	4
6	PH521	PHOTONIC AND OPTOELECTRONIC DEVICES	4
GROUP-D (Electronics & Instrumentation)			
7	PH509	INSTRUMENTATION AND CONTROL	4
8	PH510	PHYSICS OF LOW DIMENSIONAL SEMICONDUCTORS DEVICES	4
GROUP-E (Plasma Physics)			
9	PH511	INTRODUCTION TO PLASMA PHYSICS	4
10	PH512	PLASMA PROCESSING OF MATERIALS	4

ANNEXURE-XI (Specialization Elective - II & III)

S. No.	Course Code	Course Name	Credits
GROUP-A (Theoretical Physics)			
1	PH516R1	NONLINEAR DYNAMICS AND CHAOS	4
2	PH532	NONEQUILIBRIUM STATISTICAL PHYSICS	4
3	PH536	Gravitation and cosmology	4
4	PH537	QUANTUM FIELD THEORY	4
GROUP-B (Condensed Matter Physics)			
5	PH519	PHYSICS OF THIN FILMS	4
6	PH520	THEORY OF DIELECTRICS AND FERROICS	4
7	PH517	NONCONVENTIONAL ENERGY MATERIALS	4
8	PH531	TOPOLOGICAL QUANTUM MATERIALS	4
9	PH533	PHYSICS OF SOLID STATE DEVICES	4
GROUP-C (Photonics)			
10	PH522	HOLOGRAPHY AND APPLICATIONS	4
11	PH524R1	NANOPHOTONICS	4
12	PH508	QUANTUM & NONLINEAR OPTICS	4
13	PH523	QUANTUM PHOTONICS AND APPLICATIONS	4
GROUP-D (Electronics & Instrumentation)			
14	PH525	MICROPROCESSOR AND MICROCONTROLLER APPLICATIONS	4
15	PH526	INTEGRATED ELECTRONICS	4
16	PH527	MICROWAVE ELECTRONICS	4
GROUP-E (Plasma Physics)			
17	PH528	THEORY OF PLASMAS	4
18	PH529	PLASMA CONFINEMENT	4
19	PH530	WAVES AND INSTABILITIES IN PLASMA	4

TABLE-2: CREDIT DISTRIBUTION

Sem	Major	Minor	Multi-disciplinary	AEC	SEC	Value Added	Summer Internship	Project	Total
I	5.5	13.5	2	1.5	1.5	1	0		25
II	0	9.5	9.5	0	2	3	[4]		24
III	16.5	0	0	3.5	1.5	1	0		22.5
IV	14.5	0	0	3	4	1	[4]		22.5
V	12	4.5	0	0	0	0	0		16.5
VI	15.5	0	0	0	0	0	2		17.5
VII	15.5	4.0 - 4.5	0	0	0	0	0		19.5 - 20.0
VIII	16	4.0 - 5.5	0	0	0	0	0	0	20.0 - 21.5
IX	20	0	0	0	0	0	0		20
X	20	0	0	0	0	0	0	0	20
G Total	**135.5**	**36 - 37**	**11.5**	**8**	**9**	**6**	**2**	**0**	**208 - 209**
UG 3-Year	**64**	**27.5**	**11.5**	**8**	**9**	**6**	**2**	**0**	**128**
UG 4-Year	**95.5**	**36 - 37**	**11.5**	**8**	**9**	**6**	**2**	**12**	**168 - 169**

CORE - COURSES

COURSE INFORMATION SHEET

Course code: PH113
Course title: Physics
Pre-requisite(s):Intermediate Physics and Intermediate Mathematics
Co- requisite(s):Mathematics I
Credits:4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code: PH113	**Title: Physics**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students		
1	To explain principles of physical optics and to have basic idea of fiber optics.	
2	To construct Maxwell's equations from basic principles and use it to solve electromagnetic plane wave equations.	
3	To distinguish between Newtonian Mechanics and special theory of relativity and develop the relationship of length contraction, time dilation and Einstein energy mass relation and to apply the concepts of special theory of relativity in various field of physics and engineering.	
4	To illustrate the phenomena of old quantum theory and derive Heisenberg uncertainty principle and Schrodinger equation.	
5	To interpret basic lasing action, study various types of lasers, and to have basic idea of nuclear physics and plasma physics	
Course Outcomes: After the completion of this course, students will be able to		
1.	analyze the intensity variation of light due to Polarization, interference and diffraction.	
2.	formulate and solve the engineering problems on electromagnetism	
3.	explain special theory of relativity and apply its concepts in various fields of physics and engineering	
4.	explain fundamentals of quantum mechanics and apply it to problems on bound states	
5.	explain working principle of lasers and to summarize its applications, understand basic idea of nuclear and plasma physics	
Syllabus		
Module-1	Physical Optics: Polarization, Malus' Law, Brewster's Law, Double Refraction, Interference in thin films (Parallel films), Interference in wedge-shaped layers, Newton's rings, Fraunhofer diffraction by single slit, Double slit. Elementary ideas of fibre optics and application of fibre optic cables.	**08**
Module-2	Electromagnetic Theory: Gradient, Divergence and Curl, Statement of Gauss theorem & Stokes theorem, Gauss's law, Applications, Concept of electric potential, Relationship between E and V, Polarization of dielectrics, dielectric constant, Boundary conditions for E & D, Gauss's law in magnetostatics, Ampere's circuital law, Boundary conditions for B & H, Equation of continuity, Displacement current, Maxwell's equations.	**08**
Module-3	Special Theory of Relativity: Introduction, Inertial frame of reference, Galilean transformations, Postulates, Lorentz transformations and its conclusions, Length contraction, time dilation, velocity addition, Mass change, Einstein's mass energy relation.	**06**
Module-4	Quantum Mechanics: Planck's theory of black-body radiation, Compton effect, Wave particle duality, De Broglie waves, Davisson and Germer's experiment, Uncertainty principle, Brief idea of Wave Packet, Wave Function and its physical interpretation, Schrodinger equation in one-dimension, free particle, particle in an infinite square well.	**09**

Module-5	Modern Physics: Laser-Spontaneous and stimulated emission, Einstein's A and B coefficients, Population inversion, Light amplification, Basic laser action, Ruby and He-Ne lasers, Properties and applications of laser radiation, Nuclear Physics- Binding Energy Curve, Nuclear Force, Liquid drop model, Introduction to Shell model, Applications of Nuclear Physics, Concept of Plasma Physics, and its applications	**09**

Text books:

1: A. Ghatak, Optics, 4th Edition, Tata Mcgraw Hill, 2009
2: Mathew N.O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
3: Arthur Beiser, Concept of Modern Physics, 6th edition 2009, Tata McGraw- Hill
4. F. F. Chen, Introduction to Plasma Physics and controlled Fusion, Springer, Edition 2016.

Reference books:

1: Fundamentals of Physics, Halliday, Walker and Resnick

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH114
Course title: Physics Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code: PH114	**Title: Physics Lab**	**L-T-P-C [0-0-3-1.5]**

List of Experiments

1. Error analysis in Physics Laboratory.
2. To determine the frequency of AC mains with the help of sonometer.
3. To determine the resistance per unit length of a Carey Foster's bridge wire and resistivity of unknown wire.
4. Measurement of electrical equivalent of heat.
5. To determine the wavelength of sodium lines by Newton's rings method.
6. To determine the frequency of tuning fork using Melde's Experiment.
7. Measurement of voltage and frequency of a given signal using CRO.
8. To determine the emf of a cell using stretched wire potentiometer.
9. Determination of refractive index of the material of a prism using spectrometer and sodium light.
10. To study the frequency response of a series LCR circuit.
11. To study Lorentz force using Current balance.
12. Study of electromagnetic induction and verification of Faraday's laws.
13. To determine Wavelength of prominent spectral lines of mercury light by a plane transmission grating.

COURSE INFORMATION SHEET

Course code: CS101
Course title:Programming for Problem Solving
Pre-requisite(s):Mathematics-I
Co- requisite(s):Programming for Problem Solving Lab
Credits: 4 L:3 T:1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code: CS101	**Title: Programming for Problem Solving**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to		
1	To learn computer language.	
2	To Learn coding for problems.	
3	To learn the problem-solving process through computer	
4	To know the limitations of system during program execution	
Course Outcomes: After the completion of this course, students will be able		
1.	To formulate simple algorithms for arithmetic and logical problems	
2.	To translate the algorithms to programs	
3.	To test and execute the programs and correct syntax and logical errors	
4.	To apply programming to solve simple numerical method problems, differentiation of function and simple integration	
5.	To decompose a problem into functions and synthesize a complete program using divide and conquer approach	
Syllabus		
Module-1	**Introduction to Programming**: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) **Idea of Algorithm:** steps to solve logical and numerical problems. **Representation of Algorithm:** Flowchart/Pseudo code with examples. From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code.	**10**
Module-2	Arithmetic expressions and precedence, Conditional Branching and Loops, Writing and evaluation of conditionals, Iterations, Loops	**05**
Module-3	Array, Character array, strings. Case studies Discuss the various Problems related to Basic science (Newton's Law, Kirchhoff's Law, Roots of an equation etc.,) Sorting, Searching.	**07**
Module-4	Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.	**08**
Module-5	Structures, Defining structures and Array of Structures **Pointers:** Defining pointers, Use of Pointers in self-referential structures, Link List, File Handling	**10**

Text Books:

• Problem solving and Program design in C: Jery R HanlyPaerson Education.7th Edison

• Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill

• E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill

• R.G.Dromey, How to Solve it by Computer, Pearson Education • Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice

Reference Books

• Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

COURSE INFORMATION SHEET

Course code: CS102
Course title: Programming for Problem Solving Lab
Pre-requisite(s):
Co- requisite(s): Programming For Problem Solving
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code: CS102	**Title: Programming for Problem Solving Lab**	**L-T-P-C [0-0-3-1.5]**

Sample Program List

Introduction and Control Flow

• Write an interactive program that will read in a +ve integer value and determine the following
i) If the integer is a prime number ii) If the integer is a Fibonacci number
• WAP in C to compute $\sin x = x - x^3/3! + x^5/3! - x^7/7!$ ….. Continue adding successive terms in the series until the value of the next term becomes smaller (in magnitude) than 10^{-5}. Test the program for x = 1, x = 2, and x = 3. In each case display the number of terms used to obtain the final answer.
• WAP to generate every 3rd integer beginning with I = 2 and continue for all integers that are less than 150. Calculate the sum of those integers that are evenly divisible by 5.
• WAP to find whether a given year is a leap year or not. Modify it to generate a list of leap years between two year limits given by user.
• WAP to display the following pattern :

```
                  11
            11    10    11
      11    10     9    10    11
11    10     9     8     9    10    11
```

• Using Ternary / Conditional operator find the greatest among 3 numbers.

• WAP to convert a decimal number into an equivalent number of the input base. Test your program for base 2,8,10 & 16.
• WAP to read a number n, and print it out digit-by-digit, as a series of words. For e.g. 123 would be printed as "one two three".
• WAP to check whether any input +ve integer is palindrome or not.
• WAP to simulate a simple calculator (+ - / * %) that takes two operands and an operator as input and displays the result.
• WAP to find the GCD of two input +ve integer numbers.
• WAP to swap the values of two variables without using a third variable.

Array

• Read a line of mixed text, and then write it out with all lower case and uppercase letters reversed, all digits replaced by 0s and all other characters (non-letters and non-digits) replaced by '*'.
• WAP to find the product of two matrices A and B. Display the source matrices and product matrix C in matrix format.
• WAP to find whether a given matrix is a triangular matrix or not.
• WAP to find the transpose of a matrix. Display the source and the transposed matrix in matrix format.
• Implement Prob. No. – 14 to 16 using functions for reading, manipulating and displaying the corresponding matrices in matrix form.
• WAP to sort a list of strings alphabetically using a 2-dim. Character array.
• WAP to display the row sum and the column – sum of an input 2- dim. Matrix. Display the source matrix with row and column sum.

Functions, Pointer & String

• Write a recursive function to calculate S = 2 + 4 + 6 + 8 + …… +2N. Implement the function in a complete C program.
• Write a function that accepts two arguments an array and its size n. It performs Bubble up sort on the array elements. Using indirection operator '*' implement this in a complete C program. Display the source and the sorted array.
• Using pointer, write a function that receives a character string and a character as argument. Delete all occurrences of this character in the string. The function should return corrected string with no holes.
• Write a function for reading character string using pointer. Calculate the length of the string (without using strlen ()). Finally print the string in reverse order, using pointer.
• Implement prob. No. 14 using pointers representation of 2 – dim. array.
• Implement prob. No. 15 using pointer representation of 2 dim. array.
• Implement prob. No. 16 using pointer representation of 2 dim. array.
• WAP to sort a list of strings into alphabetical order using array of pointers.

Structure and File

• Create records of 60 students, where each record has fields-name, roll, gpa and fees. Write a function update () to reduce the fees of those students who have obtained gpa greater than 8.5 by 25% of the original fees. Write a complete program to exercise this function in the main program and display all the records before and after updation.
• Define a structure that describes a hotel. It should have members that include the name, address, grade, average room charge and number of rooms. Write a function to perform the following operations:
• To print out hotels of a given grade in order of charges.
• To print out hotels with room charges less than a given value.
• WAP to concatenate the contents of two files into a third file.
• WAP to copy the content of one file into another file. Names of both the files are to be input as command line arguments

Text Books:

• Problem solving and Program design in C: Jery R Hanly Paerson Education.7th Edison
• Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
• E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
• R.G.Dromey, How to Solve it by Computer, Pearson Education

Reference Books

• Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice.

COURSE INFORMATION SHEET

Course code: EE101
Course title: Basic Electrical Engineering
Pre-requisite(s):Basic Sciences
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code:EE101	**Title: Basic Electrical Engineering**	**L-T-P-C [3-1-0-4]**
Course Objectives : This course envisions to impart to students to:		
1	Classify different electrical circuit elements and apply suitable laws and theorems for the analysis of electrical systems.	
2	Represent series / parallel electric / magnetic circuits.	
3	Employ three phase circuits for transfer of electrical power both under balanced and unbalanced condition.	
4	Interpret the system responses under different operating conditions such as resonance, mutual coupling and star-delta conversion.	
5	Assess the working of different A.C. electrical machines.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Solve electrical circuits using Kirchhoff’s laws and apply concepts of magnetic circuits in electrical systems.	
2.	Analyze A.C. electrical circuits having dependent and independent sources for computation of responses such as voltage, current, power.	
3.	Evaluate the advantages of 3 phase system in electrical industrial applications and differentiate between balanced and unbalanced operation.	
4.	Assess the applicability of circuit theorems for practical applications.	
5.	Integrate the sources of energy for transferring power to the consumers (load).	
Syllabus		
Module-1	**Introduction:** Importance of Electrical Engineering in day-to-day life, Electrical elements, properties and their classification, Ideal and Real Sources, Source Conversion. **D.C. Circuits**: KCL and KVL, Loop current and Nodal voltage method Steady state analysis with independent and dependent sources; Star-Delta conversion. **Magnetic Circuits:** Introduction, Series-parallel magnetic circuits, Analysis of Linear and Non-linear magnetic circuits, Energy storage, A.C. excitation, Eddy currents and Hysteresis losses.	**10**
Module-2	**Single-phase AC Circuits: Series Circuits:** Common signals and their waveforms, RMS and Average value, Form factor & Peak factor of sinusoidal waveform, Impedance of Series circuits. Phasor diagram, Active Power, Power factor. Power triangle. **Parallel Circuits:** Admittance method, Phasor diagram. Power, Power factor. Power triangle, Series- parallel Circuit, Power factor improvement, **Series and Parallel Resonance**: Resonance curve, Q–factor, Dynamic Impedance and Bandwidth.	**10**
Module-3	**Three-Phase Circuits:** Line and Phase relation for Star and Delta connection, Power relations, Analysis of balanced and unbalanced 3 phase circuits, Measurement of Power	**07**
Module-4	**Circuit Theorems:** Superposition theorem, Thevenin’s & Norton’s Theorem, Maximum Power Transfer theorem for Independent and Dependent Sources for DC and AC circuits. **Coupled Circuits** (Dot rule), Self and mutual inductances, Coefficient of coupling.	**08**

Module-5	Principles of AC Generators, motors and transformers, working principles of measuring equipments such as digital voltmeter, ammeter, power factor meter and wattmeter.	**05**

Text Books:

1. Hughes Electrical Technology, Pearson, 10th edition, 2011.
2. Fitzgerald and Higginbotham, Basic Electrical Engineering, McGraw Hill Inc, 1981.
3. D.P. Kothari and I.J. Nagrath, Basic Electrical Engineering, 3rd Edition, TMH, 2009.

Reference Books:

- W. H. Hayt, Jr J. E. Kemmerly and S. M. Durbin, Engineering Circuit Analysis, 7th Edn TMH, 2010.
- Electrical Engineering Fundamental, Vincent Del Toro, Prentice Hall, New Delhi.

COURSE INFORMATION SHEET

Course code: MA103
Course title: Mathematics - I
Pre-requisite(s): Basic Calculus, Basic Algebra
Co- requisite(s):
Credits:4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code:MA103	**Title: Mathematics - I**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to understand:		
1	infinite sequences and series	
2	theory of matrices including elementary transformations, rank and its application in consistency of system of linear equations, eigenvalues, eigenvectors etc.	
3	multivariable functions, their limits, continuity, partial differentiation, properties and applications of partial derivatives.	
4	integrals of multivariable functions viz. double and triple integrals with their applications	
5	properties like gradient, divergence, curl associated with derivatives of vector point functions and integrals of vector point functions	
Course Outcomes: After the completion of this course, students will be able to		
1.	decide the behaviour of sequences and series using appropriate tests.	
2.	handle problems related to the theory of matrices including elementary transformations, rank and its application in consistency of system of linearequations, eigenvalues, eigenvectors etc.	
3.	get an understanding of partial derivatives and their applications in findingmaxima - minima problems	
4.	apply the principles of integrals (multivariable functions viz. double and tripleintegrals) to solve a variety of practical problems in engineering and sciences	
5.	get an understanding of gradient, divergence, curl associated with derivatives of vector pointfunctions and integrals of vector point functions and demonstrate a depth of understanding inadvanced mathematical topics, enhance and developthe ability of using the language of mathematics in engineering	
Syllabus		
Module-1	**Sequences and Series** Sequences, Convergence of Sequence. Series, Convergence of Series, Tests for Convergence: Comparison tests, Ratio test, Cauchy’s root test, Raabe’s test, Gauss test, Cauchy's Integral test, Alternating series, Leibnitz test, Absolute and Conditional Convergence.	**09**
Module-2	**Matrices** Rank of a Matrix, elementary transformations, Row - reduced Echelon form. Vectors, Linear Independence and Dependence of Vectors. Consistency of system of linear equations. Eigenvalues, Eigenvectors, Cayley - Hamilton theorem.	**09**
Module-3	**Advance Differential Calculus** Function of several variables, Limit, Continuity, Partial derivatives, Euler’s theorem for homogeneous functions, Total derivatives, Chain rules, Jacobians and its properties, Taylor series for function of two variables, Maxima – Minima, Lagrange’s method of multipliers	**09**
Module-4	**Advance Integral Calculus** Beta and Gamma functions: definition and properties. Double integrals, double integrals in polar coordinates, Change of order of integration, Triple Integrals, cylindrical and spherical coordinate systems, transformation of coordinates, Applications of double and triple integrals in areas and volumes.	**09**

Module-5	**Vector Calculus** Scalar and vector point functions, gradient, directional derivative, divergence, curl, vector equations and identities. Line Integral, Work done, Conservative field, Green's theorem in a plane, Surface and volume integrals, Gauss – divergence theorem, Stoke 's theorem.	**09**

Text Books:

- M. D. Weir, J. Hass and F. R. Giordano: Thomas' Calculus, 11th edition, Pearson Educations, 2008E.
- H. Anton, I. Brivens and S. Davis, Calculus, 10th Edition, John Wiley and sons, Singapore Pte. Ltd., 2013.
- Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint,2010.

Reference Books:

- M. J. Strauss, G. L. Bradley And K. J. Smith, Calculus, 3rd Ed, Dorling.Kindersley (India) Pvt. Ltd. (P Ed),Delhi, 2007.
- David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Ed. Asia, Indian Reprint, 2007.
- Robert Wrede & Murray R. Spiegel, Advanced Calculus, 3rd Ed., Schaum's outline series, McGraw-Hill Companies, Inc.,2010.
- D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.

COURSE INFORMATION SHEET

Course code: BE101
Course title: Biological Science for Engineers
Pre-requisite(s):NIL
Co- requisite(s):NIL
Credits: 2 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code:BE101	**Title: Biological Science for Engineers**	**L-T-P-C [2-0-0-2]**
Course Objectives: This course enables the students to		
1	Recognize and understand the basic cell biology, biomolecules, related metabolic pathways and applicable bioenergetics.	
2	Relate common biological phenomenon at molecular level.	
3	Describe the chemical nature of enzymes and mechanism of action for their function in biochemical reactions.	
4	Correlate the molecular methods of biological signal generation and propagation in living system.	
5	Comprehend the steps involved in common application of biotechnology such as applicable for creation of transgenics, stem cells, plant metabolites production, PCR, ELISA	
Course Outcomes: After the completion of this course, students will be able to		
1.	Demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules involved in living system.	
2.	Interpret the bio mechanism involved in signal generation and transmission.	
3.	Correlate the basic methods involved in common biotechnological application.	
4.	Apply and effectively communicate scientific reasoning and data involved in common biotechnological applications.	
Syllabus		
Module-1	**Basic Cell Biology:** Origin of life, Cell theory, Cell Structure and function, Biomolecules, Cell cycle and cell division, Biological Organization.	**05**
Module-2	**Bioenergetics and Metabolism**: Gibbs free energy and thermodynamics, aerobic and anaerobic respiration, Glycolysis, Krebs cycle and electron transport chain, Beta oxidation, Photosynthesis.	**06**
Module-3	**Enzymes and its Application:** Classification of enzymes, Structure and mechanism of enzyme action and uses of enzymes, factors affecting enzyme activity, Immobilization of enzymes and their application.	**05**
Module-4	**Biological Signal Generation and Propagation:** Nerve cell structure and signal propagation. Mechanism of vision and hearing, cell signaling, Circadian rhythm.	**06**
Module-5	**Engineering Biological Systems and its Applications:** Central dogma of molecular biology, Methods in genetic engineering and application, PCR, ELISA and its application, stem cell and tissue engineering. Artificial Intelligence in Biology, Plant factory.	**06**

Recommended Text Book

1. Purves et al, (1998) Life: *The Science of Biology*, 4th Ed.
2. R. Dulbecco, The Design of Life.
3. Lehninger A, Principals of Biochemistry , 5th Ed

Reference Book

1. Stryer, L. (2002). *Biochemistry*. New York: W.H. Freeman.
2. K. Wilson & K.H. Goulding, (2006) *A biologist's guide to Principles and Techniques of Practical Biochemistry*.

COURSE INFORMATION SHEET

Course code: MT132
Course title: Communication Skills - I
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I /I
Branch: ALL

Code: MT132	**Title: Communication Skills - I**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
1	demonstrate ability to listen to and comprehend complex speech in English, listento explanations, descriptions, messages, news stories, opinions, solutions, etc.	
2	demonstrate ability to speak effectively in English with peers, teachers and others, handle the various speaking situations in their academic and social sphere withconfidence	
3	demonstrate ability to read and analyse functional texts with confidence; applycritical thinking, analysis and problem-solving skills to the reading material	
4	demonstrate ability to write messages, personal accounts, critical reviews, shortbiographies, describe processes, write persuasive essays, etc.	
5	demonstrate a strong hold on functional grammar which helps them avoidcommon errors in communication	
Course Outcomes: After the completion of this course, students will be able to		
1.	Communicate confidently in English with their peers and teachers in the immediateenvironment and with colleagues, clients, etc. in their future workplaces	
2.	Apply their learning of English to domain subjects and make presentations, posters,write research papers, lab reports, etc with confidence	
3.	Handle communicative situations in their academic like such as conversations, discussions, interviews, presentations, seminars, webinars, etc. with confidence	
4.	Prepare for their future workplaces and their requirements such as handling team huddles, meetings, phone calls, client visits, field visits, inspections, etc.	
5.	Apply critical thinking abilities to analyse problems, brainstorm solutions, handlesituations that require persuasive skills, etc.	
Syllabus		
Module-1	**Effective Listening** The importance of listening; Listening for descriptions of people; listening for opinions; listening for complaints; Listening to people making, accepting, and declining requests; Listening to news stories; listening to messages and a podcast; Process of Listening, Types of Listening, Barriers to Effective Listening, Listening at different managerial levels. Listening for information about living abroad; listening to opinions; Listening to complaints; Listening to environmental problems; listening for solutions; Listening to descriptions of important events; listening to regrets and explanations; Listening to explanations; listening for the best solution; Listening to past obstacles and how they were overcome; listening for people’s goals for the future	

Module-2	**Speaking with Confidence** Describing personalities; expressing likes and dislikes; agreeing and disagreeing; complaining; Talking about possible careers; describing jobs; deciding between two jobs; Making direct and indirect requests; accepting and declining requests; Narrating a story; describing events and experiences in the past; Talking about traveling abroad; expressing emotions; describing cultural expectations; giving advice; Describing problems; making complaints; explaining something that needs to be done; Identifying and describing problems; coming up with solutions; Asking about preferences; discussing different skills to be learned; talking about learning methods; talking about life skills; asking for and giving advice or suggestions; talking about things to be accomplished in the future; Describing milestones; describing turning points; describing regrets and hypothetical situations; Describing qualities for success; giving reasons for success; interviewing for a job; talking about ads and slogans; Drawing conclusions; offering explanations; Giving opinions for and against controversial topics; offering a different opinion; agreeing and disagreeing.	
Module-3	**Art of Reading** Reading about unusual social networking sites; Reading about different types of workplaces; Reading about talking to friends about difficult topics; Types of Reading, Methods of Reading, Reading Comprehension. Reading about the reliability of online content; Reading about a problem with a ride-sharing service; Reading about a creative solution to a problem; Reading about different studying styles; Reading about young scientist; Reading about futurists and their predictions for the year 2050; Reading about a conflict and advice on how to fix it; Reading about advertisements; Reading about unexplained events; Reading about a job role; Reading about plagiarism in the digital age	
Module-4	**Writing Skills** Writing a description of a good friend; Writing about two career choices; Writing a message with requests; Writing a personal account; Writing a pamphlet for tourists; Writing a critical online review; Writing a post on a community website; Writing about a skill; Writing a message of advice; Writing a biography; Writing a message of apology; Writing a TV or web commercial; Writing about a process; Writing a persuasive essay; Writing a personal statement for an application	
Module-5	**Advanced Writing Skills** Art of condensation: Précis writing, Summary, Abstract, Synopsis, Paraphrasing; Paragraph writing; Essay writing: Writing a persuasive essay; Writing a biography; Writing about a process; Writing a personal statement for an application; Writing a critical online review; Writing about a complicated situation; Report writing; Writing technical proposals	

Text Books:

T1. Communication Skills IInd edition, Sanjay Kumar & PushpLata, Oxford University Press
T2. Business Correspondence and Report Writing,R.C.Sharma, Krishna Mohan.Mcgraw Hill
T3. Communication for Business,Shirley Taylor, V.Chandra, Pearson
T4. Basic Business Communication- .Lesikar I Flatley, McGraw Hill.
T5. Business Communication Today ,Bovee, Thill and Chatterjee, Pearson

Coursebook: *Interchange 5 edition Level 3,* Jack C. Richards, Jonathan Hull, Susan Proctor, Cambridge University Press
Components: Student’s Book with online self-study (print/online bundle)

CEFR level: B1

COURSE INFORMATION SHEET

Course code: PE101
Course title: Workshop Practice
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: I / I
Branch: ALL

Code: PE101	**Title:Workshop Practice**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
1	Familiarize with the basic manufacturing processes .	
2	Impart knowledge and skill to use tools, machines, equipment, and measuring instruments.	
3	Practice on manufacturing of components using workshop trades.	
4	Educate students of safe handling of machines and tools.	
5	Exercise individual as well as group activity with hands-on training in different workshop trades.	
Course Outcomes: At the end of the course, a student should be able to:		
1.	Be conversant with the basic manufacturing processes.	
2.	Identify and apply suitable tools and instruments for machining, welding, fitting, carpentry, foundry and forging.	
3.	Manufacture different components using various workshop trades.	
4.	Take safety and precautionary measures of self and machines during operations.	
5.	Develop skills to work as an individual or in a team during trade practices.	

LIST OF EXPERIMENT:

• **MACHINE SHOP**
EXPERIMENT – I: Center Lathe
Objective: To study lathe machine and to machine a given job on center lathe as per drawing.

• **MACHINE SHOP**
EXPERIMENT-II: Shaper Machine
Objective: To study Shaper machine and to machine a given job on shaper as per drawing.

• **CARPENTRY SHOP**
EXPERIMENT-I: Carpentry Tools and Instruments
Objective: To study the various tools, instruments and equipment used in carpentry practice.

• **CARPENTRY SHOP**
EXPERIMENT-II: Carpentry Practice
Objective: To perform the carpentry work by making a wooden job using different tools.

• **FITTING SHOP**
EXPERIMENT-I: Fitting Tools and Measuring Instruments
Objective: To study the various tools used in fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling etc.)

• **FITTING SHOP**
EXPERIMENT-II: Fitting Assembly Practice
Objective: To make a job clamping plate as per given drawing by fitting operations and to check for its assembly with a given component.

• **FORGING SHOP**
EXPERIMENT-I: Forging Tools
Objective: To study different tools and equipment used in hand forging practice.

• **FORGING SHOP**
EXPERIMENT-II: Forging Practice
Objective: To learn about hand forging practice by making a job (make a square bar from round blank and bend it at a sharp corner of 90 degree as per drawing).

• **FOUNDRY SHOP**
EXPERIMENT-I: Green Sand Moulding
Objective: To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single piece pattern).

• **FOUNDRY SHOP**
EXPERIMENT-II: Aluminium Casting
Objective: To get acquainted with melting and pouring of metal in a mould (given two- piece patterns of handle) and to make aluminium casting.

• **WELDING SHOP**
EXPERIMENT-I: Manual Metal Arc Welding
Objective: To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To joint two pieces of given metal by arc welding process.

• **WELDING SHOP**
EXPERIMENT-II: Gas Welding
Objective: To study gas welding processes including types of flames produced, filler metals and fluxes etc. To joint two pieces of given metal by gas welding process.

TEXT BOOK
• S K Hajra Choudhury, A K. Hajra, "Elements of Workshop Technology: Vol- I and Vol - II", Media Promotors Pvt Ltd. **(T1)**
• B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK
• P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**
• Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

COURSE INFORMATION SHEET

Course code: EC101
Course title: Basics of Electronics and Communication Engineering
Pre-requisite(s): N/A
Co- requisite(s): N/A
Credits: 4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: EC101	**Title: Basics of Electronics and Communication Engineering**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to		
1	understand PN Junction, diodes and their applications.	
2	comprehend BJT, FET and their bias configurations.	
3	grasp importance of feedback in amplifier circuits, op amp and its applications.	
4	understand number system, Logic Gates and Boolean algebra.	
5	apprehend fundamentals of communication technology.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Explain PN Junction, diodes and their applications.	
2.	Appraise the BJT, FET and their biasing techniques.	
3.	Comprehend feedback in amplifier circuits, op amp and its applications.	
4.	Translate one number system into another, build circuits with Logic Gates, electronic components and OPAMP IC 741 and analyze the measurement results using CRO.	
5.	Appraise the fundamentals of communication technology.	
Syllabus		
Module-1	Diodes and Applications: Introduction to PN junction diodes; Characteristics of semiconductor diodes: V-I characteristics, diode-resistance, temperature- dependence, diode-capacitance; DC & AC load lines; Breakdown Mechanisms; Zener Diode – Operation and Applications; Diode as a Rectifier: Half Wave and Full Wave Rectifiers with and without C-Filters.	**12**
Module-2	**Bipolar Junction Transistors (BJT):** PNP and NPN Transistors, Basic Transistor Action, Input and Output Characteristics of CB, CE and CC Configurations, dc and ac load line analysis, operating point, Transistor biasing: Fixed bias, emitter bias/self-bias, Low-frequency response of CE amplifier. **Field Effect Transistors:** JFET, Idea of Channel Formation, Pinch-Off and saturation Voltage, Current-Voltage Output Characteristics; MOSFET: Basic structure, operation and characteristics.	**12**
Module-3	**Sinusoidal Oscillators**: Concept of positive and negative feedback, Barkhausen criterion for sustained oscillations, Determination of Frequency and Condition of oscillation, Hartley and Colpitt's oscillator **Operational Amplifiers:** Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Inverting and non-inverting amplifiers, Offset error voltages and currents; Power supply rejection ratio, Slew Rate and concept of Virtual Ground, Summing and Difference Amplifiers, Differentiator and Integrator, RC phase shift oscillator.	**08**
Module-4	**Logic Gates and Boolean algebra:** Introduction to Boolean Algebra and Boolean operators, Symbolic representation, Boolean algebraic function and Truth table of different Digital logic Gates (AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR); Realization of Basic logic gates using universal gates, Adder, Subtractor, adder/subtractor.	**08**

Module-5	**Electronic communication:** Introduction to electronic communication system, Electromagnetic Communication spectrum band and applications, Elements of Electronic Communication System; Merits and demerits of analog and digital communication, Modes of communication; Signal radiation and propagation; Need for modulation; Introduction to Amplitude modulation and Angle modulation.	**10**

Text Books:

• Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.

• Mano M.M., “Digital Logic and Computer Design”, Pearson Education, Inc, Thirteenth Impression, 2011.
• Singal T. L., “Analog and Digital Communications”, Tata McGraw-Hill, 2/e.

• Haykin S., Moher M., “Introduction to Analog & Digital Communications”, Wiley India Pvt. Ltd., 2/e.

Reference Book:

• Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 10/e.

COURSE INFORMATION SHEET

Course code: EC102
Course title: Electronics and Communication Lab
Pre-requisite(s):
Co- requisite(s):
Credits:1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: EC102	**Title: Electronics and Communication Lab**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
1	demonstrate the measurement of voltage, frequency using CRO	
2	explain PN junction characteristics and its applications.	
3	understand the frequency response of BJT amplifier and OPAMP.	
4	Realize logic gates and implement simple Boolean expression.	
5	explain the Amplitude Modulation and Frequency Modulation	
Course Outcomes: After the completion of this course, students will be able to		
1.	Make use of CRO for measuring different parameters	
2.	Appraise PN junction characteristics and its applications.	
3.	Experiment with Diodes, BJT and OPAMP	
4.	Design specified circuit using given electronic components/ICs/logic gates.	
5.	Demonstrate the working of Amplitude Modulation and Frequency Modulation	

Syllabus

List of Compulsory experiments:

• **Name of the Experiment: MEASURMENTS USING CRO**
AIM-1: To understand the Measurement of voltage, time period and frequency of different signals on CRO.
AIM-2: To measure the frequency and phase of two different signals using Lissajous pattern.

• **Name of the Experiment: PN JUNCTION CHARACTERISTICS**
AIM-1: To determine the forward bias V-I characteristics of PN junction diode and finding its forward cut-in voltage.
AIM-2: To determine the reverse bias V-I characteristics of PN junction diode and finding its reverse breakdown voltage.

• **Name of the Experiment: ZENER DIODE**
AIM-1: To design a basic voltage regulator circuit using Zener diode.
AIM-2: To determine the reverse bias V-I characteristics of Zener diode and finding its reverse breakdown voltage.

• **Name of the Experiment: RECTIFIERS WITH FILTERS**.
AIM-1: To understand the basic operation principle of Half-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C- Filter.
AIM-2: To understand the basic operation principle of Full-wave rectifier circuit and measurement of rectification efficiency and ripple factor with and without C- Filter.
AIM-3: Simulate Half wave, Full wave and Bridge rectifier circuits and determine the following in each case ripple factor
• ratio of rectification
• TUF.
AIM-4: Simulate Half wave rectifier circuit and observe the effect on rectification at high frequency.

• **Name of the Experiment: CE TRANSISTOR AMPLIFIER**
AIM-1: To understand the basic operation principle of CE transistor amplifier circuit and finding its frequency response.

AIM-2: To determine the gain bandwidth product of CE transistor amplifier from its frequency response.
AIM-3: To determine the minimum input voltage for which the CE transistor amplifier saturates for given gain.

• **Name of the Experiment: FIELD EFFECT TRANSISTOR**
AIM-1: To determine the output and transfer characteristics of JFET. AIM-2: To measure the voltage gain of JFET.

• **Name of the Experiment: RC OSCILLATOR**.
AIM-1: To design a RC phase shift oscillator using IC-741 Op-Amp.
AIM-2: To measure its frequency of oscillation and finding the percentage of error in Comparison with the ideal one.

• **Name of the Experiment: OPERATIONAL AMPLIFIERS**
AIM-1: To design the Inverting and Non-inverting amplifier using IC 741 OP-AMP. AIM-2: To find its frequency response and calculate the gain bandwidth product.
AIM-3: To determine the minimum input voltage for which the inverting and non-inverting amplifier saturates for the gains 100 and 101 respectively.

• **Name of the Experiment: LOGIC GATES**
AIM-1: To understand basic Boolean logic functions (NOT, AND, OR).
AIM-2: To realize the basic logic gates (AND, OR, NOT) using NAND Gate (IC-7400).

• **Name of the Experiment: BOOLEAN FUNCTION**
AIM-1: To understand AND Gate IC (IC 7408) and OR Gate IC (IC 7432)
AIM-2: To implement of the Boolean expression F = (A.B.C + D.E) using AND Gate(IC 7408) and OR Gate (IC 7432).

• **Name of the Experiment: AMPLITUDE MODULATION**
AIM-1: To analyze the Amplitude modulation for three different cases (under modulation, critical modulation and over modulation) using standard setup.
. AIM-2: To determine the percentage of error between the ideal and actual observations.

• **Name of the Experiment: FREQUENCY MODULATION**
AIM-1: To analyze the Frequency modulation using standard setup.
AIM-2: To determine the value of frequency deviation from the observation.

Text Books:

• Millman J., Halkias C.C., Parikh Chetan, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw-Hill, 2/e.

• Mano M.M., “Digital Logic and Computer Design”, Pearson Education, Inc, Thirteenth Impression, 2011.

• Singal T. L., “Analog and Digital Communications”, Tata McGraw-Hill, 2/e.

• Haykin S., Moher M., “Introduction to Analog & Digital Communications”, Wiley India Pvt. Ltd., 2/e.

Reference Book:

• Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson Education, Inc, 10/e.

COURSE INFORMATION SHEET

Course code: MA107
Course title: Mathematics - II
Pre-requisite(s): Mathematics - I
Co- requisite(s):
Credits:4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: MA107	**Title: Mathematics - II**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to understand		
1	various methods to solve linear differential equations of second and higher order.	
2	special functions viz. Legendre's and Bessel's and different properties associated with them.	
3	diverse mathematical techniques for solving partial differential equations of first order and higher order, along with their applications in wave and heat equations using Fourier series.	
4	the theory of functions of a complex variable, complex differentiation and integration.	
5	about random variables and elementary probability distribution.	
Course Outcomes: After the completion of this course, students will be able to		
1.	investigate the occurrence of differential equations in science and engineering and use methods available for their solutions.	
2.	gain an understanding on complex variable functions and using their properties in real life problems.	
3.	construct appropriate probability models in solvin real world problem.	
4.	demonstrate a depth of understanding in advanced mathematical topics.	
5.	enhance and develop the ability of using the language of mathematics in engineering.	
Syllabus		
Module-1	**Ordinary Differential Equations – I** Linear differential equations, Wronskian, Linear independence and dependence of solutions, Linear differential equations of 2^{nd} and higher order with constant coefficients, Operator method, Legendre’s and Euler – Cauchy’s form of linear differential equation, Method of variation of parameters.	**09**
Module-2	**Ordinary Differential Equations – II** Ordinary and singular points of differential equation, Power and Frobenius’ series solutions. Bessel’s differential equation, Bessel function of first kind and its properties. Legendre’s differential equation, Legendre’s polynomial and its properties.	**09**
Module-3	**Fourier series and Partial Differential Equations** Fourier series: Euler formulae for Fourier series, Dirichlet conditions, Half range Fourier series. Partial Differential Equations: Linear partial differential equations, Lagrange’s method. Method of separation of variables and its application in solving one dimensional wave and heat equations.	**09**
Module-4	**Complex Variable-Differentiation & Integration** Function of a complex variable, Limit, Continuity, Differentiability, Analyticity, Analytic functions, Cauchy – Riemann equations. Harmonic functions, Harmonic Conjugate. Cauchy’s theorem, Cauchy’s Integral formula, Taylor and Laurent series expansions. Singularities and its types, Residues, Residue theorem.	**09**

Module-5	**Applied Probability** Discrete and continuous random variables, cumulative distribution function, probability mass and density functions, expectation, variance, moment generating function. Introduction to Binomial, Poisson and Normal Distribution.	**09**

Text Books:

- E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
- D. G. Zill and W.S. Wright, Advanced Engineering Mathematics, Fourth Edition, 2011.
- J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
- R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing, 3rd Ed, 2009.
- R. A . Johnson, I. Miller and J. Freund: Probability and Statistics for Engineers, PHI
- S. C. Gupta and V.K . Kapoor.: Fundamental of Mathematical Statistics, Sultan Chand and Sons

Reference Books:

- W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edition ., Wiley India, 2009.
- N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
- E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India,1995.
- G. F. Simmons, Differential Equations with Applications and Historical Notes, TMH, 2nd ed., 2003.
- P. L. Meyer: Introductory Probability and Statistical Applications, Oxford & IBH.

<u>**COURSE INFORMATION SHEET**</u>

Course code: CH101
Course title: Chemistry
Pre-requisite(s): Intermediate level chemistry
Co- requisite(s):
Credits:4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: CH101	**Title: Chemistry**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to		
1	create concept of Chemical bonding & Coordination Chemistry.	
2	understand the basic 3D structure in organic chemistry including stereochemistry, aromaticity and reaction mechanism.	
3	understand the reaction dynamics and to know different types of catalysis.	
4	understand the modern techniques related to spectroscopy and structural characterization.	
5	develop knowledge on the physical state and electrochemistry of molecules.	
Course Outcomes: After the completion of this course, students will be able to		
1.	explain the bonding in a molecular structure.	
2.	explain the 3D structure, aromaticity and stereochemistry of organic molecules.	
3.	explain the spectroscopic data for structural characterization of the molecules.	
4.	predict the rate, molecularity and mechanism of a simple as well as catalytic reaction.	
5.	interpret the phases of solid and the electrochemical behavior of the molecules.	
Syllabus		
Module-1	**Chemical Bonding** *Ionic bond:* Radius ratio rule, Born-Landé equation, Born-Haber cycle. *Metallic Bond:* valence bond and band theories, defects in solids, Werner's Theory, Bonding in Transition metal complexes, Ligands, coordination complexes, Ligand Field, Crystal Field Theory, Octahedral, Tetrahedral and square planar complexes, CFSE, Jahn Teller theorem, electronic spectra, magnetism, and isomerization in coordination compounds.	**09**
Module-2	**Organic Structure and Stereochemistry** *Covalent bond:* Lewis structure, Valence Bond theory, Molecular orbital theory, Molecular orbital of diatomic and polyatomic system, hybridization, conjugated molecules, Huckel molecular orbital theory of conjugated systems. Isomerism, Geometrical isomerism: *cis–trans* and syn-anti isomerism; Optical isomerism & Chirality; Wedge, Fischer, Newmann and Sawhorse Projection formulae and interconversions; E/Z, D/L, R/S nomenclature system; Conformational studies of ethane, n-butane, Cyclohexane	**09**
Module-3	**Kinetics and Catalysis:** Order & molecularity of reactions: chain, parallel, Competing, Side, Consecutive reactions; Kinetics of Fast reactions, Characteristics of catalyst, types of catalysis, catalytic poison; Theories of catalysis; Acid base catalysis: including kinetics, Enzyme catalysis, Mechanism and kinetics of enzyme catalyzed reaction, Michaelis-Menten equation, Important catalysts in industrial processes; Hydrogenation using Wilkinsons catalyst, Hydroformylation by using Cobalt-catalyst, Phase transfer catalyst.	**09**

Module-4	**Spectroscopic Techniques** Absorption and emission Spectroscopy, Lambert-Beers Law, Principles and applications of UV- Visible, Factors influencing for UV-VIS spectrum; Rotational and Vibrational spectroscopy, Principle of FT-IR, and NMR spectroscopy; Modern techniques in structural elucidation of compounds by UV-VIS, IR, & NMR Spectroscopy.	**09**
Module-5	**Phase and Chemical equilibrium** Phase Rule: Terms Involved, Phase diagram of one component (Water) & two component (Pb/Ag) system & their applications. Law of chemical equilibrium, equilibrium constants and their significance, Weak and strong electrolytes, Standard electrode potential and its application to different kinds of half cells, EMF and its measurement and application, Batteries and Fuel Cells, Chemical and Electrochemical corrosion, Factors affecting the rate of corrosion.	**09**

Text books:

- Huheey, J. E., Inorganic Chemistry: Principles of Structure and Reactivity, 4th edition, Pearson.
- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Seventh Edition, Pearson
- Atkins, P. W. & Paula, J. Physical Chemistry, 10th Ed., Oxford University Press, 2014.

Reference books:

- Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier (2009).
- William Kemp, Organic Spectroscopy, 3rd Ed., 2008 Macmillan.

COURSE INFORMATION SHEET

Course code: CH102
Course title: Chemistry Lab
Pre-requisite(s): Intermediate level Chemistry
Co- requisite(s):
Credits:1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Theory: 30 Lectures

Code: CH102	**Title: Chemistry Lab**	**L-T-P-C [0-0-3-1.5]**

List of Experiments

• Gravimetric estimation of Nickel by Dimethylglyoxime.

• Quantitative estimation of Ca^{2+} and Mg^{2+} ions by complexometric titration using Na_2-EDTA.

• To verify Bears Law using Fe^{3+} solution by spectrophotometer/colorimeter and to determine the concentration of a given unknown Fe^{3+} solution.

• Separation of binary organic mixture by acid-base extraction and analysis using given FTIR and NMR spectrum.

• Preparation of Diazoamino Benzene and report the melting point and yield of product.

• Draw melting point-mass percent composition diagram for two component mixture and determine the Eutectic Temperature.

• To study the kinetics of acid-catalyzed hydrolysis of ethyl acetate and to evaluate the value of the rate constant.

• To determine the rate law for the reaction between iodide and hydrogen peroxide in an acidic environment and to determine the effect of a catalyst on the rate of reaction.

• To determine the strength of the given strong acid by strong base Potentiometrically.

• To determine the transition temperature of the given salt hydrate.

• Qualitative detection of special elements in organic compounds.

• To draw the pH-titration curve of strong acid vs strong base.

Reference book:

• Experimental Physical Chemistry, By B. Viswanathan, P. S. Raghavan, Narosa Publishing House (1997).
• Vogels Textbook of Practical Organic Chemistry
• Experiments in General chemistry, C. N. R. Rao and U. C. Agarwal
• Experimental Organic Chemistry Vol 1 and 2, P R Singh, D S gupta, K S Bajpai, Tata McGraw Hill

COURSE INFORMATION SHEET

Course code: ME101
Course title: Basics of Mechanical Engineering
Pre-requisite(s):
Co- requisite(s):
Credits:4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: ME101	**Title: Basics of Mechanical Engineering**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to:		
1	introduce system of forces and write equation of equilibrium.	
2	analyse motion of particle and rigid body subjected to force.	
3	grasp the importance of internal, external combustion engines and heat transfer	
4	apprehend the fundamentals of friction and vibration.	
5	understand the different sources of energy.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Write and solve the equations of equilibrium for particles and structures members subjected to forces.	
2.	Write and solve the equations of motion for particles and rigid bodies subjected to forces.	
3.	Discuss the basics of Boilers, IC Engines and heat transfer.	
4.	Aware of different types of vibrations and friction.	
5.	Outline the non-conventional energy resources.	
Syllabus		
Module-1	**System of Forces and Structure Mechanics:** Addition of Forces, Moment of a Force, Couple, Varignon's theorem, Free Body Diagram, Equilibrium in Two and Three Dimensions, Equivalent Forces and Moment. Types of Trusses, Plane and Space Trusses. Analysis of Plane Trusses by: Method of Joints and Method of Sections, Analysis of Frames with Hinged Joints. Hooke's Law of elasticity, Stress and Strain, Relation between elastic constants, Thermal Stresses, Properties of surfaces such as centroid and area moment of inertia.	**09**
Module-2	**Kinematics & Kinetics of rigid bodies:** Types of rigid body motion– translation, rotation about fixed axis, equations defining the rotation of a rigid body about a fixed axis, plane motion, absolute and relative velocity in plane motion, instantaneous center of rotation. Equation of translational and rotational motion, Newton's law and D'Alembert's principle –inertia force and inertia couple.	**09**
Module-3	**Friction and Vibration:** Interfacial Friction (a) Laws of dry friction, static & kinetic co-efficient of friction, Analysis of static, kinetic and rolling friction. (b) Analysis of frictional forces in inclined planes, wedges, screw jacks and belt drives. Vibrations: Types of vibration, free un-damped longitudinal vibrations, free damped longitudinal vibrations.	**09**
Module-4	**Boilers and Internal Combustion Engine:** Boiler Mountings and Accessories, Fire Tube and Water Tube Boilers, Cochran Boiler, Babcock and Wilcox Boiler. Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines. Heat transfer: various modes of heat transfer, one dimensional steady state conduction, Application to composite walls and cylinder.	**09**
Module-5	**Non-Conventional Energy and their resources:** Renewable and Non-renewable Energy Resources, Advantages and Disadvantages of Renewable Resources, Renewable Energy Forms and Conversion, Solar Energy, Wind Energy, Tidal Energy, Ocean Thermal Energy; Geothermal Energy, Nuclear Energy, Hydro Energy.	**09**

Text Books

1. Engineering Mechanics, Irving H. Shames, P H I. ltd, 2011.
2. Engineering Mechanics, S. Timoshenko, D. H. Young, J. V. Rao, Sukumar Pati, McGraw Hill education, 2017.
3. Theory of vibrations with applications, Thomson and Dahleh, Pearson Education, 5th Edition, 2008.
4. Boiler operator, Wayne Smith, LSA Publishers, 2013.
5. Internal Combustion Engines, M. L. Sharma and R. P. Mathur, Dhanpat Rai Publications, 2014.
6. Heat Transfer, J. P. Holman, Souvik Bhattacharya, Mcgraw Higher Ed Publishers, 2011.
7. Fundamentals of Renewable Energy Processes, Aldo Vieira Da Rosa, Elsevier publication, 2012.

Reference Books

1. Engineering Mechanics: statics, James L. Meriam, L. G. Kraige, Wiley, 7th Edition, 2011.
2. Engineering Mechanics, S. Rajasekaran & G. Sankarasubramaniam, Vikash publishing house, 2018.
3. Engineering Vibration, Daniel J. Inman, Pearson, 2013.
4. An Introduction to Steam Boilers, David Allan Low, Copper Press Publisher, 2012.
5. Internal Combustion Engines – V Ganesan, McGraw hill, 2017.
6. Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Cengel, Afshin J. Ghajar, McGraw Hill Education Publisher, 2017.
7. Non Conventional Energy Resources, B. H. Khan, McGraw Hill Education Publisher, 2017.
8. Principles of Mechanical Engineering, R. P. Sharma & Chilkesh Ranjan, Global Academic Publishers, 2016

COURSE INFORMATION SHEET

Course code: ME102
Course title: Engineering Graphics
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: 0 T: 0 P: 4
Classes schedule per week: 4
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: ME102	**Title: Engineering Graphics**	**L-T-P-C [0-0-4-2]**
Course Objectives: This course enables the students		
1	To understand the basic principles of Engineering Graphics, which include projections of 1D, 2D and 3D objects.	
2	To visualize a solid object (including sectioned) and convert it into drawing.	
3	To visualize different views of any object.	
4	To develop skill to draw objects using software.	
5	To inculcate the imagination and mental visualization capabilities for interpreting the geometrical details of common engineering objects.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Understand the fundamentals of Engineering Graphics and sketch the orthographic projections of points, lines and planes	
2.	Sketch the orthographic projections of solids and section of solids	
3.	Sketch three dimensional isometric views and development of the surfaces	
4.	Create and modify orthographic projections using AutoCAD software	
5.	Create three dimensional solid models using AutoCAD software	
Syllabus		
Module-1	Introduction to orthographic projections, Conventions, Fundamentals of First and Third Angle projection, Orthographic projections of points, lines and planes.	**09**
Module-2	Projections of simple solids - axis perpendicular to HP, VP and inclined to one or both planes, Sectioning of solids, section plane perpendicular to one plane and parallel or inclined to other Plane.	**09**
Module-3	Development of surfaces- Development of prisms, pyramids and cylindrical & conical surfaces, Isometric projection and isometric views of different planes and simple solids, introduction to perspective projection.	**09**
Module-4	Working with AutoCAD Commands, Cartesian Workspace, Basic Drawing & Editing Commands, Drawing: Lines, Rectangles, Circles, Arcs, Polylines, Polygons, Ellipses, Creating Fillets and Chamfers, Creating Arrays of Objects, Working with Annotations, Adding Text to a Drawing, Hatching, Adding Dimensions, Dimensioning Concepts, Adding Linear Dimensions, Adding Radial & Angular Dimensions, Editing Dimensions.	**09**
Module-5	Create views of engineering parts in AutoCAD, case studies with examples of Mechanical/ Electrical/Civil engineering drawings.	**09**

Text Books

1. Engineering Drawing by N. D. Bhatt, Charotar Publishing House Pvt.Ltd., 53rd, Edition, 2014.
2. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International (P) Limited, 4th Reprint: June, 2017.

Reference Books

1. Engineering Graphics with Autocad by J. D. Bethune, Prentice Hall, 2007.

COURSE INFORMATION SHEET

Course code: CE101
Course title: Environmental Science
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: 2 T: 0 P: 0
Classes schedule per week: 2
Class: B. Tech. /I. M. Sc. (Physics)
Semester / Level: II / I
Branch: ALL

Code: CE101	**Title: Environmental Science**	**L-T-P-C [2-0-0-2]**
Course Objectives: This course enables the students to		
1	develop basic knowledge of ecological principles and their applications in environment.	
2	identify the structure and composition of the spheres of the earth, the only planet sustaining life.	
3	analyse, how the environment is getting contaminated and probable control mechanisms for them.	
4	generate awareness and become a sensitive citizen towards the changing environment.	
Course Outcomes: After the completion of this course, students will be able to		
1.	explain the structure and function of ecosystems and their importance in the holistic environment.	
2.	identify the sources, causes, impacts and control of air pollution.	
3.	distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms.	
4.	judge the importance of soil, causes of contamination and need of solid waste management.	
5.	predict the sources of radiation hazards and pros and cons of noise pollution.	
Syllabus		
Module-1	**Ecosystem and Environment** Concepts of Ecology and Environmental science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management, fate of environmental pollutants, environmental status and reports on climate change.	**05**
Module-2	**Air Pollution** Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, control methods and equipment for air pollution control, vehicular emissions and control, indoor air pollution, air pollution episodes and case studies.	**05**
Module-3	**Water Pollution** Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, various water quality indices, water and waste water treatment: primary, secondary and tertiary treatment, advanced treatments (nitrate and phosphate removal); Sludge treatment and disposal.	**05**
Module-4	**Soil Pollution and Solid Waste Management** Lithosphere – composition, soil properties, soil pollution, ecological & health effects, Municipal solid waste management – classification of solid wastes, MSW characteristics, collection, storage, transport and disposal methods, sanitary landfills, technologies for processing of MSW: incineration, composing, pyrolysis.	**05**

Module-5	**Noise pollution & Radioactive pollution** Noise pollution: introduction, sources: Point, line and area sources; outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques and analysis, prevention of noise pollution; Radioactive pollution: introduction, sources, classification, health and safety aspects, Hazards associated with nuclear reactors and disposal of spent fuel rods-safe guards from exposure to radiations, international regulation, Management of radioactive wastes.	**05**

Text books:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd.
2. R. Rajagopalan.2016.Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press.
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia.
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press.
5. S.C. Santra. 2011. Environmental Science. New Central Book Agency.

Reference books:

1. D.W.Conell. Basic Concepts of Environmental Chemistry, CRC Press.
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International
3. G.M. Masters& Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers.

COURSE INFORMATION SHEET

Course code: PH101R1
Course title: Mechanics
Pre-requisite(s):
Co- requisite(s):
Credits:3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH101R1	**Title: Mechanics**	**L-T-P-C [3-0-0-3]**
Course Objectives:		
1	A gentle introduction to the kinematics of rigid bodies and the concepts of work and energy.	
2	Advancing the above notions to explain collision processes, and teaching rotational dynamics	
3	Discussion of some preliminary ideas of fluid motion and elasticity	
4	Exemplification of the notion of central force motion through discussions on gravitation	
5	Providing familiarity with the mathematical structure of oscillations	
Course Outcomes:		
1.	Ability to solve problems on mechanics using the notion of work and energy	
2.	Developing intuitive as well as mathematical understanding of rotational dynamics	
3.	Ability to explain basic concepts of fluid motion and elasticity	
4.	Getting equipped with mathematical tools to handle problems on central force motion	
5.	Capacity to grasp the underlying principles of oscillations	
6	Ability to solve problems in accelerating and rotating frames	
Syllabus		
Module-1	**Fundamentals of Dynamics:** Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Motion of a projectile in Uniform gravitational field, Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum, Momentum of variable-mass system: motion of rocket, Impulse. **Work and Energy:** Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non- conservative forces. Law of conservation of Energy.	**08**
Module-2	**Collisions:** Elastic and inelastic collisions between particles. Elastic collisions in centre of mass and laboratory frames. **Rotational Dynamics**: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation **Fluid Motion:** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **Elasticity:** Relation between Elastic constants. Twisting torque on a Cylinder or Wire.	**10**
Module-3	**Gravitation and Central Force Motion:** Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	**08**

Module-4	**Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states solutions; Resonance, sharpness of resonance, power dissipation and Quality Factor.	**06**
Module-5	**Non-Inertial Systems:** Non-inertial frames and fictitious forces. Uniformly accelerated and uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal and Coriolis forces, and their applications. Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.	**08**

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

COURSE INFORMATION SHEET

Course code: PH103R1
Course title: Mechanics Lab
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH103R1	Title: Mechanics Lab	L-T-P-C [0-0-3-1.5]

List of Experiments

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

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

COURSE INFORMATION SHEET

Course code: PH102R1
Course title: Electricity and Magnetism
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits:3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH102R1	**Title: Electricity and Magnetism**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	know and apply the basic theorems related to electrostatics potential and field	
2	know how to deal electrostatics situation when dielectric is involved.	
3	know the various laws of magnetostatics in vacuum and when there is magnetic medium	
4	know the laws of electrodynamics and its application in AC circuits.	
5	know about Network theorems in linear circuits	
Course Outcomes: After the completion of this course, students will be able to		
1.	apply Gauss's law and uniqueness theorem to calculate electric field	
2.	to calculate various quantities like displacement vector and polarization in the presence of dielectircs.	
3.	to apply the laws of magnetostatics-like Biot-Savart law, Ampere's circuital law, and to calculate the hysteresis energy loss.	
4.	to apply Maxwell's equations, and the laws of electromagnetic induction to deal AC circuits.	
5.	to apply network theorems to get the information about the voltage and current in various branches of a dc circuit	
Syllabus		
Module-1	**Electric Field and Electric Potential** Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.	**06**
Module-2	Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere **Dielectric Properties of Matter:** Gauss' Law in dielectrics, Capacitor (parallel plate, spherical, cylindrical) filled with dielectric.	**08**
Module-3	**Magnetic Field**: Biot-Savart's Law and its simple applications: straight wire and circular loop. Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements, Torque on a current loop in a uniform Magnetic Field. Magnetic Properties of Matter: Magnetization vector (**M**). Magnetic Intensity(**H**). Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.	**08**
Module-4	**Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. **Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.	**08**

Module-5	**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. **Ballistic Galvanometer:** Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity	**10**

COURSE INFORMATION SHEET

Course code: PH104R1
Course title: Electricity and Magnetism Lab
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH104R1	**Title: Electricity and Magnetism Lab**	**L-T-P-C [0-0-3-1.5]**

List of Experiments

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b)Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heineman Educational Publishers
- Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, VaniPub.

COURSE INFORMATION SHEET

Course code: PH105R2
Course title: Mathematical Physics-I
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH105R2	**Title: Mathematical Physics-I**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	Review Matrices and Vectors	
2	Review and learn to do vector calculus on both flat and curved surfaces	
3	Learn Fourier decomposition and it's use	
4	Learn Fourier transforms and their physical importance	
5	Learn Laplace transform and their physical importance	
Course Outcomes: After the completion of this course, students will be able to		
1.	Work with matrices and vectors.	
2.	Do 2D, 3Dintegral on vectors and write down Nabla and Laplacian operator in curvilinear surfaces	
3.	Fourier expand any function in a finite domain	
4.	Use Fourier transforms to solve simple wave like equation and similar equation of states	
5.	Use Laplace transforms to solve simple wave like equation and similar equation of states	
Syllabus		
Module-1	Sequence, Series, Convergence tests, Absolute and conditional convergence. Vector spaces, Matrix algebra, properties of matrices, change of basis, elementary transformations, Vectors, Definition and Properties of vectors and their products, Vector identities. Linear (in)dependence of vectors, Linear equations, Eigenvalues and eigenvectors, Caley-Hamilton theorem.	**8**
Module-2	Vector Calculus: Gradient, Divergence, Curl and Laplacian operators and their physical significance. Vector Integration, Ordinary integrals of vectors. Multiple integrals, Jacobian. Line, Surface and Volume integrals of vector fields. Gauss' divergence theorem, Green's and Stokes Theorems and their applications. Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian operator in Polar, Spherical and Cylindrical Coordinate Systems.	**9**
Module-3	Fourier Series expansion: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions- over an interval. Even and odd functions. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. Solving wave and heat equation, Summing of Infinite Series.	**8**
Module-4	Integral Transforms: Fourier Transforms (FT), Fourier Integral theorem. FT of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral and other properties. FT of derivatives, Inverse Fourier transform, Convolution theorem. Properties of FT (translation, change of scale, complex conjugation, etc.). Three-dimensional FT with examples. One dimensional Wave and Diffusion/Heat Flow Equations.	**8**

Module-5	Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to solve 2nd order Differential Equations: Damped Harmonic Oscillator, Solution of heat flow along infinite bar using Laplace transform.	**7**

Reference Books:

• Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
• Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7 thEdn., Elsevier.
• An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
• Differential Equations, George F. Simmons, 2007, McGraw Hill.
• Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
• Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
• Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
• Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
• Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press

COURSE INFORMATION SHEET

Course code: PH106R1
Course title: Waves and Optics
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH106R1	**Title: Waves and Optics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To provide thorough knowledge of superposition principle, superposition of collinear and perpendicular oscillations; and basic information about waves.	
2	To appreciate the variation in velocity of waves and formation of standing waves.	
3	To understand the concept of interference and instruments based on this phenomenon.	
4	To know the concept of diffraction, its theory and classes.	
5	To understand the polarized light and its basic principles.	
Course Outcomes: After the completion of this course, students will		
1.	Be able to explain superposition principle, formation of Lissajous figure and classes of waves.	
2.	Be able to understand changes in waves and characteristics of standing waves.	
3.	Be able to explain the optical phenomenon interference and working of instruments based on this phenomenon.	
4.	Get familiar with optical phenomenon diffraction and various theory explaining it.	
5.	Acquire knowledge of polarization and dispersion of light.	
Syllabus		
Module-1	Superposition of two collinear Harmonic Oscillations with equal phase differences and equal frequency differences. Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods, Lissajous Figures with equal an unequal frequency and their uses. Differential Wave Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.	**08**
Module-2	Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Superposition of N Harmonic Waves. Wave Optics: Electromagnetic nature of light.	**08**
Module-3	Interference: Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interferometer: Michelson Interferometer- Idea of form of fringes, Determination of Wavelength, Wavelength Difference, Refractive Index, and Visibility of Fringes. Fabry-Perot interferometer- its theory, resolving power and applications.	**08**
Module-4	Fraunhofer diffraction: Multiple slits. Plane diffraction grating. Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.	**08**

Module-5	**Polarization:** Unpolarised light, linear, circular, elliptical polarized light, Malus' law, Polarisation by reflection, refraction, and scattering, double refraction, Nicol's prism, Babinet compensator. **Dispersion:** Normal dispersion, Cauchy's equation, Hartmann formula, Anomalous dispersion, Sellmeir's formula, Experimental demonstration of Anomalous dispersion, electromagnetic theory of dispersion.	**08**

Text Books

T1: Optics, Ajoy Ghatak, 2008, Tata McGraw Hill Reference Books

T2: Principles of Optics, B. K. Mathur, New Gopal Printing Press

Reference Books:

R1: Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

R2: Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill

R3: Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

R4: The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

R5: The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

R6: Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

COURSE INFORMATION SHEET

Course code: PH108R1
Course title: Waves and Optics Lab
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: PH108R1	Title: Waves and Optics Lab	L-T-P-C [0-0-3-1.5]

List of Experiments

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercurysource.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringesproduced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffractiongrating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

COURSE INFORMATION SHEET

Course code: PH213R1
Course title: Mathematical Physics-II
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IV/II
Branch: PHYSICS

Code: PH213R1	**Title: Mathematical Physics-II**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students		
1	To expertise on techniques to sole ODEs in context of physics	
2	To expertise on techniques to sole PDEs in context of physics.	
3	To understand the concepts of complex analysis and its application in physics.	
4	To have a basic understanding of tensors and their role in physics.	
5	To understand how probability works.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Solve ODE's that appear in physics problems	
2.	Solve PDE's that appear in physics problems.	
3.	To solve problems using complex analysis techniques for various physics problems.	
4.	To calculate the Fourier transform or inverse transform of common functions including sinusoidal, gaussian, delta, etc.	
5.	To solve second-order ordinary differential equations using Laplace transforms and inverse Laplace transformation.	
Syllabus		
Module-1	Ordinary Differential Equations: Ordinary and singular points, Frobenius method, Series solution, Wronskian Method, Integrating factor, Existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. Constrained Maximization using Lagrange Multipliers. Special Functions. Legendre, Bessel. Generating Function, Recurrence relations. Beta and Gamma Functions and Relation between them. Error Function.	**11**
Module-2	Solving partial differential equations: Laplace's equation, Poisson's equation, the wave equation, the diffusion equation, Schrödinger's equation. General and particular solutions. Characteristic, Existence, Uniqueness of solutions. Separation of variable method in spherical polar coordinates. Integral transform methods. Elements of calculus of variation, Euler-Lagrange equation.	**10**
Module-3	Complex variables: Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Theorem. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residue Theorem. Application – complex potentials.	**11**
Module-4	Elementary Tensor analysis: Physical laws, N-dimensional space, Coordinate transformations, Basis, Rank, Cartesian tensors, Contravariant, covariant and mixed tensors, Second and higher order tensors, Symmetric and skew-symmetric tensor, Kronecker delta and Levi-civita tensors.	**10**

Module-5	Probability Theory: Axioms and theorems, Conditional probability, Bayes theorem. Permutation and combination, Random and continuous variables, and their distributions. Properties of a distribution, Generating functions. Some important discrete and continuous distributions.	**8**

Textbooks:

T1**:**MathematicalMethods for Physics and Engineers, K.F Riley, M.P. Hobson and S.J. Bence,3rd ed.,2006,Cambridge University Press

T2: Mathematics for Physicists, P. Dennery and A. Krzywicki,1967, Dover Publications

Reference books:

R1: Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press

R2: Complex Variables, A. K. Kapoor, 2014, Cambridge Univ. Press

R3: Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill

R4: First course in complex analysis with applications, D.G. Zill and P.D. Shanahan,1940, Jones& Bartlett

COURSE INFORMATION SHEET

Course code: PH201R1
Course title: Thermal Physics
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: IV /II
Branch: PHYSICS

Code: PH201R1	**Title: Thermal Physics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	understand the basic laws, concepts of thermodynamics and heat engines.	
2	explains the second law of thermodynamics with concept of entropy, Carnot cycle and thermodynamic potentials.	
3	understand the derivation of Maxwell's thermodynamic relations.	
4	enlighten the kinetic theory of gases and distribution of velocities.	
5	appreciate behavior of ideal and real gas and detailed discussion about it.	
Course Outcomes: After the completion of this course, students will		
1.	Be able to explain the laws of thermodynamics, reversible and irreversible processes and heat engines.	
2.	Acquire knowledge of entropy, Carnot cycle and thermodynamic potential definitions	
3.	Get familiar with Maxwell's thermodynamic relations and its applications	
4.	Be able to appreciate the kinetic theory of gases, equipartition of energy and molecular collision	
5.	Be able to understand difference in ideal and real gases, laws and theory related with real gas.	
Syllabus		
Module-1	**Zeroth, First and Second Law of Thermodynamics**: Thermodynamic variables and equilibrium, Zeroth law of thermodynamics & concept of temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, General Relation between C_P and C_V, Thermodynamic processes, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient., Conversion of Work into Heat and Heat into Work. Carnot engine& efficiency. Refrigerator & coefficient of performance, Carnot's Theorem, Kelvin-Planck and Clausius Statements and their Equivalence.	**12**
Module-2	**Entropy & Second Law of Thermodynamics and Third Law of Thermodynamics**: Concept of Entropy, Clausius Theorem and Inequality, Second Law of Thermodynamics in terms of Entropy. Temperature-Entropy diagrams for Carnot's Cycle. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes. Third Law of Thermodynamics. Unattainability of Absolute Zero.	**08**
Module-3	**Maxwell's Thermodynamic Relations and Phase changes**: Four Thermodynamic Potentials and their definitions. Derivations and applications of Maxwell's equations, Magnetic Work and adiabatic demagnetization, Joule-Kelvin coefficient for Ideal and Van der Waal Gases, Energy equations, First and second order Phase Transitions with examples, Clausius Clapeyron and Ehrenfest equations. Open system and chemical potentials	**08**

Module-4	**Kinetic Theory of Gases:** Law of Equipartition of Energy. Maxwell-Boltzmann distribution of speed and velocities. Molecular distribution and pressure, molecular flux and effusion, the mean free path and collisions. Transport and thermal diffusion.	**06**
Module-5	**Real Gases:** Van der Waal's Equation of State for Real Gases. Virial equations. Boyle temperature. Joule's Experiment. The porous plug and Joule-Thomson experiment. Temperature of Inversion. Joule- Thomson Cooling.	**06**

Reference Books:

- Finn's Thermal Physics, Andrew Rex, CRC Press, Taylor & Francis Group, Third Edition, 2017
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

COURSE INFORMATION SHEET

Course code: PH204R1
Course title: Thermal Physics Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: IV /II
Branch: PHYSICS

ode: PH204R1	Title: Thermal Physics Lab	L-T-P-C [0-0-3-1.5]

List of Experiments

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton'sdisc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer(PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of itsTwo Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2)Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH202R1
Course title: Digital Systems & Applications
Pre-requisite(s):
Co- requisite(s):
Credits:3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: IV /II
Branch: PHYSICS

Code: PH202R1	**Title: Digital Systems & Applications**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	understand number representation and conversion between different representation in digital electronic circuits	
2	analyze logic processes and implement logical operations using combinational logic circuits.	
3	understand characteristics of memory and their classification.	
4	understand concepts of sequential circuits and to analyze sequential systems.	
5	understand basic architecture of 16 bit and 32 bit microprocessors.	
Course Outcomes: After the completion of this course, students will be able to		
1.	develop a digital logic and apply it to solve real life problems.	
2.	analyze, design and implement combinational logic circuits.	
3.	classify different semiconductor memories	
4.	analyze, design and implement sequential logic circuits.	
5.	write programs to run on 8085 microprocessor based systems.	
Syllabus		
Module-1	**Introduction to CRO:** Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.	**06**
Module-2	**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	**10**
Module-3	**Data processing circuits:** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.	**08**
Module-4	**Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in Parallel-out Shift Registers (only up to 4 bits). Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.	**08**

Module-5	**Intel 8085 Microprocessor Architecture:** Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.	**08**

Text Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw (T1)
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.(T2)
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.(T3)
4. Digital Electronics G K Kharate ,2010, Oxford University Press(T4)

Reference Books

1. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning (R1)
2. Logic circuit design, Shimon P. Vingron, 2012, Springer.(R2)
3. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.(R3)
4. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill (R4)
5. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, PrenticeHall. (R5)

COURSE INFORMATION SHEET

Course code: PH205R1
Course title: Digital Systems & Applications Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: IV /II
Branch: PHYSICS

Code: PH205R1	**Title: Digital Systems & Applications Lab**	**L-T-P-C [0-0-3-1.5]**

List of Experiments

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
    a) Addition and subtraction of numbers using direct addressing mode.
    b) Addition and subtraction of numbers using indirect addressing mode.
    c) Multiplication by repeated addition.
    d) Division by repeated subtraction.
    e) Handling of 16-bit Numbers.
    f) Use of CALL and RETURN Instruction.
    g) Block data handling.
    h) Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994,Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S.Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa,2010, PHI Learning.

COURSE INFORMATION SHEET

Course code: PH301R1
Course title: Quantum Physics and Applications
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V / III
Branch: PHYSICS

Code: PH301R1	**Title: Quantum Physics and Applications**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	Define wave functions associated with moving quantum systems and interpret their dynamical variables. Outline the basics of crystallography and define various types of imperfections in crystals.	
2	Define eigenstates and eigenvalues and demonstrate Heisenberg's uncertainty principle. Explainelastic and plastic deformation in solids and summarize the strain hardening mechanisms.	
3	Solve Schrödinger equations associated with quantum mechanical systems. Define ceramics andexplain its types and applications.	
4	Illustrate the eigenstates and eigenvalues of hydrogen-like atoms. Define polymers and composites and categorize them on the basis of their applications.	
5	Demonstrate the behaviour of atoms in electric and magnetic fields. Define Nanotechnology and outline the various properties of nano materials and their fabrication techniques.	
Course Outcomes: After the completion of this course, students will be able to		
1.	formulate wavefunction for any quantum mechanical system and predict its position, momentum and energy asfunction of time. formulate the Heisenberg & Dirac formulation of quantum mechanics. explain various types of imperfections in crystals.	
2.	construct Schrodinger equations for any quantum mechanical system in terms of linear combinations of stationary states, and interpret Gaussian wave-packet, measure the position and time of a particle with limited accuracy. solve the linear harmonic oscillator and hydrogen-like atom problems using Dirac formulation. analyze the mechanisms behind elastic and plastic deformation is solids and compare different strengthening techniques.	
3.	solve square well potential and harmonic oscillator problem and explain the existence of bound states demonstrate angular momentum operators associated with spherical and symmetrical systems. summarize ceramics and its types and relate their applications with properties.	
4.	Justify the discrete energy levels of hydrogen-like atoms and explain scattering theory, formulate and sol scattering equation. classify polymers and composites based on their properties and applications.	
5.	Demonstrate atomic phenomena like, Zeeman effect, Stark effect, etc., and illustrate the existence ofdifferen series of spectral lines in the atomic spectra of hydrogen-like atoms apply the Variational principle and WKB Approximation to solve the real problems. Classify nanomaterials, their fabrication techniques and co relate the effects of confinement to nanoscale on their properties.	
Syllabus		
Module-1	**Time dependent Schrodinger equation** Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.	**06**

Module-2	**Time independent Schrodinger equation** Hamiltonian, stationary states and energy eigenvalues; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; Fourier transforms and momentum space wavefunction. Position-momentum uncertainty principle for Gaussian wave-packets.	**08**
Module-3	**General discussion of bound states in an arbitrary potential** continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy.	**08**
Module-4	**Quantum theory of hydrogen-like atoms** time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells.	**08**
Module-5	**Atoms in Electric & Magnetic Fields** Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Total angular momentum. Zeeman Effect, Gyromagnetic Ratio and Bohr Magneton. Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Vector Model. Spin-orbit coupling in atoms L-S and J-J couplings. Hund's Rule. Term symbols. Spectraof Hydrogen and Alkali Atoms (Na etc.).	**10**

Textbooks:

1. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Reference books:

1. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
2. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
3. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

COURSE INFORMATION SHEET

Course code: PH302R1
Course title: Solid State Physics
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V / III
Branch: PHYSICS

Code: PH302R1	**Title: Solid State Physics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To become familiar with the concepts of crystal structure and understand how crystal structure affects X-ray diffraction.	
2	To understand how vibrations of atoms can be quantized and how this is manifested in physical properties like specific heat.	
3	To acquire an understanding of the magnetic and dielectric properties of matter.	
4	To get familiarized with ferroelectricity and understand formation of band gap and classification of solids into metals, semiconductors and insulators on the basis of band gap.	
5	To develop a basic understanding of superconductivity.	
Course Outcomes: After the completion of this course, students will be able to		
1.	differentiate between different crystal structures and predict the X-ray pattern for a particular crystal structure.	
2.	apply the concept of phonons to understand the differences between the predictions of classical and quantum theories regarding specific heat of solids and to explain the electrical properties of solids	
3.	explain the different theories of magnetism.	
4.	describe the principles underlying the dielectric properties of matter and ferroelectricity and the formation of ferroelectric domains and other related phenomena.	
5.	describe the basic laws of Superconductivity	
Syllabus		
Module-1	**Crystal Structure:** Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis, Unit Cell. Miller Indices. Types of Lattices, Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.	**06**
Module-2	**Elementary Lattice Dynamics:** Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law **Electrical properties of Materials:** Electrons in metals: Drude Model, Kronig Penny model (Qualitative), Band Gap. Effective mass, mobility, Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect.	**11**
Module-3	**Magnetic Properties of Materials:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis, hard and soft material and Energy Loss.	**06**

Module-4	**Dielectric Properties of Materials:** Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations, Langevin-Debye equation, Complex Dielectric Constant. **Ferroelectric properties of Materials:** Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie – Weiss Law, Ferroelectric domains, PE hysteresis loop.	**10**
Module-5	**Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (Qualitative).	**06**

Text Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

Reference Books:

- Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

COURSE INFORMATION SHEET

Course code: PH316R1
Course title: Statistical Mechanics
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH316R1	**Title: Statistical Mechanics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To learn to use classical statistics to compute the macroscopic properties of the system by using the knowledge of microscopic properties of the particles.	
2	To understand the theory of radiation by using the statistical properties of particles obeying classical mechanics	
3	To predict the laws of radiations assuming that the photons behave quantum mechanically and follow Bose-Einstein statistics.	
4	To investigate various physical systemsandphenomenaarisingduetotheparticlesfollowingBose-Einsteinstatistics.	
5	TostudythermodynamicpropertiesofvarioussystemsfollowingFermi-Diracstatistics.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Understand the connection between statistics and thermal.	
2.	Apply the concept of classical statistics to understand the properties of radiations and the failure of classical theory.	
3.	Appreciate the correctness of Bose-Einstein statistics in explaining the properties of radiations.	
4.	Identify the systems following Bose-Einstein statistics and predict their macroscopic behavior.	
5.	Compute thermodynamic properties of the systems which follow Fermi-Dirac statistics.	
Syllabus		
Module-1	**Classical Statistics:** Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur-Tetrode equation, Law of Equipartition of Energy (with proof)– Applications to Specific Heat and its Limitations.	**08**
Module-2	**Classical Theory of Radiation:** Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.	**08**
Module-3	**Quantum Theory of Radiation:** Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.	**08**
Module-4	**Bose-Einstein Statistics:** B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose-Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas.	**08**
Module-5	**Fermi-Dirac Statistics:** Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.	**08**

Textbooks:

T1**:** Statistical Mechanics, R.K.Pathria, Butterworth Heinemann: 2nd Ed.,1996,OxfordUniversityPress.

Reference books:

R1**:** Statistical Physics, Berkeley Physics Course, F.Reif,2008,TataMcGraw-Hill

R2: Statistical and Thermal Physics,S.LokanathanandR.S.Gambhir.1991,PrenticeHall

R3:Thermodynamics,KineticTheoryandStatisticalThermodynamics,FrancisW.SearsandGerhardL.Salinger,1986,

COURSE INFORMATION SHEET

Course code: PH323R1
Course title: Statistical Mechanics Lab
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH323R1	**Title: Statistical Mechanics Lab**	**L-T-P-C [0-0-3-1.5]**

Course Objectives: This course enables the students

1	To learn to simulate evolution of a system of particles under different initial conditions
2	To learn to compute the partition function of ideal gases satisfying classical or quantum statistics using C/C^{++}/ Scilab.
3	To learn to plot radiation laws like Planck's law, Rayleigh-Jeans law in different temperature regimes
4	To learn to calculate and plot specific heat in different temperature regimes using C/C^{++}/Scilab
5	To plot classical and quantum distribution functions using C/C^{++}/Scilab.

Course Outcomes: After the completion of this course, students will be able to

1.	Calculate the equilibrium properties and study transient behavior of a system of interacting particles
2.	Calculate the partition function of ideal gases.
3.	Compare laws of radiations in various temperature regimes.
4.	Compare specific heat predicted by various laws at different temperatures.
5.	Compare distribution functions predicted by classical and quantum statistics.

List of Assignments

Use C/C^{++}/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
   a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
   b) Study of transient behavior of the system (approach to equilibrium)
   c) Relationship of large N and the arrow of time
   d) Computation of the velocity distribution of particles for the system and comparison with theMaxwell velocity distribution
   e) Computation and study of mean molecular speed and its dependence on particle mass
   f) Computation of fraction of molecules in an ideal gas having speed near the most probablespeed
2. Computation of the partition function Z(b) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
   a) Study of how Z(b), average energy <E>, energy fluctuation DE, specific heat at constant volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.
   b) Ratios of occupation numbers of various states for the systems considered above
   c) Computation of physical quantities at large and small temperature T and comparison of variousstatistics at large and small temperature T.
3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperatureand low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
5. Plot the following functions with energy at different temperatures
   a) Maxwell-Boltzmann distribution
   b) Fermi-Dirac distribution
   c) Bose-Einstein distribution

Reference Books

- Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears andGerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and JanTobochnik, Princeton University Press, 2010.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB:
- Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L. M. Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH401R1
Course title: Mathematical Methods in Physics
Pre-requisite(s): Mathematical Physics
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VII / IV
Branch: PHYSICS

Code: PH401R1	**Title: Mathematical Methods in Physics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	To expertise on techniques to use complex analysis in context of physics.	
2	To learn to solve Oes and PDEs and calculus of variations in physics.	
3	To understand how integral transforms are used and how probability works.	
4	To understand the concepts of group theory.	
5	To have a basic understanding of tensors and their role in physics.	
Course Outcomes: After the completion of this course		
1.	To solve problems using complex analysis techniques for various physics problems.	
2.	Solve PDE’s that appear in physics problems.	
3.	To calculate the integral transforms or inverse transform to solve differential equations.	
4.	To evaluate and understand group theoretic aspect of a physical system which essentially dictates to its symmetry properties.	
5.	Work with tensors and tensorial equations.	
Syllabus		
Module-1	**Complex Analysis**: Functions on Complex plane. Cauchy-Riemann Conditions. Singular functions: poles and branch points, order of singularity, branch cuts. Cauchy's Theorem. Cauchy’s Integral formula. Residue Theorem. Application – complex potentials, conformal transformations, Location of zeroes, Series summation, Inverse Laplace transform, Stokes equation.	**06**
Module-2	**ODEs and PDEs:** Brief review on Solution methods. Eigenfunction method. Sturm-Liouville equation. Green’s function. Special Functions, Associated Legendre Polynomials, Spherical harmonics, Spherical Bessel functions, Laguerre functions, Hermite polynomial, Recurrence relations, Rodrigue’s formula, Hermite Polynomials, Gamma and Beta functions Calculus of variations, Euler-Lagrange equation. Variational principles- Fermat’s principle in optics, Hamilton’s principle in mechanics. Basic idea about Integral equations.	**09**
Module-3	**Integral Transform:** Fourier Transforms (FT), FT of trigonometric, Gaussian, finite wave train & other functions. Inverse Fourier transform, Convolution theorem. Properties of FT. Laplace Transform, Inversion, Applications of Laplace Transform; Application in solving PDEs **Probability Theory:** Axioms and theorems, Conditional probability. Permutation and combination, Random and continuous variables, Generating functions. The central limit theorem and what it means.	**10**
Module-4	**Group theory:** Review of basic definition and properties-- Finite, Infinite, (Non)-abelian groups. Permutation groups, Subgroups, Equivalence relations and classes, Congruence and cosets, conjugacy classes. Reducible and irreducible representation. Character table, Physical applications—Dipole moment of molecules, Matrix elements in quantum mechanics, Degeneracy of normal modes.	**08**

Module-5	**Tensor analysis**: Physical laws, Coordinate transformations, Basis, Cartesian tensors, Contravariant, Tensor algebra, Symmetric and skew-symmetric tensor, Kronecker delta and Levi-Civita tensors. Isotropic tensors, Improper rotation and pseudo-tensors, Dual tensors. Physical applications, metric tensor, Electromagnetic tensor field.	**07**

Textbooks:

T1: Hans J. Weber George B. Arfken, Mathematical Methods for Physicists, (2005), Academic Press.
T2: L. A. Pipes, Applied Mathematics for Engineering and Physics (1958) McGraw-Hill.
T3: Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.

Reference books:

R1: Charlie Harper, Introduction to Mathematical Physics (2003), Prentice-Hall India.
R2: Erwin Kreyszig, Advanced Engineering Mathematics (1999), Wiley.
R3: N. P. Bali, A. Saxena and N.C. S. W. Iyengar, A Textbook of Engineering Mathematics (1996), Laxmi Publications (P) Ltd.
R4: Group Theory and its Applications to Physical Problems by Morton Hamermesh, 1989, Dover

COURSE INFORMATION SHEET

Course code: PH402
Course title: Electrodynamics
Pre-requisite(s): Electricity and Magnetism
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VII / IV
Branch: PHYSICS

Code: PH402	**Title: Electrodynamics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	Introducing the mathematical tools used in electrodynamics.	
2	Review of electrostatics and magnetostatics in matter.	
3	Providing easy headway into the covariant formulation of Maxwell's equations.	
4	Teaching basic principles of waveguides and transmission lines.	
5	Rendering insights into fields generated by oscillating sources, and their applications.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Able to use basic mathematical tools to solve problems in electrodynamics.	
2.	Gain proficiency in electrostatics and magnetostatics.	
3.	Obtain command on four-vector and tensor notations.	
4.	Learn about TM, TE and TEM modes in waveguides.	
5.	Understand radiations by moving charges.	
Syllabus		
Module-1	The concept of a scalar potential. Poisson's and Laplace's equations for scalar potential. Green's theorem, Electrostatic field energy density. Solutions of Laplace's equation in rectangular, spherical and cylindrical coordinates using the method of separation of variables, Method of images, Multipole expansion of potential due to a localized charge distribution.	**08**
Module-2	Electrostatics in matter; Polarization and electric displacement vector. Electric field at the boundary of an interface, Linear dielectrics. Magnetostatics, Biot-Savart Law, Ampere's Law, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Boundary conditions.	**08**
Module-3	Electromagnetic induction, Faraday's Law, Maxwell's equations, Maxwell's equations in matter, Conservation of charge, Poynting's theorem, Solutions of Maxwell's Equations, Covariant formulation of electrodynamics, Inhomogeneous wave equations and their solutions.	**08**
Module-4	Electromagnetic waves in matter, Reflection and refraction at a plane interface between dielectrics, Fresnel's equations. Phase velocity and group velocity, spreading of a pulse propagating in a dispersive medium, propagation in a conductor, skin depth. Transmission lines and wave guides; Dynamics of charged particles in static and uniform electromagnetic fields.	**08**
Module-5	EM Field of a localized oscillating source. Fields and radiation in dipole and quadrupole approximations. Antenna: Radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.	**08**

References:

1. Introduction to Electrodynamics by D. J. Griffiths
2. Classical Electrodynamics by J. D. Jackson
3. Lectures on Electromagnetism by A. Das

COURSE INFORMATION SHEET

Course code: PH403
Course title: Classical Mechanics
Pre-requisite(s): Mechanics and Electricity & Magnetism
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VII / IV
Branch: PHYSICS

Code: PH403	**Title: Classical Mechanics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To define the concepts of Lagrangian Mechanics.	
2	To interpret the concepts of Hamiltonian Mechanics.	
3	To explain generating function, canonical transformation & Poisson brackets.	
4	To illustrate the dynamics of a rigid body and non-inertial frames of reference.	
5	To formulate the concepts of coupled oscillators.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Formulate the Lagrangian mechanics concepts and solve the problems with the help of Lagrangian mechanics.	
2.	Compare the formulation of Hamiltonian and Lagrangian mechanics and solve the problems of classical and relativistic mechanics	
3.	Solve the problems of generating function, canonical transformation & Poisson brackets.	
4.	Formulate the equations of rigid body dynamics and demonstrate the examples of non-inertial frames of reference.	
5.	Solve the equations of coupled oscillator and to examine the two coupled pendulums, and double pendulum related problems.	
Syllabus		
Module-1	Constraints, classification of constraints, generalized coordinates, principal of virtual work, D Alembert’s principal, Lagrange’s equations of motion, properties of kinetic energy function, theorem on total energy, generalized momenta, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation, concept of symmetry, invariance under Galilean transformation, velocity dependent potential. Two body central force problem: reduction of two body problem to equivalent one body problem, equation of motion under central force and first integrals, differential equation for an orbit, Kepler’s law, stability of orbits, virial theorem, scattering in a central force field.	**10**
Module-2	Hamilton’s function and Hamilton’s equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian of relativistic particles, Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.	**07**
Module-3	Generating function, Conditions for canonical transformation and problem. Poisson Brackets, its definitions, identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity, invariance of PB under canonical transformation. Lagrange bracket.	**05**
Module-4	Dynamics of a Rigid Body: Rigid body and space reference system, Euler's angles, angular momentum and inertia tensor, principal moment of inertia, rotational kinetic energy of rigid body, symmetric bodies, moments of inertia for different body system, Euler's equation of motion for a rigid body by Newtonian method and Lagrange’s method Non-inertial frames of reference, fictitious force, uniformly rotating frames, Coriolis force, Foucault’s pendulum, Larmor precession, effects of Coriolis force on river flow on the surface of the earth, air flow on the surface of the earth, projectile motion.	**10**

Module-5	Coupled Oscillator: Potential energy and equilibrium of one-dimensional oscillator, differential equations for coupled oscillator, kinetic and potential energies of the coupled oscillators, theory of small oscillations, examples of coupled oscillator: two coupled pendulums, double pendulum.	**08**

Reference books:

1. Classical Mechanics by H. Goldstein, Pearson Education Asia.
2. Classical Dynamics of Particles and Systems by Marion and Thomtron, Third Edition, Horoloma Book Jovanovich College Publisher.
3. Classical Mechanics by P. V. Panat, Narosa Publishing Home,, New Delhi.
4. Classical Mechanics by N. C. Rana and P. S. Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
5. Introduction to Classical Mechanics by R. G. Takwale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
6. Landau and Lifsitz

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH404R1
Course title: Quantum Mechanics
Pre-requisite(s): Mathematical Physics I and II
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VII / IV
Branch: PHYSICS

Code: PH404	**Title: Quantum Mechanics**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	To learn Dirac Bra-ket Algebra.	
2	To understand basics of quantum mechanics.	
3	To understand Hydrogen atom problem.	
4	To understand the concepts quantum spin.	
5	To learn to solve systems with coupled angular momenta.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Master the mathematical foundation of quantum mechanics.	
2.	apply basic tools of Quantum mechanics.	
3.	Find quantum properties of Hydrogen like atoms and more complicated systems.	
4.	Understand how quantum spin is a unique quantum property.	
5.	Derive Clebsch-Gordon coefficients and deal with identical particles.	
Syllabus		
Module-1	**Introduction to Dirac and Heisenberg Formulation:** The Stern-Gerlach experiment. Linear vector space. Kets, Bras and Operator algebra. Basis, matrix representations, Measurements, observables, eigen-values and eigen-functions. Position and Momentum representation. Continuous basis, Dirac-Delta function Uncertainty relations.	**09**
Module-2	**Foundations of quantum mechanics:** Postulates, Schrodinger equation, Review of particle in a box, Tunnelling. Quantisation of linear harmonic oscillator, Heisenberg uncertainty relation, asymptotic behaviour, energy levels, correspondence with classical theory. Symmetries, Translational invariance in space and time, Parity invariance, Time-reversal invariance, symmetry.	**07**
Module-3	**Hydrogen atom problem** Translation and rotation in 2D, Eigenvalue problem of orbital angular momentum operators. Solution of rotationally invariant problem. Spherically symmetric potential in three dimensions, hydrogen atom, wave functions, eigenvalues, degeneracy, etc	**07**
Module-4	**Quantum Spin** Quantum spin, rotation and angular momentum commutation relations, Symmetry, invariance and conservation laws, Finite rotation, Eigenvalues and Eigenstates of spin angular momentum operator, Spin dynamics, Pauli's spin matrices, Stern-Gerlach experiment. Entanglement.	**08**

Module-5	**Addition of angular momenta and Identical particles** Spin states of two spin-1/2 particles, Spin-Spin coupling, Spin-Orbital coupling, General problem of addition of angular momenta, Clebsch-Gordon coefficients. Principle of identical particles, symmetrisation postulate, Pauli's exclusion principle. Two electron system, Helium atom, Young Tableaux.	**09**

Textbooks:

T1**:** R. Shankar, Principles of Quantum Mechanics, Springer, 2014
T2: Modern Quantum Mechanics, J. J. Sakurai, Addison Wesley (1993)
T3: C. Cohen-Tannoudji, Quantum Mechanics, Vol I, (1996)

Reference books:

R1: Quantum Mechanics by L. D. Landau and E. M. Lifshitz (Pergamon, Berlin)
R2. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (McMillan India

COURSE INFORMATION SHEET

Course code: PH405R2
Course title: Modern Computational Techniques and Programming
Pre-requisite(s): Mathematical Physics
Co- requisite(s):
Credits: 2 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: VII / IV
Branch: PHYSICS

Code: PH405R2	**Title: Modern Computational Techniques and Programming**	**L-T-P-C [2-0-0-2]**
Course Objectives: The idea behind the course is to teach students to solve problem in physics using MAPLE and MATLAB. In this regard the objectives are to		
1	Teach to calculate various errors which arise while solving different equations	
2	Train them to solve systems of linear equations.	
3	Teach them the concept of interpolation	
4	Instruct them to calculate integrals and differentials using different numerical methods	
5	Train them to solve partial differential equations numerically	
Course Outcomes: After the completion of this course, students will be able to		
1.	Estimate errors while solving equations.	
2.	Effectively use methods like matrix inversion, Gauss elimination and LU decomposition to solve linear equations.	
3.	Enrich a given set of data points using interpolation methods like cubic spline, Newton's divided difference, etc	
4.	Numerically differentiate and integrate expressions.	
5.	Solve equations from physics like heat equation, diffusion equation, etc. numerically.	
Syllabus		
Module-1	Approximation Methods, Errors and Roots of Equations, Accuracy and precision, Truncation and round-off errors, Bracketing Methods (false position, bisection), Iteration Methods (Newton-Raphson and secant).	**08**
Module-2	Systems of linear algebraic equations. Gauss elimination, matrix inversion and LU decomposition methods.	**04**
Module-3	Curve fitting and Interpolation Least squares regression, Linear, multiple linear and nonlinear regressions, Cubic spline. Newton's divided difference and Lagrange interpolating polynomials.	**06**
Module-4	Numerical differentiation and integration, Divided difference method for differentiation, Newton-Cotes formula, Trapezoidal and Simpson's rules, Romberg and Gauss quadrature methods.	**05**
Module-5	Ordinary and Partial differential equations, Euler's method and its modifications, Runge-Kutta methods, Boundary value and Eigen value problems. Finite difference equations, Elliptic equations, Laplace's equation and solutions, Parabolic equations, Solution of the heat conduction equation	**12**

Text books:

T1: Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India (1983)

Reference books:

R1: Numerical Analysis, V. Rajaraman

R2: Numerical Methods for Engineering, S.C. Chopra and R.C. Canale, McGraw-Hill (1989).

R3: Numerical Methods for Scientists and Engineers, Prentice Hall of India (1988).

COURSE INFORMATION SHEET

Course code: PH409
Course title: Atomic and Molecular Spectroscopy
Pre-requisite(s): Quantum Physics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VIII / IV
Branch: PHYSICS

Code: PH409R1	**Title: Atomic and Molecular Spectroscopy**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students		
1	To learn about the intricacies of spectra of Hydrogen-like atoms	
2	To understand the details of rotational, vibrational and Raman spectra of molecules.	
3	To know about the different regions of spectra, and the corresponding instrumentations.	
4	To learn about NMR spectra and its application	
5	To get a feeling of the principles of mass spectroscopy and ionization methods.	
Course Outcomes: After the completion of this course, students will be		
1.	Able to deal with problems related to Hydrogen-like atomic spectra	
2.	Having knowledge about the rotational, vibrational and Raman spectroscopy of molecules	
3.	Able to comprehend the instrumentation techniques that are used in different regions of spectra	
4.	Understanding NMR spectra and visualize the physical phenomenon	
5.	Learning about mass spectroscopy and its usage	
Syllabus		
Module-1	Atomic Physics: Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; Spectral terms, L-S and J-J coupling schemes, Singlet-Triplet separation for interaction energy of L-S coupling. Lande Interval rule, Zeeman, Paschen Back & Stark effect; width of spectral lines	**10**
Module-2	Molecular Spectroscopy: Types of molecular spectroscopy, applications, Rotational, vibrational and electronic spectra of diatomic and polyatomic molecules; Born Oppenheimer approximation, Frank – Condon principle and selection rules. Molecular hydrogen, Fluorescence and Phosphorescence, Instrumentations of IR and Microwave Spectroscopy and Applications. Raman Effect, Rotational Raman spectra. Vibrational Raman spectra. Stokes and anti-Stokes lines and their Intensity difference, Instrumentation and applications.	**12**
Module-3	Characterization of electromagnetic radiation, regions of spectrums, spectra representation, basic elements if practical spectroscopy, resolving power, width and intensity of spectral transition, Fourier transform spectroscopy, concept of stimulated emission.	**10**
Module-4	NMR Spectroscopy: Nuclear spin, nuclear resonance, saturation, spin-spin and spin-lattice relaxations, chemical shift, de shielding, coupling constant, instrumentation and applications.	**08**
Module-5	Principle and applications of Mass Spectroscopy, Thomson's method of determining e/m of electrons, Aston mass spectrograph, Dempster's mass spectrometer, Ionization Methods, instrumentation and applications.	**10**

Textbooks:

1. Introduction to Atomic Spectra", H.E. White, McGraw-Hill.
2. Fundamentals of Molecular Spectroscopy" C. N. Banwell, Tata McGraw-Hill
3. Atomic Physics", G. P. Harnwell & W.E. Stephens, McGraw-Hills Book Company, Inc.
4. Modern Spectroscopy", J. M. Hollas, John Wiley

Reference books:

1. "Physics of Atoms and Molecules" by Bransden & Joachain, Pearson
2. "Introduction to Spectroscopy" by Pavia et. al., Cengage Learning India Pvt. Ltd.

COURSE INFORMATION SHEET

Course code: PH410
Course title: Electronic Devices and Circuits
Pre-requisite(s): Digital and Analog Systems
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VIII / IV
Branch: PHYSICS

Code: PH410R1	**Title: Electronic Devices and Circuits**	**L-T-P-C [3-0-0-3]**
Course Objectives:		
1	To impart knowledge about a To impart knowledge about a variety of special, power and microwave solid state electronic devices, their structure and the underlying physical principles.	
2	To expose the students to the integrated circuit chip development technologies and associated processes.	
3	Amplifiers would be dealt with in all its expanse and rigor to give a good feel of the associated design and mathematical intricacies.	
4	A rigorous treatment on integrated circuit operational amplifiers is to be delivered to supplement their understanding on amplifiers.	
5	Linear and non-linear applications of op-amps are introduced to add to the knowledge on the variety of circuits encompassing all major class of applications.	
6	Nanoelectronic devices and concepts are introduced to give a feel of the future electronics devices and the quantum effects that manifest	
Course Outcomes:		
1.	Understanding the physics of the devices their characteristics and applications, to be able to use them in electronic circuits.	
2.	Students would develop an insight into the technologies that go into an IC chip that they would be extensively using during and after the course.	
3.	In depth understanding would enable the students to appreciate the beauty of the subject and design amplifiers that are technically sound.	
4.	Students would develop a comprehensive understanding of contemporary integrated circuit amplifier design.	
5.	Students would be aware of various signal conditioning, processing and generation techniques thus being better equipped to understand their use in larger and complex systems.	
6.	Students would enjoy the new and stimulating ideas behind the future novel devices and would also appreciate the link between electronics and the quantum effects that come into play.	
Syllabus		
Module-1	**Electronic Devices** Varactor diode, photo-diode, Schottky diode, solar cell, Principle of Operation and I-V Characteristics of JFET, MOSFET. Thyristors (SCR, LASCR, Triac and Diac) Microwave semiconductor devices: Tunnel diode, IMPATT, Gunn effect and Gunn diode.	**06**
Module-2	**Integrated circuits:** Monolithic lC's, Hybrid lC's. Materials for IC fabrication (Si and GaAs), Crystal growth and wafer preparation, processes Epitaxy, Vapour phase epitaxy (VPE), Molecular beam epitaxy (BME), MOCVD Oxidation, Ion implantation, Optical lithography, electron beam lithography, Etching processes.	**06**
Module-3	**Amplifiers using discrete devices** Amplifiers using BJTs, FETs, MOSFETs and their analysis. Feedback in amplifiers, characteristics of negative feedback amplifiers, input resistance, output resistance, method of analysis of a feedback amplifier, feedback types and their analyses, Bode plots, two-pole and three–pole transfer function with Feedback, approximate analysis of a multipole feedback amplifier, stability, gain and phase margins, compensation, dominant-pole compensation, pole-zero compensation.	**10**

Module-4	**Operational amplifiers** Differential Amplifier, emitter-coupled differential amplifier, transfer characteristics of a differential amplifier, current mirror and active load, Measurement of op-amps parameters, frequency response of op-amps, dominant–pole compensation, pole-zero compensation, lead compensation, step response of op-amps.	**08**
Module-5	**Applications of Op-Amps** **Linear:** instrumentation amplifier, precision rectifiers, active filters (low-pass, high-pass, band- pass, band-reject/ notch), Analog computation circuits **Nonlinear:** Comparators, Schmitt trigger, multivibrators, AMV and MMV using 555 timer, waveform generation, D/A converters, binary weighted, A/D converters, simultaneous, counter type, dual slope converter. **Single electron devices:** Quantum point contact, Coulomb blockade, Resonant tunneling transistor, Single electron transistor (SET).	**10**

Textbooks:

T1: Physics of Semiconductor Devices- S. M. Sze

T2: Solid State Electronic Devices- B. G. Streetman, PHI

T3: VLSI Technology, S. M. Sze Mc Graw Hill

T4: Integrated Electronics, Jacob Millman and Christos Halkias, -Tata McGraw Hill Publication

T5: Thomas L. Floyd. ELECTRONIC. DEVICES. 9th Edition. Prentice Hall.

T6: Louis Nashelsky and Robert Boylestad, Electronic Devices and Circuit Theory T7: Khan and Dey, A First course in Electronics, PHI

T8: Operational amplifiers and Linear Integrated Circuits- R. A. Gayakwad, PHI.

T9: Linear Integrated Circuits- D. R. Choudhary and S. B. Jain, New Age Publications

Reference books:

R1: Operational amplifier and Linear Integrated Circuits- R. F. Coughlin, F. F. Driscoll, PHI

COURSE INFORMATION SHEET

Course code: PH412R1
Course title: Electronics Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VIII / IV
Branch: PHYSICS

Code: PH412R1	Title: Electronics Lab	L-T-P-C [0-0-3-1]
List of Experiments: 1. Verification of truth tables of OR, NOT and AND gates using NAND gates 2. Verification of truth tables of OR, NOT and AND gates using NOR gates 3. Realization of XOR and XNOR gates using NAND and NOR gates 4. Design and verification of a 2 bit binary half adder 5. Design and verification of a 2- bit binary full adder 6. Design of a half subtractor and verification of its truth table 7. Design of a half subtractor and verification of its truth table 8. Design and implementation of clocked R-S flipflops using NAND gates 9. Design and implementation of clocked J-K flipflops using NAND gates 10. Design and testing of monostable vibrator using IC 555 timer 11. Design and testing of astable multivibrator using IC 555 timer 12. Design and testing of Schmidt Trigger using IC 741 13. Design and testing of modulo 9 ripple counter using IC CD4029. 14. Design and testing of CMOS switch and 2:1 multiplexer using IC 4066.		

COURSE INFORMATION SHEET

Course code: PH502R1
Course title: Advanced Quantum Mechanics
Pre-requisite(s): Quantum Mechanics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VIII / IV
Branch: PHYSICS

Theory: 30 Lectures

Code: PH502R1	**Title: Advanced Quantum Mechanics**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students		
1	To learn approximation methods.	
2	To learn time dependent and independent perturbation methods.	
3	To learn to compute scattering amplitude.	
4	To learn relativistic quantum mechanics.	
5	To understand the tools of density matrix formalism of quantum mechanics.	
Course Outcomes: After the completion of this course, students will be able to		
1.	To solve problems using variational and WKB methods.	
2.	Use time dependent and independent perturbation methods to solve integro-differential equations.	
3.	predict outcomes of a scattering experiment or phenomenon.	
4.	understand dynamics of electrons.	
5.	Approach a quantum system using density matrix formalism.	
Syllabus		
Module-1	**Approximation Methods:** Variational Principle, WKB approximation, solution near a turning point, connection formula, tunnelling through barrier. Boundary conditions in the quasi-classical case. Examples.	**09**
Module-2	**Time Independent perturbation** theory, harmonic oscillator in a magnetic field. Selection rules. Degenerate perturbation theory, Stark effect in Hydrogen atom, Fine structure splitting. **Time dependent perturbation** theory, First order perturbations—Sudden, Adiabatic and Periodic. Interaction of atoms with electromagnetic radiation.	**11**
Module-3	**Scattering theory:** Review of 1D scattering, Differential and total scattering cross-section laws, Partial wave analysis Born approximation (Time dependent and independent) validity and simple applications. Integral form of scattering equation, Optical theorem. Resonance.	**10**
Module-4	**Relativistic wave equations**: Klein-Gordon equation for a free particle and particle under the influence of an electromagnetic potential, Dirac's relativistic Hamiltonian, Dirac's relativistic wave equation, positive and negative energy states, significance of negative energy states.	**10**
Module-5	**Density Matrices**: General Properties of Density Matrices, Pure and Mixed States, Time Evolution, von Neumann Equation, Bloch sphere. Density matrix at thermal equilibrium, The density matrix in the interaction picture, Correlation Functions and Response Functions.	**10**

Textbooks:

T1**: R. Shankar, Principles of Quantum Mechanics, Springer, 2014**

T2.: Modern Quantum Mechanics, J. J. Sakurai, Addison Wesley (1993)

T3: C. Cohen-Tannoudji, Quantum Mechanics, Vol I, (1996)

Reference books:

R1: Quantum Mechanics by L. D. Landau and E. M. Lifshitz (Pergamon, Berlin)

R2. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (McMillan India

COURSE INFORMATION SHEET

Course code: PH503R1
Course title: Laser Physics and Applications
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VIII / IV
Branch: PHYSICS

Code: PH503R1	**Title: Laser Physics and Applications**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To identify conditions for lasing phenomenon and properties of the laser.	
2	To discuss stable, unstable resonators and cavity modes.	
3	To compare continuous and pulsed lasers.	
4	To classify different types of lasers with respect to design and working principles	
5	To illustrate various applications of laser e.g. holographic non-destructive testing.	
Course Outcomes: After the completion of this course, students will be able to		
1.	To evaluate conditions for lasing phenomenon and properties of the laser.	
2.	To calculate cavity modes of a given cavity and identify the given resonator is stable or unstable one.	
3.	To evaluate Q-switching and the mode-locked lasing phenomenon.	
4.	To appraise different type of lasers with respect to design and working principles.	
5.	To assess applications of a laser for measurement of distance, holography and medical surgeries etc.	
Syllabus		
Module-1	Interaction of radiations with atoms and ions: Spontaneous and Stimulated emissions, Stimulated absorption. Population inversion, gain oscillation, gain saturation, threshold, rate equation, 3 and 4 level systems, laser line shape, hole burning, Lamb dip, output power. Properties of laser: coherence, monochromaticity, divergence.	**12**
Module-2	Theory of resonator. Stable and unstable resonator, Optical cavities, Cavity modes, longitudinal and transverse modes of the cavity.	**08**
Module-3	Continuous wave, Pulsed, Q- switched and Mode locked lasers.	**04**
Module-4	Different type of lasers, design (in brief) and functioning of different lasers - Ruby laser, Nd: YAG laser, He-Ne laser, CO_2 laser, Argon ion laser, Dye laser, Excimer laser. Free electron laser.	**08**
Module-5	Measurement with laser, alignment, targeting, tracking, velocity measurement, surface quality measurement. Measurement of distance (interferometric, pulse echo, Beam modulation). laser gyroscope, Holographic nondestructive testing (NDT). Application in communication. Material Processing: cutting, welding, drilling and surface treatment. Medical Applications, Laser trapping.	**08**

Textbooks:

T1: O. Svelto; Principles of Lasers, Springer (2004)

T2: Laser Fundamentals: William T. Silfvast, Cambridge University Press (1998) R1 K. Shimoda, Introduction to laser Physics, Springer Verlag, Berlin (1984) R2: Laser Electronics: J.T.Verdeyen, 3rdEd, Prentice Hall (1994).

Reference books:

R1 Laser Applications in Surface Science and Technology; H.G.Rubahn; John Wiley & Sons (1999).

R2 Optical Methods in Engineering Metrology: Ed D.C.Williams; Chapman &Hall

COURSE INFORMATION SHEET

Course code: PH513R1
Course title: Laser Physics Lab
Pre-requisite(s):
Co- requisite(s): Laser Physics and Applications
Credits: 1 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VIII / IV
Branch: PHYSICS

Code: PH513R1	**Title: Laser Physics Lab**	**L-T-P-C [0-0-3-1]**
List of Experiments 1. To determine the wavelength of He-Ne Laser using Michelson Interferometer 2. Demonstrate interference fringe pattern using Mach Zehnder interferometer. 3. To determine the grating element of a transmission grating using He-Ne laser. 4. Determine the coherence length of a diode laser using a Michelson Interferometer. 5. Perform Faraday Effect experiment and find verdet constant of flint glass. 6. To study the birefringence with respect to applied voltage in an electro optic crystal. 7. To determine the Kerr constant of the liquid (Nitro Benzene) 8. Determine the wavelength of a diode laser using Fabri-Perot interferometer. 9. To find the velocity of ultrasonic wave in a liquid using ultrasonic diffraction apparatus.		

COURSE INFORMATION SHEET

Course code: PH501
Course title: Nuclear and Particle Physics
Pre-requisite(s): Introduction to Nuclear and Particle Physics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH501	**Title: Nuclear and Particle Physics**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students		
1	To impart the knowledge regarding the fundamental and basics of Nucleus and its models.	
2	To provide the knowledge of the Two-nucleus problem, concept of nuclear force.	
3	To acquire knowledge about the nucleus by the study of scattering of particles.	
4	To have a good understanding of interaction of charged particles with matter.	
5	To have an elementary idea of particles and their classification.	
Course Outcomes: After the completion of this course, students will		
1.	have an idea developed about the nucleus.	
2.	have a concept and nature of nuclear force.	
3.	learn about the method and analysis of Scattering process.	
4.	have an idea about the interaction of particles with matter.	
5.	understand the nature, interaction etc.. of the elementary particles.	
Syllabus		
Module-1	Nuclear Models Liquid Drop Model, semi-empirical mass formula, transitions between odd A isobars, transitions between even isobars, odd-even effects and magic numbers, Shell model, collective model.	**10**
Module-2	Two nucleon problem, The deuteron, ground state of deuteron, nature of nuclear forces, excited state of deuteron, spin dependence of nuclear force, meson theory of nuclear force.	**10**
Module-3	Scattering, Cross section, differential cross section, scattering cross section, nucleon nucleon scattering, proton-proton and neutron-neutron scattering at low energies.	**10**
Module-4	Interaction of radiation with matter, Interaction of charged particles with matter, stopping power of heavy charged particles, energy loss of electrons, absorption of gamma rays, photoelectric effect, Compton effect and pair production.	**10**
Module-5	Classification of elementary particle, Eightfold way, Baryon octate and meson octate, Quark model, Baryon Decuplet, meson nonlet, Intermediate vector Boson, Strong electromagnetic and week interactions, standard model, lepton classification and quark classification.	**10**

References

1. Nuclear Theory-Roy and Nigam
2. Introductory Nuclear Physics- Kenneth S-Krane
3. Nuclear Physics: D. Halliday
4. Elements of Nuclear Physics: Pandya and Yadav
5. Introduction to Elementary Particle: David Griffiths

COURSE INFORMATION SHEET

Course code: PH408R1
Course title: Advanced Statistical Mechanics
Pre-requisite(s): Mathematical Physics
Co- requisite(s): Quantum Physics
Credits: 4 L: 3 T:1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH408R1	Title: Advanced Statistical Mechanics	L-T-P-C [3-1-0-4]
Course Objectives: This course enables the students		
1	To understand the dependence of equilibrium properties of various systems on their microscopic constituents and compute thermodynamic parameters by using classical statistics.	
2	To learn to use methods of quantum statistics to obtain properties of systems made of microscopic particles which either obey Fermi-Dirac statistics or Bose-Einstein statistics.	
3	To grasp the concepts of first order and second order phase transitions and critical phenomena.	
4	To understand phase transition arising in Ising model.	
5	To learn to obtain the properties of out-of-equilibrium systems using concepts from equilibrium physics.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Use various ensemble theories to calculate the thermodynamic properties of different systems.	
2.	Compute properties of systems behaving as ideal Fermi gas or ideal Bose gas.	
3.	Classify transitions as first order or second order	
4.	The student should be able to reproduce the exact solution of Ising model in one dimension and solve it using mean field theory	
5.	Understand the approach required to predict the evolution of non-equilibrium systems	
Syllabus		
Module-1	**Formalism of Equilibrium Statistical Mechanics** Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles: microcanonical, canonical, grand canonical and their partition functions, connection to thermodynamics, fluctuations, applications of various ensembles, equation of state for a non-ideal gas, Van der Waals' equation of state, Meyer cluster expansion, virial coefficients.	**08**
Module-2	**Quantum Statistics** Formalism of Fermi-Dirac and Bose-Einstein statistics. Applications of the formalism to: (a) Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation, Bose-Einstein condensation, degeneracy, BEC in a harmonic potential. (b) Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat	**08**
Module-3	**Phase Transitions and Critical Phenomena** First and Second order Phase transitions, Diamagnetism, paramagnetism, and ferromagnetism, Landau theory, critical phenomena, Critical exponents, scaling hypothesis.	**08**
Module-4	**Ising Model:** Ising Model, mean-field theory, exact solution in one dimension.	**06**
Module-5	**Nonequilibrium Systems:** Correlation of space-time dependent fluctuations, fluctuations and transport phenomena, Diffusion equation, Random walk and Brownian motion, Langevin theory, fluctuation dissipation theorem, Fokker-Planck equation.	**10**

COURSE INFORMATION SHEET

Course code: PH411R2
Course title: Condensed Matter Physics
Pre-requisite(s): Quantum Mechanics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH411R2	**Title: Condensed Matter Physics**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students		
1	To relate crystal structure to symmetry, recognize the correspondence between real and reciprocal space.	
2	To acquire knowledge of the behaviour of electrons in solids based on classical and quantum theories	
3	To become familiar with the different types of magnetism and magnetism based phenomenon.	
4	To develop an understanding of the dielectric properties and ordering of dipoles in ferroelectrics.	
5	To get familiarized with the different parameters associated with superconductivity and the theory of superconductivity.	
Course Outcomes: After the completion of this course, students will be able to		
1.	correlate the X-ray diffraction pattern for a given crystal structure based on the corresponding reciprocal lattice.	
2.	explain how the predicted electronic properties of solids differ in the classical free electron theory, quantum free electron theory and the nearly free electron model.	
3.	explain various magnetic phenomena and describe the different types of magnetic ordering based on the exchange interaction.	
4.	differentiate between ferroelectric, anti-ferroelectric, piezoelectric and pyroelectric materials.	
5.	differentiate between type-I and type-II superconductors and their theories.	
Syllabus		
Module-1	**CRYSTAL DIFFRACTION AND RECIPROCAL LATTICE** Revision of concepts, crystal structure, Bravais Lattice, lattice translation vector, unit cells, Wigner Seitz cells, symmetry operations and elements, simple crystal structures, Miller indices, lattice planes, Braggs' law, Reciprocal lattice to SC, BCC, FCC, Laue's equation and Bragg's law in terms of reciprocal lattice vector, Laue's method, powder crystal diffraction, rotating crystal method, scattered wave amplitude, Fourier analysis of the basis, structure factor of lattices (sc, bcc, fcc), atomic form factor.	**12**
Module-2	**ENERGY BAND THEORY** Classical free electron theory, wave mechanical treatment of electron in 1D and 3D well, Wiedemann-Franz law, quantum theory of thermal conductivity, failure of free electron theory, density of states, Fermi-Dirac statistics, effect of temperature on Fermi distribution function, electrons in a periodic potential, Bloch's theorem, Kronig Penney Model, construction of Brillouin zone, reduced zone scheme, concept of energy band, energy band structure of conductors, semiconductors and insulators.	**10**
Module-3	**MAGNETISM** Magnetic Susceptibility, diamagnetism, paramagnetism, the ground state of an ion and Hund's rules, adiabatic demagnetization, crystal fields, orbital quenching, Jahn-Teller effect, nuclear magnetic resonance, electron spin resonance, Mossbauer spectroscopy, magnetic dipolar interaction, exchange interaction, ferromagnetism, antiferromagnetism, ferrimagnetism, spin glasses	**10**

Module-4	**DIELECTRICS AND FERROELECTRICS** Macroscopic Maxwell equation of electrostatics, theory of local field, theory of polarizability, dielectric constant, Claussius-Mosotti relation, optical properties of ionic crystals, dielectric breakdown, dielectric losses, ferroelectric, anti-ferroelectric, piezoelectric, pyroelectric, frequency dependence of dielectric properties, classification of ferroelectric crystal, ferroelectric phase transitions, relax or ferroelectrics.	**09**
Module-5	**SUPERCONDUCTIVITY** Basic properties of superconductors, phenomenological thermodynamic treatment, London equation, penetration depth, superconducting transitions, order parameter, Ginzburg-Landau theory, Cooper pair, electron-phonon interaction, BCS theory, coherence length, flux quantization, Josephson junction, high T_C superconductors, mixed state.	**09**

Textbooks:

1. Introduction to Solid State Physics 8th Edition, Charles Kittel, John Wiley and Sons, 2005.
2. Solid State Physics, Neil W. Ashcroft, N. David Mermin, Saunders College Publishing, 1976.

References:

1. Condensed Matter Physics 2nd Edition, Michael. P Marder, John Wiley and Sons, 2010.
2. Magnetism in Condensed Matter, Oxford Master Series in Condensed Matter Physics 4, Stephen Blundell, Oxford University Press, 2001.

COURSE INFORMATION SHEET

Course code: PH413
Course title: Condensed Matter Physics Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 2 L: T:0 P: 4
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH413	**Title: Condensed Matter Physics Lab**	**L-T-P-C [0-0-4-2]**

List of experiments:

1. To study the permeability of a ferrite substance as a function of frequency. (Take at least 20 data)
2. To study the relative permittivity of a dielectric material as a function of temperature. (Take at least 20 data).
3. Analysis of XRD data using JCPDS software.
4. Analysis of FESEM data using ImageJ software to calculate density function.
5. Analysis of XRD data using CheckCell software.
6. Measurement of resistance of a semiconductor as a function of temperature.
7. Measurement of susceptibility using lock in amplifier.
8. Synthesis of a ceramic sample using a programmable furnace.
9. Analysis of XRD data using FullProf software.
10. Design of crystal structure using VESTA software.

ANNEXURES

<u>**COURSE INFORMATION SHEET**</u>

Course code: SEC301R1
Course title: PHYSICS WORKSHOP SKILLS
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 1 T: 0 P: 1
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: SEC301R1	**Title: PHYSICS WORKSHOP SKILLS**	**L-T-P-C [1-0-1-1.5]**
Course Objectives: This course enables the students to		
1	train students on a variety of basic physical measurements with possible accuracy and precision.	
2	introduce commonly used materials and methods in mechanical manufacturing processes.	
3	introduce and provide adequate training on common machining tools and processes for making use of the same.	
4	impart training on fabrication of simple electrical and electronic circuits and systems using discrete or modular components.	
5	introduce the basics of parts and components of commonly used prime mover equipment and power generation mechanism	
Course Outcomes: After the completion of this course, students will be able to		
1.	carry out measurements on a variety of objects of various physical dimensions with good accuracy and precision.	
2.	suitably choose from a host of materials and manufacturing methods for basic structures, experimental setups, or attachments.	
3.	fabricate or steer-through workshop processes for fabrication of simple experimental setups and attachments involving mechanical processes or to make desired modifications in the existing ones.	
4.	diagnose, analyze, and troubleshoot systems involving simple subsystems in electrical and electronic units commonly dealt with in laboratories.	
5.	understand the working of common components of prime mover equipment and deploy simple mechanical systems for carrying out tasks at hand.	
Syllabus		
Module-1	**Introduction:** Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calipers, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet,etc. Use of Sextant to measure height of buildings, mountains, etc.	**04**
Module-2	**Mechanical Skill - I**: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming, and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood.	**05**
Module-3	**Mechanical Skill - II**: Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file.Drilling of holes of different diameter in metal sheet and wooden block. Use of bench viceand tools for fitting. Make funnel using metal sheet.	**08**
Module-4	**Electrical and Electronic Skill:** Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, electronic switch using transistor and relay.	**07**

Module-5	**Introduction to prime movers:** Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.	**06**

Reference Books:

- A text book in Electrical Technology - B L Theraja – S. Chand and Company.
- Performance and design of AC machines – M.G. Say, ELBS Edn.
- Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
- Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes[ISBN: 0750660732]
- New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Companyof Ireland [ISBN: 0861674480]

<u>**COURSE INFORMATION SHEET**</u>

Course code: SEC305R1
Course title: ELECTRICAL CIRCUITS AND NETWORK SKILLS
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 1 T: 0 P: 1
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: III / II
Branch: PHYSICS

Code: SEC305R1	**Title: ELECTRICAL CIRCUITS AND NETWORK SKILLS**	**L-T-P-C [1-0-1-1.5]**
Course Objectives:		
1	Introducing basics of electrical circuits	
2	Imparting skills of electrical drawing	
3	Knowledge of various electrical and solid-state devices	
4	Knowledge of electrical protection circuits	
5	Knowledge about different types of electrical wiring and electrical layouts.	
Course Outcomes: After the completion of this course, students will		
1.	Be able to design electrical circuits.	
2.	Gain proficiency in electrical drawing.	
3.	Have capability to use variety of electrical and solid-state devices.	
4.	Have skills of implementing variety of electrical protection circuits.	
5.	Have capability of laying down the electrical wirings and fault debugging.	
Syllabus		
Module-1	Basic Electricity Principles and Electrical Circuits Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter andammeter. Main electric circuit elements and their combination.Rules to analyze DC sourced electrical circuits. Current andvoltage drop across the DC circuit elements. Single-phase andthree-phase alternating current sources. Rules to analyze ACsourced electrical circuits. Real, imaginary and complex powercomponents of AC source. Power factor. Saving energy andmoney.	**07**
Module-2	Electrical Drawing and Symbols Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.	**04**
Module-3	Electrical and Solid-State Devices DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers, Single-phase, three- phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. : Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.	**11**
Module-4	Electrical Protection Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)	**04**
Module-5	Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire-nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.	**05**

References:

1) A text book in Electrical Technology - B L Theraja - S Chand & Co.
2) A text book of Electrical Technology - A K Theraja
3) Performance and design of AC machines - M G Say ELBS Edn.

COURSE INFORMATION SHEET

Course code: SEC401
Course title: RADIATION SAFETY
Pre-requisite(s):
Co- requisite(s):
Credits: 02 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: IV / II
Branch: PHYSICS

Code: SEC401	**Title: RADIATION SAFETY**	**L-T-P-C [2-0-0-2]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		**08**
Module-2		**08**
Module-3		**04**
Module-4		**04**
Module-5		**06**

<u>**COURSE INFORMATION SHEET**</u>

Course code: SEC405
Course title: WEATHER FORECASTING
Pre-requisite(s):
Co- requisite(s):
Credits: 02 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: IV / II
Branch: PHYSICS

Code: SEC405	**Title: WEATHER FORECASTING**	**L-T-P-C [2-0-0-2]**
Course Objectives: This course enables the students to		
1	Understand the basics of atmosphere	
2	Understanding regarding the various parameters defining weather	
3	Introduction regarding the main weather systems	
4	Introduction to climate, its classification and climate change	
5	Basics for the weather forecasting	
Course Outcomes: After the completion of this course, students will		
1.	Be able to explain the composition of atmosphere and pressure system	
2.	Be able to explain weather parameters	
3.	Be able to understand and explain dominant weather systems	
4.	Understand the importance of climate change	
5.	Learn the basic tools regarding the weather forecasting	
Syllabus		
Module-1	**Introduction to atmosphere:** Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.	**09**
Module-2	**Measuring the weather:** Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.	**04**
Module-3	**Weather systems:** Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropicalcyclones: classification; tornadoes; hurricanes.	**03**
Module-4	**Climate and Climate Change:** Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.	**06**
Module-5	**Basics of weather forecasting:** Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.	**08**

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
2. The weather Observers Handbook, Stephen Burt, 2012, CambridgeUniversity Press.
3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
4. Textbook of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers,Nagpur.
5. Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.
7. Atmospheric Sciences: An Introductory Survey- John M. Wallace and Peter V. Hobbs,University of Washington.

COURSE INFORMATION SHEET

Course code: SEC407
Course title: BASIC INSTRUMENTATION SKILLS
Pre-requisite(s):
Co- requisite(s):
Credits: 02 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: IV / II
Branch: PHYSICS

Code:	**Title: BASIC INSTRUMENTATION SKILLS**	**L-T-P-C [2-0-0-2]**
Course Objectives:		
1	To train the students on a variety of basic electrical measurements with possible accuracy and precisionfor achieving utmost reliability.	
2	To develop an understanding of working principle, internal structure, basic functionalities, and the applicability of CRO in measurements of time varying signals for their analyses.	
3	To develop an understanding on a variety of waveform generators for probing and analyzing circuits and systems.	
4	To understand the working principle of electrical bridges and their relevance viz-a-viz phase, frequencyand amplitude in performing precision measurements.	
5	To develop an insight of the pros and cons of analog and digital measuring instruments, and on measurements involving very high impedance measuring instruments to avert source loading effects.	
Course Outcomes: After the completion of this course, students will be able to		
1.	understand the relevance of measurements and their reliability and will be able to choose the appropriate measurement schema.	
2.	carry out measurements of time varying physical quantities and perform desired analyses over the acquired signals.	
3.	effectively use a variety of waveform generators to probe and perform analysis of circuits and systems.	
4.	design bridges using impedances for time dependent signals and perform measurements thereon.	
5.	effectively choose between analog and digital measuring instruments and perform reliable measurements.	
Syllabus		
Module-1	**Basic of Measurement:** Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage, dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. **Electronic Voltmeter:** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. **AC millivoltmeter**: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier-amplifier. Block diagram of ac millivoltmeter, specifications and their significance.	**08**
Module-2	**Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage, frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	**08**
Module-3	**Signal Generators and Analysis Instruments:** Block diagram, explanation and specifications of low frequency signal generator, pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.	**04**

Module-4	**Impedance Bridges & Q-Meters:** Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges	**04**
Module-5	**Digital Instruments:** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. **Digital Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.	**06**

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

COURSE INFORMATION SHEET

Course code: SEC303
Course title: COMPUTATIONAL PHYSICS SKILLS
Pre-requisite(s):
Co- requisite(s):
Credits: 02 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: IV / II
Branch: PHYSICS

Code: SEC303	**Title: COMPUTATIONAL PHYSICS SKILLS**	**L-T-P-C [2-0-0-2]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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5.		
Syllabus		
Module-1		**08**
Module-2		**08**
Module-3		**04**
Module-4		**04**
Module-5		**06**

COURSE INFORMATION SHEET

Course code: SEC307
Course title: RENEWABLE ENERGY AND ENERGY HARVESTING
Pre-requisite(s):
Co- requisite(s):
Credits: 02 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: IV / II
Branch: PHYSICS

Code: SEC307	**Title: RENEWABLE ENERGY AND ENERGY HARVESTING**	**L-T-P-C [2-0-0-2]**
Course Objectives:		
1	The objective of this multidisciplinary course is to address one of the most critical socio-economic issues of our time, affordable and sustainable energy.	
2	Familiarizing with the basics of solar and wind energies.	
3	Learning about ocean and geothermal energies.	
4	Gaining knowledge of hydro and piezoelectric energies.	
5	Learning the use of electromagnetic energy and experiments on renewable energies.	
Course Outcomes: After the completion of this course, students will be able to		
1.	This course will provide the basic knowledge and information in sustainable and renewable energy,and different important approaches.	
2.	Realizing the significance and applications of solar and wind energies.	
3.	Understanding the principal benefits and basic issues related to ocean and geothermal energies.	
4.	Ability to recognize the importance of hydro and piezoelectric energies and its drawbacks.	
5.	To acknowledge the need and relevance of electromagnetic energy, current technology status and new opportunities for energy harvesting and to inspire further interest in related research and development.	
Syllabus		
Module-1	**Fossil fuels and Alternate Sources of energy:** Fossil fuels andnuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion,biogas generation, geothermal energy tidal energy, hydroelectricity.	**04**
Module-2	**Solar energy**: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications ofsolar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **Wind Energy harvesting**: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.	**08**
Module-3	**Ocean Energy**: Ocean Energy Potential against Wind and Solar,Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, OceanThermal Energy, Osmotic Power, Ocean Bio-mass. **Geothermal Energy**: Geothermal Resources, GeothermalTechnologies.	**07**
Module-4	**Hydro Energy**: Hydropower resources, hydropower technologies,environmental impact of hydro power sources. **Piezoelectric Energy harvesting**: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectricenergy harvesting applications, Human power.	**06**

Module-5	**Electromagnetic Energy Harvesting**: Linear generators, physicsmathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy,sustainability. **Demonstrations and Experiments** 1. Demonstration of Training modules on Solar energy, windenergy, etc. 2. Conversion of vibration to voltage using piezoelectricmaterials 3. Conversion of thermal energy into voltage usingthermoelectric modules.	**05**

Textbooks:

- (**T1**) Solar energy - Suhas P Sukhatme and J K Nayak, McGraw Hill Education (India)Private Limited, Third Edition (2013)
- (**T2**) Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004,Oxford University Press, in association with The Open University.
- (**T3**) Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

References:

- (**R1**) Solar energy - M P Agarwal - S Chand and Co. Ltd.
- (**R2**) Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- (**R3**) J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
- (**R4**) Research articles

COURSE INFORMATION SHEET

Course code: SEC403
Course title: APPLIED OPTICS
Pre-requisite(s):
Co- requisite(s):
Credits: 02 L: 2 T:0 P: 0
Classes schedule per week: 2
Class: I.M.Sc.
Semester / Level: IV / II
Branch: PHYSICS

Code: SEC403	Title: APPLIED OPTICS	L-T-P-C [2-0-0-2]
Course Objectives: This course enables the students to		
1	identify conditions for the lasing phenomenon and properties of the laser.	
2	Familiarizing with the basic techniques of Fourier optics and its applications.	
3	understand the basics of holography and its applications.	
4	Understand the basics of fiber optics communication system.	
Course Outcomes: After the completion of this course, students will be able to		
1.	evaluate conditions for lasing phenomenon and properties of the laser	
2.	be able to use Fourier optics in image processing.	
3.	Knowledge about holography and its different uses in industries.	
4.	have an idea how today's communication system works.	
Syllabus		
Module-1	Lasers, Spontaneous and stimulated emissions, Theory oflaser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers. **Experiments on Lasers:** a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid-state laser. b. To find the width of the wire or width of the slit usingdiffraction pattern obtained by a He-Ne or solid-state laser. c. To find the polarization angle of laser light usingpolarizer and analyzer d. Thermal expansion of quartz using laser. **Experiments on Semiconductor Sources and Detectors** a. V-I characteristics of LED b. Study the characteristics of solid-state laser. c. Study the characteristics of LDR. d. Photovoltaic Cell e. Characteristics of IR sensor	**09**
Module-2	**Fourier Optics** Concept of Spatial frequency filtering, Fouriertransforming property of a thin lens **Experiments on Fourier Optics:** **a. Fourier optic and image processing** 1. Optical image addition/subtraction 2. Optical image differentiation 3. Fourier optical filtering 4. Construction of an optical 4f system **b. Fourier Transform SpectroscopyExperiment:** To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fouriertransform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters.Computer simulation can also be done.	**06**

Module-3	**Holography** Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, applicationof holography in microscopy, interferometry, and character recognition **Experiments on Holography and interferometry:** 1. Recording and reconstructing holograms 2. Constructing a Michelson interferometer or a FabryPerot interferometer 3. Measuring the refractive index of air 4. Constructing a Sagnac interferometer 5. Constructing a Mach-Zehnder interferometer 6. White light Hologram	**06**
Module-4 & Module-5	**Photonics: Fiber Optics** Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Singlemode and multimode fibres, Fibre optic sensors: Fiber Bragg Grating **Experiments on Photonics: Fiber Optics** a. To measure the numerical aperture of an optical fiber b. To study the variation of the bending loss in amultimode fibre c. To determine the mode field diameter (MFD) offundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern d. To measure the near field intensity profile of a fibre and study its refractive index profile e. To determine the power loss at a splice between two multimode fibres.	**09**

Textbooks:

1. Principles of Lasers, O. Svelto. Springer.
2. Laser Fundamentals William T Silfvast, Cambridge University Press.
3. Introduction to Fourier Optics, Joseph W Goodman,
4. Optical Holography, Principle, Techniques and Application P Hariharan CambridgeUniversity Press.
5. Introduction to Fiber Optics: A.K. Ghatak and K. Thayagarajan, CambridgeUniversity press

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH307
Course title: EXPERIMENTAL TECHNIQUES
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V /III
Branch: PHYSICS

Code: PH307	**Title: EXPERIMENTAL TECHNIQUES**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	The course on *Experimental techniques* is designed to cater need of understanding of basic instrumentation to learners.	
2	Module-1 contains information about various measurement parameters like precession, accuracy and curve fitting.	
3	Under 2nd Module knowledge about variety of signals, frequency response of systems and noise measurements would be transferred.	
4	Module-3 contains information about working, efficiency and applications of Transducers and sensors.	
5	The 4th module contains knowledge about working and construction of digital multimeter, impedance bridges and Q-meter	
6	The working, construction and efficiency of variety of vacuum pumps and techniques of vacuum level measurement are topic of 5th module	
Course Outcomes: After the completion of this course, students will be able to		
1.	The course intends to impart knowledge of basic instrumentation tools and techniques to physics undergraduates, so that they can conceive / design experiments to test physic principles.	
2.	Leaners would gain knowledge of accuracy, precession and types of errors.	
3.	Students would also gain knowledge of type of signals, variety of noise types and methods of grounding/ shielding.	
4.	Course intends to impart knowledge of variety of transducers / sensors required for industrial instrumentation.	
5.	Working and design of digital multimeters and bridges is planned to be covered in this course.	
6.	Knowledge about variety of vacuum pumps and vacuum measurement techniques will enrich the learners about vacuum techniques: one of the basic experimental skill required to understand working / experiments of variety of branches of physics and engineering like low-temperature physics (cryogenics), ion-beam physics, semiconductor growth and devices and nuclear instrumentation.	
Syllabus		
Module-1	**Measurements:** Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution	**08**
Module-2	**Signals and Systems:** Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise. **Shielding and Grounding:** Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference	**08**

Module-3	**Transducers & industrial instrumentation (working principle, efficiency, applications):** Static and dynamic characteristics of measurement Systems. Generalized performance of systems, zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.	**14**
Module-4	**Digital Multimeter:** Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement. **Impedance Bridges and Q-meter:** Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.	**10**
Module-5	**Vacuum Systems:** Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).	**10**

Text books:

T1: Albert D. Helfrick and William David Cooper, Modern Electronic Instrumentation and Measurement Techniques, PEARSON INDIA

T2: Thomas L. Floyd. Electronic Device. 9th Edition. Prentice Hall.

T3: Louis Nashelsky and Robert Boylestad, Electronic Devices and Circuit Theory

Reference books:

R1: H. S. Kalsi, Electronic Instrumentation, McGraw Hill

COURSE INFORMATION SHEET

Course code: PH314R1
Course title: EXPERIMENTAL TECHNIQUES LAB
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V / III
Branch: PHYSICS

Code: PH314R1	**Title: EXPERIMENTAL TECHNIQUES LAB**	**L-T-P-C [0-0-3-1.5]**

Course Objectives: This course enables the students to

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Course Outcomes: After the completion of this course, students will be able to

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List of Experiments

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. To measure the change in temperature of ambient using Resistance TemperatureDevice (RTD).
8. Create vacuum in a small chamber using a mechanical (rotary) pump and measure thechamber pressure using a pressure gauge.
9. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
10. To design and study the Sample and Hold Circuit.
11. Design and analyze the Clippers and Clampers circuits using junction diode.
12. To plot the frequency response of a microphone.
13. To measure Q of a coil and influence of frequency, using a Q-meter

Reference Books:

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill
3. Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Man singh, 2005, PHI Learning.

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH306
Course title: MATERIALS SCIENCE AND NANOTECHNOLOGY
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V /III
Branch: PHYSICS

Code: PH306	**Title: MATERIALS SCIENCE AND NANOTECHNOLOGY**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	Outline the basics of crystallography and define various types of imperfections in crystals.	
2	Explain elastic and plastic deformation in solids and summarize the strain hardening mechanisms.	
3	Define ceramics and explain its types and applications.	
4	Define polymers and composites and categorize them on the basis of their applications.	
5	Define Nanotechnology and outline the various properties of nano materials and their fabrication techniques.	
Course Outcomes: After the completion of this course, students will be able to		
1.	explain various types of imperfections in crystals.	
2.	analyze the mechanisms behind elastic and plastic deformation is solids and compare different strengthening techniques.	
3.	summarize ceramics and its types and relate their applications with properties.	
4.	classify polymers and composites based on their properties and applications.	
5.	Classify nanomaterials, their fabrication techniques and co relate the effects of confinement to nanoscale on their properties.	
Syllabus		
Module-1	**Imperfections in solids and elastic deformation** Introduction to crystallography, types of imperfections, point defects, edge dislocation, screw dislocation, mixed dislocation, Burger's vector, dislocation density, surface defects, grains, grain boundary, volume defects.	**08**
Module-2	**Elastic and Plastic deformation** Elastic deformation, Hooke's law, atomic view of elasticity, anelasticity, elastic moduli plastic deformation, yield point phenomena, slip, slip systems, resolved shear stress, plastic deformation of single crystals and polycrystalline materials, strain hardening, annealing, recovery, recrystallization, grain growth, introduction to fracture, fatigue, creep.	**10**
Module-3	**Ceramics** Ceramic structures, imperfections in ceramics, mechanical properties of ceramics, types and applications of ceramics, advanced ceramics and their applications.	**07**
Module-4	**Polymers and composites** Polymer structure, Thermoplastic and Thermosetting polymers, Copolymers, Polymer crystallinity, Mechanical behaviour of polymers, Types of polymers and their applications, Advanced polymers and their application, **Composites:** General properties, and applications of composites, Classification of composite materials: Particles-reinforced Fibre-reinforced and Structural composites, Influence of fibre length & orientation on the mechanical properties of fibre-reinforced composites.	**07**

Module-5	**Nanotechnology** Quantum well, wire and dots, Properties of nanomaterials, Synthesis routes of nano materials: Bottom-up approaches, Top-down approaches, Consolidation of nanopowders, Applications of nanomaterials: Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nanosensors, Nanocatalysts, medical Applications, Energy Structural Applications.	**08**

Textbooks:

1. W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 6th Edition, 2003.
2. W. F. Smith, Principles of Materials Science and Engineering, McGraw Hill International, 1986.
3. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, John Wiley & Sons, 2013.

Reference books:

1. The Structure and Properties of Materials, Wiley Eastern
   Vol. –I, Moffatt, Pearsall and Wulff
   Vol. –III, Hayden, Moffatt and Wulff

2. Physical Properties of Materials, M. C. Lovell, A. J. Avery, M. W. Vernon, ELBS

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH313R1
Course title: MATERIALS SCIENCE AND NANOTECHNOLOGY LAB
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V / III
Branch: PHYSICS

Code: PH313R1	**Title: MATERIALS SCIENCE AND NANOTECHNOLOGY LAB**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus

List of Experiments

1. Nano crystalline or ultra nano crystalline thin film preparation using Microwave Plasma Enhanced Chemical Vapor Deposition
2. Particle size analysis of broad nano peaks of XRD or GXRD.
3. Optical analysis of given nanocrystalline sample
4. Preparation of nano particles using ball milling
5. Measurement of nano hardness of given thin film
6. Raman analysis of given nano sample
7. Preparation of thin film using Anodic Vacuum Arc technique
8. Measurement of thickness of deposited thin film
9. Determination of the surface area of nano materials by the BET method Brunauer–Emmett–Teller (BET) technique.
10. Measurement of Contact angle of hydrophobic and hydrophilic nano thin film or powder.
11. Synthesis of ZnO nano particle using chemical route

COURSE INFORMATION SHEET

Course code: PH320R1
Course title: ATMOSPHERIC PHYSICS
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V /III
Branch: PHYSICS

Code: PH320R1	**Title: ATMOSPHERIC PHYSICS**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To explains the various component of the Earth system specially atmosphere and to understand the physics associated with atmospheric phenomenon.	
2	To understand the dynamics associated with the atmospheric motion	
3	To appreciate the basic laws associated with the solar radiation and remote sensing	
4	To understand the basic instruments based on the remote sensing	
5	To enlighten atmospheric aerosols and related laws to govern its role in atmosphere	
Course Outcomes: After the completion of this course, students will be able to		
1.	Be able to explain thermal structure of earth, composition of atmosphere and various atmospheric phenomenon	
2.	Be able to explain the dynamics of atmospheric motion	
3.	Be able to appreciate the laws of atmospheric radiation balance and basic laws of remote sensing.	
4.	Get familiar with instruments based on remote sensing	
5.	Acquire knowledge of atmospheric aerosols and its impact	
Syllabus		
Module-1	**General features of Earth's atmosphere:** Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations.	**08**
Module-2	**Atmospheric thermodynamics** Laws of thermodynamics, Virtual Temperature, Entropy, Potential Temperature, Moisture variables, Claussius – Clapeyron Equation, Hydrostatic equilibrium **Atmospheric Instability** Lapse rates, Stability and Instability for unsaturated and saturated air, Conditional instability, Lifting Condensation level, level of free convection, Convective available potential energy, Convective inhibition energy.	**10**
Module-3	**Atmospheric Dynamics:** Scale Analysis, Fundamental Forces, Non-inertial Reference Frames and "Apparent" Forces, Structure of The Static Atmosphere**,** Basic Conservation Laws, Total Differentiation, Total Differentiation of a Vector in a Rotating System, The Vectorial Form of The Momentum Equation in Rotating Coordinate System, The Continuity Equation, The Thermodynamic Energy Equation.	**08**

Module-4	**Atmospheric radiation and remote sensing:** Fundamental laws of radiation: Planks law, Stefan's Boltzmann law, Wien's displacement law, Kirchhoff's law; Spectral distribution of solar radiation and atmosphere interaction, path radiance, Radiation budget, Atmospheric windows, optical depth, Single scattering, Multiple scattering, **Atmospheric Aerosols:** Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Lambert's and Beer's laws, Radiative and health effects.	**10**
Module-5	**Atmospheric Radar and Lidar:** Active and Passive remote sensing, Types of satellites Radar equation and return signal, Various type of atmospheric radars, Lidar and its applications.	**04**

Text/Reference Books:

T1: Atmospheric Science : An Introductory Survey ,Second Edition -John M.Wallace and Peter V. Hobbs, University of Washington

R2: Atmospheric chemistry and physics: from air pollution to climate change, Second edition- John H. Seinfeld, Spyros N. Pandis, a wiley-interscience publication, john wiley & sons, inc.

R3: An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004

R4: Radar for meteorological and atmospheric observations – S. Fukao and K. Hamazu, Springer Japan, 2014

R5: Fundamentals of Remote Sensing, George Joseph and Jeganathan, c. (2017). 3rd Edition, Universities Press, ISBN 978 93 86235 46 6

COURSE INFORMATION SHEET

Course code: PH325R1
Course title: ATMOSPHERIC PHYSICS LAB
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: V / III
Branch: PHYSICS

Code: PH325R1	**Title: ATMOSPHERIC PHYSICS LAB**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus

List of Experiments

1) Monitoring and estimation of Respirable Suspended Particulate Matter in the ambient air by respirable dust sampler.
2) Monitoring and estimation of NO_x in the ambient air by NO_x analyzer.
3) Monitoring and estimation of SO_x in the ambient air by High Volume Sampler.
4) Monitoring and estimation of CO in the ambient air by CO analyzer.
5) Monitoring and analysis of CO_2 in the ambient air by CO_2 monitor.
6) Statistical analysis for one month data of atmospheric parameters (Temperature, Relative humidity, pressure, wind speed)
7) Computational analysis for few months data of atmospheric parameters i.e. Temperature, Relative humidity, pressure, wind speed (find daily variation, diurnal variation, wind rose)
8) Estimation and analysis of aerosol optical with satellite data
9) Estimation of analysis of aerosol related properties from AERONET data of any site
10) Estimation and analysis of Sea surface temperature with satellite data
11) Estimation and analysis of Outgoing longwave radiation with satellite data
12) Calculation of color temperature by Planck law

COURSE INFORMATION SHEET

Course code: CS263
Course title: Data Structures and Algorithm
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in CS or M&C
Semester / Level: V /III
Branch: PHYSICS

Code: CS263	**Title: Data Structures and Algorithm**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		**08**
Module-2		**08**
Module-3		**04**
Module-4		**04**
Module-5		**06**

<u>**COURSE INFORMATION SHEET**</u>

Course code: CS264
Course title: Data Structures and Algorithm Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: Minor in CS or M&C
Semester / Level: V / III
Branch: PHYSICS

Code: CS264	**Title: Data Structures and Algorithm Lab**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		**08**
Module-2		**08**
Module-3		**04**
Module-4		**04**
Module-5		**06**

COURSE INFORMATION SHEET

Course code: EC303R1
Course title: Microprocessor and Microcontroller
Pre-requisite(s): Digital system Design
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in EC
Semester / Level: V /III
Branch: PHYSICS

Code: EC303R1	**Title: Microprocessor and Microcontroller**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	To explain the basic building blocks of a Microprocessor/ Microcontroller architecture and the operation with relevant timing diagrams.	
2	To demonstrate the knowledge of different addressing modes and instruction set of a Microprocessor/ Microcontroller in developing efficient programing logic.	
3	To develop the interfacing circuits for different applications with appropriate peripherals.	
4	To analyze the evolution of Microprocessor/Microcontroller and compare the different features.	
5	To design a Microprocessor/ Microcontroller based system suitable for industrial applications.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Define the architectural differences between Microprocessor and Microcontroller.	
2.	Apply the programming concepts for the design of efficient codes.	
3.	Make use of different I/O chips for the desired application by programming them in different modes.	
4.	Illustrate the advancements made to the recent generations Microprocessor/ Microcontroller.	
5.	Develop Microprocessor/ Microcontroller based products to meet the industrial requirements.	
Syllabus		
Module-1	Revision of logic circuits with emphasis on control lines, SAP concepts with stress on timing diagrams, Microinstructions, Microprogramming, Variable machine cycle, Architecture of 8085 Processor, Functions of all signals, Bus concepts, Multiplexed and De-multiplexed Bus. Instruction set, Addressing modes, Timing diagrams. FEO.	**08**
Module-2	8085 Programming examples on Time delay, Looping, Sorting and Code conversions. 8085 based Microcomputer system, Memory Organization, Memory Interfacing, Memory Mapped I/O, I/O Mapped I/O, Interrupts, Hardware and Software Interrupts, Interrupt instructions, Programmed I/O, Interrupt driven I/O, and DMA.	**08**
Module-3	Introduction to 16-bit processor, 8086 architectures, BIU and EU, Pin description, Maximum and Minimum Mode, Instruction set, Addressing modes. Memory organization, Advantages of memory segmentation, Memory banking (even and odd), Programming Examples.	**08**
Module-4	Introduction of programmable peripheral interfacing (PPI), Architecture of 8255, Modes of operation, ADC 0801/0808, and its interfacing with 8085/86, DAC 0808 and its interfacing with 8085/86, Sample and Hold. DAS architecture and its programming in automation application. 8253(PIT), Modes of operation, Programming examples.	**08**
Module-5	Introduction to Microcontrollers: Architecture of 8051, Memory structure. Pin descriptions, Instruction set, Addressing modes. Programming examples for simple control applications.	**08**

Textbooks:

1. Digital Computer Electronics, 2/e. by A. P. Malvino.
2. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
3. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.
4. The 8051 Microcontroller and Embedded System by Muhammad Ali Mazidi.
5. ARM architecture reference manual, 2/e by David Seal.

Reference books:

1. Intel Manual's for 8085, 8086, 8051 and other peripheral chips.
2. Advanced Microprocessor" by Y. Rajasree.
3. Microprocessor and Interfacing, Programming of Hardware" by Douglas Hall.

COURSE INFORMATION SHEET

Course code: EC304R1
Course title: Microprocessor and Microcontroller Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: Minor in EC.
Semester / Level: V / III
Branch: PHYSICS

Code: EC304R1	**Title: Microprocessor and Microcontroller Lab**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students		
1	To develop efficient 8085 based program for different tasks.	
2	To develop efficient 8086 based program for different tasks.	
3	To develop efficient 8051μc based program for different tasks.	
4	To build interfacing circuits for different tasks.	
5	To be able to develop microprocessor and microcontrollers based systems for industrial applications.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Demonstrate the programming concepts of 8085/8086/8051 for efficient coding.	
2.	Show the interfacing of different peripherals with 8085/8086/8051.	
3.	Analyse the output of different peripherals when programmed in different modes using 8085/8086/8051.	
4.	Develop the interfacing circuits for different applications with appropriate peripherals.	
5.	Design 8085/8086/8051 based system for various real time applications.	

Syllabus

Lab is the application of the theory (i.e., hands-on experiments related to the course contents). Therefore, **EC303 Microprocessors and Microcontrollers** is the syllabus for the **EC304 Microprocessors and Microcontrollers Lab**. Following experiments are the guidelines for the students. However, the questions for exams are not limited to this experiment list.

List of experiments:

8085 AND 8086 PROGRAMMING

1. Name of the Experiment

Data Transfers
Aim1: REARRANGING BYTES
Aim2: GROUPING ODD, EVEN, DIVIDE BY 4 AND DIVIDE BY 16 BYTES
Aim3: FORMATION OF A THIRD BLOCK
Aim4: FILLING UP 128 LOCATIONS

2. Name of the Experiment

Arithmetic Operations
Aim1: ADDITION OF 12 BYTES
Aim2: MULTIPLICATION OF SINGLE BYTE BY SINGLE BYTE
Aim3: ADDITION OF 18 BCD NO'S **Aim4:** ADDITION OF TWO 10-BYTE NO'S
Aim5: ADDITION OF TWO 20-DIGIT BCD NO's:
Aim6: BCD SUBTRACTION
Aim7: MULTIPLICATION OF TWO 5-BYTE BINARY NUMBERS
Aim8: BCD MULTIPLICATION
Aim9: BINARY DIVISION

3. Name of the Experiment

Logical Operations
Aim1: CHECKING BITS OF A WORD

Aim2: LOGICAL OPERATION

4. Name of the Experiment
Data Processing
Aim1: NUMBER OF BITS IN BYTES
Aim2: MAXIMUM AND MINIMUM BYTES
Aim3: SIZE OF A BLOCK ENDING WITH A SPECIFIED BYTE
Aim4: SIZE OF A BLOCK STARTING WITH 00H AND ENDING WITH 60H
Aim5: SIZE OF A BLOCK ENDING WITH THREE ALTERNATE 00H
Aim6: NUMBER OF TIMES FFH OCCURS AS PAIR
Aim7: CONSECUTIVE MEMORY LOCATIONS WITH IDENTICAL DATA
Aim8: COUNT OF SPECIFIED BYTES
Aim9: ADDRESS OF LAST NON-BLANK CHARACTER
Aim10: REPLACING TRAILING ZEROS WITH BLANKS
Aim11: ADDING EVEN PARITY TO ASCII CHARACTERS
5. Name of the Experiment

Sorting
Aim1: SORTING IN DESCENDING ORDER
Aim2: SORTING EVEN AND ODD PARITY BYTES
Aim3: SORTING SIGNED BYTES
Aim4: SORTING SIGNED BINARY BYTES IN ASCENDING ORDER
6. Name of the Experiment

String Operations
Aim1: COMPARISON OF TWO ASCII STRINGS
Aim2: AN ASCII STRING TO BYTE CONVERSION
Aim3: INSERTION TO A LIST

7. Name of the Experiment
Parallel Communication
Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING 8255.
Aim2: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA THROUGH PORT A OF 8255 IN MODE – 0
Aim3: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8-BIT DATA THROUGH PORT A OF 8255 IN MODE – 1 THROUGH STATUS CHECK.
Aim4: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING 8253.
Aim5: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO GENERATE TRIANGULAR WAVE USING DAC 0808.
Aim6: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO GENERATE SAW TOOTH WAVE OF MAGNITUDE 0 VOLT TO +4 VOLTS USING DAC 0808.
Aim7: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONVERT ANALOG SIGNALS OF MAGNITUDE +3.5 VOLTS TO +5 VOLTS IN STEPS OF 0.1 VOLTS TO DIGITAL EQUIVALENT HEX VALUES.
Aim8: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONTROL THE SPEED OF STEPPER MOTOR USING 8255 PPI.
Aim9: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CONTROL THE TRAFFIC LIGHTS USING 8255 PPI
8. Name of the Experiment

Serial Communication
Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR GENERATION OF SQUARE WAVE USING SERIAL OUTPUT PIN
Aim2: WRITE AN ASSEMBLY LANGUAGE PROGRAM FOR INPUTTING AN 8- BIT DATA SERIALLY THROUGH SERIAL INPUT PIN.

9. Name of the Experiment

Interrupts
Aim1: To study the software and hardware interrupts of 8085.
Aim2: To study the Interrupt controller 8259.
Aim3: To study the Interrupt features of 8051.

10. Name of the Experiment Timers
Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO CALCULATE THE CONVERSION TIME OF ADC USING 8253 TIMER.
Aim2: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO OBSERVE WAVEFORMS OF 8253 TIMER IN DIFFERENT MODES.
11. Name of the Experiment

Keyboard and Display
Aim1: WRITE AN ASSEMBLY LANGUAGE PROGRAM TO FLASH AND ROTATE "HELP US" USING 8259 PIC.
12. Name of the Experiment

Code Conversion
Aim1: BINARY TO BCD CONVERSION
Aim2: BCD TO BINARY CONVERSION
Aim3: CONVERSION OF NIBBLES TO ASCII CODES
Aim4: ASCII TO HEXADECIMAL CONVERSION

Textbooks:

1. Microprocessor Architecture, Programming and Applications with 8085 by R. S. Gaonkar.
2. Advanced Microprocessors and Peripherals by K. M. Bhurchandi and A. K. Ray.
3. The 8051 Microcontroller and Embedded System by Muhammad Ali Mazidi.

Reference books:

4. Intel Manual's for 8085, 8086, 8051 and other peripheral chips.
5. Advanced Microprocessor" by Y. Rajasree.
6. Microprocessor and Interfacing, Programming of Hardware" by Douglas Hall.

COURSE INFORMATION SHEET

Course code: EE102
Course title: Electrical Engineering Lab
Pre-requisite(s): Physics, Fundamentals of Mathematics and Electrical Engineering.
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: Minor in EE
Semester / Level: V / III
Branch: PHYSICS

Code: EE102	**Title: Electrical Engineering Lab**	**L-T-P-C [0-0-3-1.5]**

Course Objectives: This course enables the students

1	To describe students' practical knowledge of active and passive elements and operation of measuring instruments.
2	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems.
3	To establish voltage & current relationships with the help of phasors and correlate them to experimental results.
4	To conclude performance of 1 – Φ AC series circuits by resonance phenomena.
5	To evaluate different power measurement for both 1-φ and 3- φ circuits.

Course Outcomes: After the completion of this course, students will be able to

1.	classify active and passive elements, explain working and use of electrical components, different types of measuring instruments.
2.	illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine.
3.	measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations.
4.	analyze response of a circuit and calculate unknown circuit parameters.
5.	recommend and justify power factor improvement method in order to save electrical.

Syllabus

LIST OF EXPERIMENTS ***(The experiment list may vary to accommodate recent development in the field)***

1. **Name:** Measurement of low & high resistance of DC shunt motor

Aim:
(i) To measure low resistance of armature winding of DC shunt motor
(ii) To measure high resistance of shunt field winding of DC shunt motor

2. **Name:** AC series circuit

Aim:
(i) To obtain current & voltage distribution in AC RLC series circuit and to draw the phasor diagram
(ii) To obtain power & power factor of single-phase load using 3- Voltmeter method and to draw phasor diagram.

3. **Name:** AC parallel circuit

Aim:
(i) To obtain current & voltage distribution in AC RLC parallel circuit and to draw the phasor diagram
(ii) To obtain power & power factor of single-phase load using 3- Ammeter method and to draw the phasor diagram

4. **Name:** Resonance in AC RLC series circuit

Aim:
(i) To obtain the condition of resonance in AC RLC series circuit
(ii) To draw phasor diagram

5. **Name:** 3 phase Star connection

Aim:
(i) To establish the relation between line & phase quantity in 3 phase star connection
(ii) To draw the phasor diagram

6. **Name:** 3 phase Delta connection

Aim:
(i) To establish the relation between line & phase quantity in 3 phase delta connection
(ii) To draw phasor diagram
7. **Name:** 3 phase power measurement

Aim:
(i) To measure the power input to a 3-phase induction motor using 2 wattmeter method
(ii) To draw the phasor diagram
8. **Name:** Self & mutual inductance

Aim: To determine self & mutual inductance of coils
9. **Name:** Verification of Superposition, Thevenin's and the Reciprocity theorem

Aim:
(i) To verify the Superposition theorem for a given circuit
(ii) To verify Thevenin's theorem for a given circuit
10. **Name:** Verification of Norton's, Tellegen's and Maximum Power transfer theorem

Aim:
(i) To verify Norton's theorem for a given circuit
(ii) To verify the Maximum Power transfer theorem for a given circuit

COURSE INFORMATION SHEET

Course code: EE201
Course title: Electrical Measurement and Instrumentation
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in EE
Semester / Level: V /III
Branch: PHYSICS

Code: EE201	**Title: Electrical Measurement and Instrumentation**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To outline the students an idea of calibration, standards, different errors, static and dynamic performance characteristics.	
2	To explain the operating principle of different analog and digital instruments used for electrical parameter measurement.	
3	To classify and outline the operation and construction of various a.c. and d.c. bridges for measurement and display devices.	
4	To state the basic principle of commonly available transducers and their uses for measuring different electrical or non-electrical variables.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Identify and analyze errors and state the static and dynamic characteristics of instruments.	
2.	Explain the working of different analog instruments (PMMC, Moving iron, electrodynamometer type) and their use for measuring voltage, current, power, phase and frequency.	
3.	Show how to balance and design different bridge networks to find the value of unknown components.	
4.	State the working of digital instruments, display devices and recorders.	
5.	Reproduce the different working principles of transducers and also design transducers for measurement of non-electrical quantities.	
Syllabus		
Module-1	Introduction: Definition of measurement, Generalized input-output configuration of measuring instruments and instrumentation systems. Performance characteristics (static and dynamic), Accuracy, Precision, Types of error, Statistical analysis, Standards of measurement. Systems of units. Fundamental and derived units. Dimensions.	**05**
Module-2	Instruments: Basic requirement of a measuring instrument. Introduction to D' Arsonval galvanometer, Construction and principle of Moving coil, Moving iron, Induction types of instruments, Measurement of voltage, current and power, phase, frequency, Range extension including current and potential transformers. Digital voltmeter, vector voltmeter, Vector Impedance meter and Q-meter.	**10**
Module-3	Bridge: DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Wien's bridges. Measurement of frequency, localization of cable fault. Potentiometers: DC and AC potentiometers, Principles, Standardization and application.	**09**
Module-4	Oscilloscopes: CRT, Construction, Basic CRO circuits, Block diagram of a modern oscilloscope, Y-amplifiers, X-amplifiers, Triggering, Oscilloscopic measurement. Special CRO's: Dual trace, Dual beam, Sampling oscilloscope, Storage CROs. Display Devices & Recorders: Digital display, LED, LCD, Strip chart recorder, X-Y recorder.	**10**
Module-5	Transducers: Classification, Inductive, Resistive and Capacitive transducers, Analog and Digital Transducers with applications. Hall effect, Piezo Electric, Photovoltaic transducer. Measurement of temperature and pressure.	**06**

Textbooks:

1. Helfrick and Cooper - Modern Electronic Instrumentation and Measurement, Pearson Education, New Delhi.
2. Sawhney A.K. - Electrical & Electronic Measurement and Instrumentation, Dhanpat Rai & Son's

Reference books:

1. Patranabis D – Sensors and Transducers, Wheeler, 1996.
2. Kalsi - Electronics Instrumentation, TMH Publication, New Delhi.
3. Deoblin – Measurement Systems.
4. Patranabis D – Principles of Industrial Instrumentation, TMH Publication, New Delhi, 1976.
5. Golding- Electrical Measurement, Wheeler Publication.

COURSE INFORMATION SHEET

Course code: PH318R1
Course title: Introduction to Nuclear and Particle Physics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH318R1	**Title: Introduction to Nuclear and Particle Physics**	**L-T-P-C [4-0-0-4]**
Course Objectives: Students will try to learn		
1	The fundamental principles governing nuclear and particle physics and have a working knowledge of their applicationto real life problems.	
2	About the subatomic physics, including radioactivity, experimental techniques, nuclear structure, particle interactions,and particle collisions and decays.	
3	Skills needed to explain how radiation detector function and use for the measurement of radioactivity.	
4	About the different types of nuclear reactors in use and how they produce nuclear energy for the useful purposes.	
5	Classification of elementary particles and their decay modes.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Understand the fundamental principles and concepts governing classical nuclear and particle physics and have aworking knowledge of their application to real -life problems.	
2.	Explain why nuclear radiations are emitted by radionuclides with very heavy atoms and understand the nature and properties of the radiations.	
3.	Explain how charged and uncharged ionizing radiations interact with matter and the effects of the interactions on the material through which they traverse.	
4.	Classify and explain the function of different nuclear reactors.	
5.	Classify elementary particles and their possible decay modes	
Syllabus		
Module-1	General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.	**16**
Module-2	Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) α-decay: energy kinematics for α-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission &kinematics, internal conversion. Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).	**12**

Module-3	Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.	**10**
Module-4	Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.	**04**
Module-5	Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.	**08**

Textbooks:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
4. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons

Reference Books

1. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
2. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

COURSE INFORMATION SHEET

Course code: PH327R1
Course title: Nuclear and Particle Physics Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH327R1	Title: Nuclear and Particle Physics Lab	L-T-P-C [0-0-3-1.5]
Syllabus		

COURSE INFORMATION SHEET

Course code: PH203R1
Course title: Classical Dynamics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IV
Branch: PHYSICS

Code: PH203R1	**Title: Classical Dynamics**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To recall the concepts of Newtonian Mechanics and Electrodynamics.	
2	To explain the concepts of generalized coordinates and to introduce the formulationof Lagrangian and Hamiltonian Mechanics.	
3	To develop the concepts of potential energy and small amplitude oscillations.	
4	To develop the foundation of special theory of relativity and Minkowski space.	
5	To build the concepts of fluid mechanics.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Solve the problems of Newtonian Mechanics and Electrodynamics.	
2.	Illustrate the formulation of Lagrangian and Hamiltonian mechanics and solve the related problems.	
3.	Solve the problems of small amplitude oscillations.	
4.	Explain the space-time diagrams, time-dilation, length contraction and twin paradox, four-velocity and acceleration, metric and alternating tensors, four-momentum and energy-momentum relation etc.,and apply these to solve the problems.	
5.	Illustrate the formulation of the basic equations in fluid mechanics like continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille’s equation, Navier-Stokes equation, etc.	
Syllabus		
Module-1	Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields.	**05**
Module-2	Generalized coordinates and velocities, Hamilton’s principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such ascoupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton’s equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.	**15**
Module-3	Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations, example of N identical masses connected in a linear fashion to (N -1) identical springs.	**10**
Module-4	Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.	**15**

Module-5	Density and pressure in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number	

Text books:

1. Classical Mechanics by H. Goldstein, Pearson Education Asia.
2. Classical Mechanics by N. C. Rana and P. S. Joag, Tata Mc-Graw Hill Publishing Company Limited,New Delhi.

Reference books:

1. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
2. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
3. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
4. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH206R1
Course title: Classical Dynamics Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH206R1	Title: Classical Dynamics Lab	L-T-P-C [0-0-3-1.5]

Syllabus

List of Experiments

(For computation purpose use Matlab, Mathematica or, Scilab)

1. Study of motion of a charged particle in a (a) transverse electric field and (b) Magneticfield?
2. Using Matlab, draw the locus of a charge particle in a (a) mutually perpendicular and (b)parallel electric and magnetic fields?
3. To determine the coupling coefficient of coupled pendulums.
4. To determine the coupling coefficient of coupled oscillators.
5. Experimental visualization of coupled modes of oscillation of LC circuits and mathematical modelling of experimentally observed results?
6. Mathematical calculation of variation of time delay and length contraction with varying speed of the particle?
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the moment of inertia of a flywheel.
9. To determine the speed of sound in air using a water filled open ended pipe.
10. To determine Coefficient of Viscosity by Stoke's method.
11. To determine Coefficient of Viscosity by rotating viscometer.
12. To determine the rate of flow of a liquid using venturimeter.
13. To determine damping coefficient of a damped harmonic oscillator.
14. To determine charge to mass ratio for electron.

COURSE INFORMATION SHEET

Course code: PH208
Course title: Elements of Modern Physics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH208	**Title: Elements of Modern Physics**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to		
1	To teach about the history of Quantum Mechanics and appreciate the necessity for initiating such a new theory	
2	To help them become conversant with the basic mathematical tools of Quantum Mechanics.	
3	To introduce preliminary concepts in nuclear physics and radioactivity.	
4	To venture further into nuclear physics and establish familiarity with the theories of stellar energy and lasers.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Understanding of concepts leading to the advent of quantum theory.	
2.	Working out simple examples using Schrodinger equation.	
3.	Getting a good grasp on the theory and simple numericals on radioactivity.	
4.	Knowledge on nuclear fission/fusion and working principle of lasers.	
Syllabus		
Module-1	Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.	**15**
Module-2 & 3	Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.	**15**
Module-4	Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino;Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.	**10**

Module-5	Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitativediscussions). Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.	**10**

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan.

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.

COURSE INFORMATION SHEET

Course code: PH211R1
Course title: Elements of Modern Physics Lab
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH211R1	Title: Elements of Modern Physics Lab	L-T-P-C [0-0-3-1.5]

Syllabus

List of Experiments

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy ofphoto-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To set up the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books

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

COURSE INFORMATION SHEET

Course code: PH304R1
Course title: Nanomaterials and Applications
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH304R1	**Title: Nanomaterials and Applications**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To become familiar with length scales in physics and their relevance for nanoscience.	
2	To be familiarized with the top down and bottom up processes for synthesis of nanomaterials.	
3	To become familiar with the various methods of characterization of nanomaterials.	
4	To become acquainted with optical properties of nanostructures and the role of quasiparticles.	
5	To develop an understanding of the quantization of charge transport in nanostructures and application of nanomaterials.	
Course Outcomes: After the completion of this course, students will be		
1.	Able to quantify the change in the energy levels as materials are confined in one, two or three dimensions.	
2.	Able to describe the various methods of nanomaterial synthesis.	
3.	Able to compare and choose from the different characterization tools available for nanomaterial characterization.	
4.	Able to relate the optical properties with the concept of quasiparticles.	
5.	Able to correlate the discrete nature of charge and energy states with the quantization of electron transport in nanostructures.	
Syllabus		
Module-1	NANOSCALE SYSTEMS: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation-Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.	**12**
Module-2	SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.	**12**
Module-3	CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy Scanning Electron Microscopy Transmission Electron Microscopy Atomic Force Microscopy Scanning Tunneling Microscopy.	**10**
Module-4	OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures.	**14**

Module-5	ELECTRON TRANSPORT: Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	**12**

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI LearningPrivate Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, CambridgeUniversity Press.
7. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

COURSE INFORMATION SHEET

Course code: PH311R1
Course title: Nanomaterials and Applications Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH311R1	**Title: Nanomaterials and Applications Lab**	**L-T-P-C [0-0-3-1.5]**

Syllabus

List of Experiments

1. Preparation of thin film using Anodic Vacuum Arc technique
2. Preparation of nano particles using ball milling
3. Nano crystalline or ultra-nano crystalline thin film preparation using Microwave Plasma Enhanced Chemical Vapor Deposition
4. Synthesis of Gold nano particle using chemical route
5. Measurement of thickness of deposited thin film, optical/weight. Quartz crystal.
6. Particle size analysis of broad nano peaks of XRD or GXRD.
7. Optical analysis of given nanomaterials sample
8. Measurement of nano hardness of given thin film
9. Raman analysis of given nano sample
10. Determination of the surface area of nano materials by the BET method Brunauer–Emmett–Teller (BET) technique.
11. Measurement of Contact angle of hydrophobic and hydrophilic thin film or powder.
12. Synthesis of ZnO nano particle using chemical route

Reference Books

1. Coating Technology Hand book, by D. Satas, A. A. Tracton, Marcel Dekker, 2001.
2. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004)
3. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
4. Surface Analysis- The principle Techniques, J. C. Vickerman, John Wiley and Sons, 1997.
5. The Materials Science of Thin Films by M. Ohring, Academic Press 1992.
6. Nanomaterials by A. K. Bandyopadhyay, New Age Publ., 2009.

COURSE INFORMATION SHEET

Course code: PH321
Course title: Advanced Experimental Techniques
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH321	Title: Advanced Experimental Techniques	L-T-P-C [4-0-0-4]
Course Objectives: This course enables the students to		
1	To provide knowledge of various types of experimental techniques used to analyze all types of materials.	
2	Students learn to analyze gaseous, liquid, amorphous and crystalline materials.	
3	They learn to analyze elemental composition, thickness of the thin film, elemental depth profiling, etc.	
4	They will know how to generate vacuum to prepare different types of materials.	
5	To understand the use and applications of vacuum systems.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Student will be able to judge that which techniques will be useful to analyze the given materials.	
2.	They can design novel experiments to take up scientific problems.	
3.	They will be able to collect, critically analyze and interpreted the data.	
4.	They can generate good quality of data and will be able to take up the industrial problems of any field.	
5.	Students learn about basics of vacuum and various pumps and their applications in R&D.	
Syllabus		
Module-1	X-ray Diffraction Methods: Classification of crystal system, Bragg's law and Laue conditions, Powder methods, crystal size analysis,Rietveld method of structural analysis, X-ray fluorescence spectroscopy, applications of emission spectra for compounds and alloys, Applications of absorption spectra for solid solutions and transitional metal compounds, Neutron spectroscopy. X-Ray Reflectivity.	**10**
Module-2	Microscopy & Spectroscopy Optical microscopy, metallurgical microscope, TEM, SEM and AFM, Atomic absorption spectrophotometer and its application to environmental analysis, UV-visible spectroscopy and its application, IR-spectroscopy and its application, AES, XPS, Introduction to RBS, SIMS, and its applications. Basic principles of ESR, Instrumentations and applications, Principle of Mossbauer spectroscopy, Isomer shift, Quadruple splitting and hyperfine interaction, applications-in determination of phases and diffusion studies.	**15**
Module-3	Thermochemical analysis Thermo analytical techniques, Instrumentation and applications of TGA, DTA, DSC.	**05**
Module-4	Electrochemical Techniques Electrochemical Instrumentation, Coulometry, polarography, cyclic voltametry, application to oxidation-reduction reaction, Principle of Corrosion, types and prevention.	**10**
Module-5	Vacuum Technology & Thin film Deposition Technique Application to Vacuum Technology, Types of vacuum pumps, different technique of thin film depositionCVD, PVD, MBE, MOCVD.	**10**

References:

1. Solid State Physics- Structure and Properties of Materials M. A. Wahab, Narosa 2015.
2. Spectroscopy, Vol. I, II and III, ed. By Straughan and Walker, John Wiley.
3. Surface Analysis – The Principal Techniques, Edited by J. C. Vickerman, John Willey & Sons
4. Instrumental Methods of Chemical Analysis By G. W. Ewing, Mcgraw –Hill Book Company
5. Vacuum Science and Technology by V.V. Rao, T.B. Gosh, K.L. Chopra, Allied Publishers, 17-Oct-1998

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH326R1
Course title: Advanced Experimental Techniques Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH326R1	**Title: Advanced Experimental Techniques Lab**	**L-T-P-C [0-0-3-1.5]**
Syllabus		

List of Experiments

1. To find corrosion rate using tafel plot.
2. To do plasma nitriding coating using nitriding system.
3. To understand the working of magnetron coating unit and deposit thin film.
4. To deposit nanocrystalline coating.
5. To deposit hard coating and determine hardness of thin film.
6. To deposit thin film using anodic vacuum arc coating.
7. Determination of elemental and structural analysis using EDX and SEM.
8. structural and particle size determination using XRD.
9. Band gap determination using UV-visible spectrometer.
10. To study the polarization vs electric field of ferroelectric materials.
11. Phase transition study of barium titanate.

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH328
Course title: Biophysics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 3 T: 1 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH328	**Title: Biophysics**	**L-T-P-C [3-1-0-4]**
Course Objectives: This course enables the students to		
1	Understanding of basics of cells and thermodynamic processes.	
2	Investigating the chemical diffusion processes and application of state functions.	
3	Exploring the genesis of bioelectricity and action potentials.	
4	Understanding influence of external radiation to the living cells.	
5	Investigating how modern devices gauge the biophysical phenomena.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Application of laws of thermodynamics.	
2.	To apply the differential equations in biological processes.	
3.	Application of physical and mathematical theorems to investigate action potentials.	
4.	Application of electromagnetic radiations to investigate tissue-matter interactions.	
5.	Application of imaging and sensing technologies to bring innovations in medical instrumentations.	
Syllabus		
Module-1	**Biophysical aspects of cell** Cell biomechanics, The Heat equation, Joule heating of tissue. Living State Thermodynamics, Thermodynamic equilibrium, first law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics.	**10**
Module-2	**Biochemical aspects of cell** Open systems and chemical thermodynamics: Enthalpy, Gibbs free energy and chemical potential, activation energy and rate constants, Diffusion and transport Maxwell-Boltzmann statistics, Fick's law of diffusion, Navier stokes equation.	**10**
Module-3	**Basic Electrophysiology** Membranes, Bioelectric current loops: Membrane current, Conduction along an intracellular path, Conduction along an intracellular path, duality, Membrane polarization: Polarized state, depolarized state, Action Potentials: Cardiac action potential, Nerve action potential, Hodgkin-Huxley model of nerve and cardiac action potential.	**10**
Module-4	**Bioelectromagnetism and Bio-photonics** Elements of electromagnetics, Interactions between Light and a Molecule, Optical Properties of Tissue, Light–Tissue Interactions, Cellular Imaging: Optical coherence Tomography, Biosensors for Medical Applications: Fiber-Optic Biosensors, Electric andoptics based glucose sensors.	**10**
Module-5	**Modeling and Instrumentation** Electrical analog of the cell, Bioelectric signals, Biopotential amplifiers, Noninvasive Arterial Blood Pressure and Mechanics, Cardiac Output Measurement, Bioelectric Impedance Measurements, Cole-Cole Model.	**10**

References:

Text books:

1. Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers, Year 2010 Edition.
2. Aspects of Biophysics, Hughe S W, John Willy and Sons. Year 1980 Edition.
3. Essentials of Biophysics by P Narayanan, New Age International. 2^{nd} Edition.

Reference books:

1. Molecular biology of the cell, Bruce Alberts, Garland Science (Taylor and Francis Group), 6^{th} Edition

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH329R1
Course title: Biophysics Lab
Pre-requisite(s): Understanding of Matlab or Mathematica
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 3
Classes schedule per week: 3
Class: I.M.Sc.
Semester / Level: VI / III
Branch: PHYSICS

Code: PH329R1	**Title: Biophysics Lab**	**L-T-P-C [0-0-3-1.5]**

Syllabus

List of Experiments

Experiments related with section 3

1. Cellular response at kilohertz frequencies
2. Cellular response at megahertz frequenciesMeasurement of macro-electricity
3. Electrocardiogram (ECG)
4. Electromyogram (EMG)
5. Electroencephalogram (EEG)

Simulation (Ansys Electromagnetic Module):

6. A 2D (two-dimensional) electrostatic problem: creating the microstrip project.
7. A 2D (two-dimensional) magnetostatic problem: creating the solenoid project.
8. Intracellular and Extracellular current measurements at kHz frequencies.
9. Intracellular and Extracellular current measurements at MHz frequencies.

Mathematical modeling (Matlab or Mathematica):

10. Analysis of nerve action potential via Hodgkin-Huxley model

Reference Books

- Ansys tutorials
- Matlab or Mathematica handbook
- Biomedical engineering handbook

COURSE INFORMATION SHEET

Course code: CS450
Course title: Mini Project
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: T:0 P: 0
Classes schedule per week:
Class: Minor in CS
Semester / Level: VII / IV
Branch: PHYSICS

Code: CS450	**Title: Mini Project**	**L-T-P-C [0-0-0-4]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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COURSE INFORMATION SHEET

Course code: EC331
Course title: Communication System
Pre-requisite(s): Good understanding of mathematical tools like integration, differentiation etc.
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in EC
Semester / Level: VII / IV
Branch: PHYSICS

Code: EC331	**Title: Communication System**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course aims to		
1	Explain basics of analog and digital communication system and various modulation- demodulation schemes.	
2	Explain the method to design analog and digital modulation-demodulation system.	
3	Explain the concept of sampling, quantization and coding required for various pulse modulation schemes.	
4	Explain to evaluate the performance of communication system in the presence of noise.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Demonstrate an understanding on communication system and representation of signals.	
2.	Demonstrate an understanding on different methods of analog and digital modulation and demodulation schemes, their design, operation and applications.	
3.	Demonstrate an understanding on multiplexing scheme and heterodyne receiver.	
4.	Evaluate the performance of communication system in the presence of noise.	
Syllabus		
Module-1	Overview of Electronic Communication Systems, Basic Blocks of Communication System, Need for Modulation, Amplitude (Linear) Modulation- AM, DSB-SC, SSB-SC, Methods of generation and detection of AM waves, DSB-SC & SSB-SC, Comparison between AM, DSB-SC and SSB-SC, Frequency Division Multiplexing.	**08**
Module-2	Angle (Non-Linear) Modulation, Frequency and Phase Modulation, NBFM, WBFM, Transmission Bandwidth of FM signals, Methods of generation of FM wave and demodulation of FM wave, Superheterodyne Receivers.	**08**
Module-3	Pulse modulation: Sampling Process, Pulse Modulation- PAM, PDM, PPM, Methods of generation and detection of PAM, PDM and PPM, Analog to Digital Conversion, Quantization Process, Pulse Code Modulation, Differential Pulse Code Modulation, Delta Modulation, Time Division Multiplexing.	**08**
Module-4	Digital Modulation and Transmission: BASK, BFSK, and BPSK- Transmitter and Receiver, M-ary PSK, M-ary FSK and QAM, Spread Spectrum Modulation and its use, PN Sequence generation and its characteristics.	**08**
Module-5	Noise in Communication System, Various Types of Noise, Noise Calculation, Equivalent Noise Bandwidth, Noise Température, Noise Figure. Shannon's Theorem, Channel Capacity, Bandwidth S/N Trade-off.	**08**

Textbooks

1. Herbert Taub, Donald L Schilling and Gautam Saha "Communication Systems" McGraw Hill Education (India), pvt. Ltd., New Delhi, 4th edition, 2013.

Reference Books

1. Simon Haykin, "Communication Systems" Wiley, 4th edition, 2001.
2. D. Roddy & J. Coolen, "Electronics Communication", 4th Edition, PHI, 2005

COURSE INFORMATION SHEET

Course code: EC332
Course title: Communication Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1 L: 0 T:0 P: 2
Classes schedule per week: 2
Class: Minor in EC
Semester / Level: VII / IV
Branch: PHYSICS

Code: EC332	**Title: Communication System Lab**	**L-T-P-C [0-0-2-1]**
Course Objectives: This course enables the students to		
1	To develop an understanding about the Analog Modulation Techniques, V-F conversion and Butterworth LPF.	
2	To develop an understanding about the signal sampling, quantization and its reconstruction.	
3	To develop an ability to understand and design the various waveform coding techniques.	
4	To develop an ability to evaluate and design various digital modulation Techniques.	
5	To develop an ability to evaluate and design Time Division Multiplexing Technique.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Demonstrate understanding of the various Analog Modulation Techniques, V-F conversion and Butterworth LPF.	
2.	Analyse the signal sampling, quantization and its reconstruction.	
3.	Design the generation and detection of various waveform coding techniques such as PCM, DM and ADM.	
4.	Design the modulators and demodulators for various digital modulation techniques such as ASK, PSK, FSK, QPSK, and QAM.	
5.	Design system for Time Division multiplexing Technique.	

Syllabus

List of Compulsory experiments:

1. Name of the Experiment: Generation and detection of Amplitude Modulated
AIM-1: Generation and detection of Amplitude Modulated wave and calculation of percentage modulation using ACL 01 and ACL 02 Kits
AIM-2: Design of Amplitude Modulation, DSB-SC, and SCB-SC Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.

2. Name of the Experiment: : **Generation and detection of Frequency Modulated wave**
AIM-1: Generation and detection of Frequency Modulated wave using ACL 03 and ACL 04 FM trainer Kits
AIM-2: Design of Frequency Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.

3. Name of the Experiment: Generation and detection of PAM, PWM, PPM
AIM-1: Generation and detection of PAM, PWM, PPM using DCL 08 Falcon kit.
AIM-2: Design of PAM, PWM, PPM Modulation and Demodulation Systems using ALTAIR Solid Thinking Embed/Comm.

4. Name of the Experiment: Design and implementation of 2nd and 4th order Low pass Butterworth filters
AIM-1: Design and implementation of 2nd and 4th order Low pass Butterworth filters using Multisim.
AIM-2: Design and implementation of 2nd and 4th order Low pass Butterworth filters.

5. Name of the Experiment: Investigation of Signal Sampling and Reconstruction
AIM-1: Investigation of Signal Sampling and Reconstruction using DCL 01 Falcon kit
AIM-2: Investigation of Signal Sampling and Reconstruction using ALTAIR Solid Thinking Embed/Comm.

6. Name of the Experiment: Investigation of TDM system
AIM-1: Investigation of TDM system using DCL02 Falcon kit

7. Name of the Experiment: Investigation of practical PCM system
AIM-1: Investigation of practical PCM system using DCL03 and DCL04 Falcon kit

8. Name of the Experiment: Investigation of Delta Modulation system
AIM-1: Investigation of Delta Modulation and Adaptive Delta modulation system using DCL07 Falcon kit

9. Name of the Experiment: Investigation of ASK, FSK, PSK modulation/demodulation
AIM-1: Investigation of ASK, FSK, PSK modulation/demodulation using trainer kits
AIM-2: Design of ASK, PSK, FSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

10. Name of the Experiment: Investigation of MSK modulation/demodulation
AIM-1: Investigation of MSK modulation/demodulation using trainer kits
AIM-2: Design of MSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

11. Name of the Experiment: Investigation of QAM modulation and demodulation
AIM-1 : Investigation of QAM modulation and demodulation using ST 2112 QAM trainer kit
AIM-2: Design of QAM modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

12. Name of the Experiment: Investigation of QPSK modulation and demodulation
AIM-1: Investigation of QPSK modulation and demodulation using ST 2112 QAM trainer kit
AIM-2: Design of QPSK modulator/demodulator using ALTAIR Solid Thinking Embed/Comm

Text Book:
1. “Principles of Communication Systems”, 2/e, by H. Taub and DL Schilling, Tata McGraw Hills, ND.
2. “Communication Systems”, 4/e by Simon Haykin, John Wiley and Sons, Delhi.

Reference Books:
3. Simon Haykin, “Communication Systems”, Wiley Eastern Limited, New Delhi, 2016, 4/e.
4. J. Schiller, “Mobile Communication” 2/e, Pearson Education, 2012.

COURSE INFORMATION SHEET

Course code: EE205
Course title: Circuit Theory
Pre-requisite(s): Basic Electrical Engineering
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week:
Class: Minor in EE
Semester / Level: VII / IV
Branch: PHYSICS

Code: EE205	**Title: Circuit Theory**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1	Network Topology: Definition and properties, Matrices of Graph, Network Equations &Solutions: Node and Mesh transformation; Generalized element; Source transformation; Formulation of network equations; Network with controlled sources; Transform networks; Properties of network matrices; Solution of equations; Linear time-invariant networks; Evaluation of initial conditions; Frequency and impedance scaling.	
Module-2	Network Theorem: Substitution theorem, Tellegen's theorem, Reciprocity theorem; State space concept and State variable modelling.	
Module-3	Multi-terminal Networks: Network function, transform networks, natural frequency (OCNF and SCNF); Two-port parameters, Equivalent networks.	
Module-4	Elements of Network Synthesis: Positive real function, Reactance functions, RC functions, RL Network, Two-port functions, Minimum phase networks.	
Module-5	Approximation: Filter specifications; Butterworth approximation; Chebyshev approximation; Frequency transformation; High pass; Band pass; all pass and notch filter approximation.	

Textbooks:

1. V.K. Aatre, Network Theory & Filter Design, New Age International Pvt. Ltd., New Delhi. (T1)

2. M.S. Sukhija, T.K.Nagsarkar, Circuits and Networks, Oxford University Press, 2nd ed., New Delhi.(T2)

Reference Books:

1. M.E. Van Valkenberg, Introduction to Modern Network Synthesis, John Wiley & Sons (1 January 1966) (R1)

2. Balabanian, N. and T.A. Bickart, “Electric Network Theory”, John Wiley & Sons, New York, 1969. (R2)

3. C. L. Wadhwa, Network Analysis and Synthesis, New Age International Pvt. Ltd., New Delhi(R3)

COURSE INFORMATION SHEET

Course code: CS206
Course title: Design and Analysis of Algorithm
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in M&C
Semester / Level: VII / IV
Branch: PHYSICS

Code: CS206	**Title: Design and Analysis of Algorithm**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students		
1	To analyze the performance of recursive and nor-recursive algorithms.	
2	To understand various algorithm design techniques.	
3	To use of different paradigms of problem solving.	
4	To find efficient ways to solve a given problem.	
5	To compare various algorithms of a given problem.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Define the concepts and mathematical foundation for analysis of algorithms.	
2.	Explain different standard algorithm design techniques, namely, divide & conquer, greedy, dynamic programming, backtracking and branch & bound.	
3.	Demonstrate standard algorithms for fundamental problems in Computer Science.	
4.	Design algorithms for a given problem using standard algorithm design techniques.	
5.	Analyze and compare the efficiency of various algorithms of a given problem.	
Syllabus		
Module-1	Algorithms and Complexity Introduction, Algorithm Complexity and various cases using Insertion Sort, Asymptotic Notations, Time complexity of Recursive Algorithm, Solving Recurrences using Iterative, Recursion Tree and Master Theorem.	**08**
Module-2	Divide and Conquer Discussion of basic approach using Binary Search, Merge Sort , Quick Sort , Selection in Expected linear time, Maximum Subarray , Matrix Multiplication , Introduction of Transform and Conquer and AVL Tree.	**08**
Module-3	Dynamic Programming Introduction and Approach, Rod Cutting, LCS, Optimal BST, Transitive closure and All-pair Shortest Path, Travelling Salesperson Problem.	**04**
Module-4	Greedy and other Design Approaches Introduction to greedy using fractional knapsack, Huffman Code, Minimum Spanning Tree – Prim and Kruskal, Single Source Shortest Path Dijkstra's and Bellman-Ford, Introduction to Backtracking using N-Queens problem, Introduction to Branch and Bound using Assignment Problem or TSP.	**04**
Module-5	NP Completeness and Other Advanced Topics Non-deterministic algorithms – searching and sorting, Class P and NP, Decision and Optimization problem, Reduction and NPC and NPH, NP Completeness proof for: SAT, MaxClique, Vertex Cover, Introduction to Randomized Algorithms, Introduction to Approximation Algorithms.	**06**

Reference Books:

1 Horowitz E., Sahani, Fundamentals of Computer Algorithms, Galgotia Publication Pvt. Ltd. (R1)

2 Dave and Dave, Design and Analysis of Algorithms, 2 nd Edition, Pearson. (R2)

3 Goodrich, Tamassia. Algorithm Design. Wiley. (R3)

COURSE INFORMATION SHEET

Course code: CS207
Course title: Design and Analysis of Algorithm Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: Minor in M&C
Semester / Level: VII / IV
Branch: PHYSICS

Code: CS207	**Title: Design and Analysis of Algorithm Lab**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
1	implement various design strategies of algorithms.	
2	examine the efficiency of algorithm by changing the places of important steps.	
3	compare approximate and exact solutions.	
4	investigate effect randomness on correctness and efficiency of algorithms.	
5	design approximate, random and parallel solution of different problems.	
Course Outcomes: After the completion of this course, students will be able to		
1.	know the different notions of asymptotic complexity and determine the asymptotic complexity of algorithms including the solving of recurrence relations.	
2.	determine the practical implications of asymptotic notations.	
3.	Implement, analyze, and compare algorithms.	
4.	Know the difference between the dynamic programming concept and a greedy approach.	
5.	know and use basic and advanced graph algorithms including DFS, BFS, and Bellman Ford.	

Syllabus

List of Programs as Assignments:

1. Lab Assignment No: 1
   Programs on Polynomial vs logarithmic running times
   Lab Assignment No: 2
   Programs on Divide-and-conquer algorithms

2. Lab Assignment No: 3
   Programs on Greedy and dynamic-programming algorithms

3. Lab Assignment No: 4
   Programs on Binary trees

4. Lab Assignment No: 5
   Programs on Heaps and priority queues

5. Lab Assignment No: 6
   Programs on Binary search trees

6. Lab Assignment No: 7
   Programs on Hash tables

7. Lab Assignment No: 8
   Programs on Graph traversal

8. Lab Assignment No: 9
   Programs on Shortest paths in graphs.

Textbooks:

1. Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, MIT Press/McGraw-Hill, 2001. (T1)
2. SanjoyDasgupta, Christos H. Papadimitriou and Umesh V. Vazirani, Algorithms, Tata McGraw-Hill, 2008. (T2)
3. Jon Kleinberg and ÉvaTardos, Algorithm Design, Pearson, 2005. (T3)

COURSE INFORMATION SHEET

Course code: IT263
Course title: Object Oriented Programming
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in CS
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: IT263	**Title: Object Oriented Programming**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		**08**
Module-2		**08**
Module-3		**04**
Module-4		**04**
Module-5		**06**

COURSE INFORMATION SHEET

Course code: IT264
Course title: Object Oriented Programming Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: Minor in CS
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: IT264	**Title: Object Oriented Programming Lab**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		**08**
Module-2		**08**
Module-3		**04**
Module-4		**04**
Module-5		**06**

COURSE INFORMATION SHEET

Course code: EC355R1
Course title: Fiber Optic Communication
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 3 T:0 P: 0
Classes schedule per week: 3
Class: Minor in EC
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: EC355R1	**Title: Fiber Optic Communication**	**L-T-P-C [3-0-0-3]**
Course Objectives: This course enables the students to		
1	To demonstrate the different generations, elements required to establish the fiber optic link, the losses and the dispersion effects in fiber optic communication.	
2	To identify the types of couplers, optical sources for fiber optic communication system.	
3	To identify the types of photodiode, optical receivers in fiber optic communication system and understand system performance through the link power budget and dispersion limitations of digital fiber optic link.	
4	To understand WDM, optical amplifiers, optical switching in fiber optic networks.	
5	To understand different network topologies and nonlinear effects in fiber optic communication.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Identify the elements required to establish the fiber optic link and determine the losses and the dispersion effects in fiber optic communication.	
2.	Choose the appropriate couplers, optical sources for fiber optic communication system.	
3.	Select the types of photodiodes/optical receivers in fiber optic communication system and assess the system performance through the link power budget and dispersion limitations of digital fiber optic link.	
4.	Implement the WDM, optical amplifiers, optical switching for fiber optic networks.	
5.	Analyze the different network topologies and nonlinear effects in fiber optic communication.	
Syllabus		
Module-1	Generations of optical communication, Basic elements of an optical fiber transmission link, Fiber types and fiber parameters, Fiber material and fabrication methods, Ray and modal analysis in Step Index (SI) and Graded index (GI) fibers, Modes in SI&GI fibers, Power flow in step index fibers, Attenuation mechanisms in optical fibers, Dispersion effects in optical fibers.	**10**
Module-2	Structure and materials of LED and LD sources, Operating characteristics and modulation capabilities of the LED and LD sources, Source to Fiber Power launching and coupling, Lensing scheme for coupling improvement, Fiber to fiber coupling and alignment methods, Splicing techniques, Fiber Connectors.	**10**
Module-3	Principle of PIN photodiode and Avalanche photodiode, Noise in photodetectors, Detector response time, Photodiode materials, Optical receiver configuration and performance, Pre-amplifier design for optical receiver, analog and digital receiver. Optical link design - BER calculation, quantum limit, power penalties, Point to point transmission links, Link power and rise time budget.	**07**
Module-4	WDM and DWDM operational principles, Optical couplers, Fiber Bragg grating, AWG router/multiplexer, Add/Drop Multiplexer, Optical amplifiers, Amplification mechanism of semiconductor optical amplifier (SOA) and Erbium doped fiber amplifier (EDFA), EDFA architecture, Optical switches, Wavelength converters.	**08**
Module-5	SONET/ SDH architecture, SONET/ SDH Rings, All optical WDM networks, Single hop and multihop networks, Nonlinear effects on network performance, SRS, SBS, Self-phase modulation (SPM), Soliton pulses, Soliton based communication.	**05**

Textbooks:

1. “Optical Fiber Communications” G.Keiser, 3/e, McGraw Hill
2. “Optical Fiber Communication”,J. M. Senior, PHI,2nd Ed.
3. “Optical Networking and WDM”, Walter Goralski, Tata McGraw-Hill

Ref. Books:

1. “Introduction to Fiber Optics”, Ghatak &Thyagarajan, Cambridge University press.
2. “Optical Communications”, J.H.Franz &V.K.Jain Narosa Publishing House.
3. “Fiber Optics Communication”, Harold Kolimbiris, Pearson Education.
4. “Fundamentals of Fiber optics in telecommunication and sensor systems”, B. P. Pal, New age International (P) Ltd.
5. “Optical Communication Networks”, B.Mukherjee McGraw Hill.

COURSE INFORMATION SHEET

Course code: EC356
Course title: Fiber Optic Communication Lab
Pre-requisite(s): Knowledge of Semiconductor Devices, Electromagnetic Theory
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week: 3
Class: Minor in EC
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: EC356	**Title: Fiber Optic Communication Lab**	**L-T-P-C [0-0-3-1.5]**

Course Objectives: This course enables the students to

1	Demonstrate fiber optic analog link and digital link without and with multiplexing.
2	Illustrate fiber attenuation, coupling losses and numerical measurement.
3	Inspect different modulation format in fiber optic link.
4	Design of optical fiber and characterize optical amplifier.
5	Realize wavelength division multiplexing and de-multiplexing in fiber optic link.

Course Outcomes: After the completion of this course, students will be able to

1.	Design single mode and multimode fiber, and measure fiber parameters.
2.	Choose the modulation techniques for the short haul and long haul fiber optic link.
3.	Apply multiplexing techniques, and coding schemes in analog and digital fiber optic link.
4.	Design and characterize the optical amplifier.
5.	Design modulator based on Mach-Zehnder interferometer.

Syllabus

List of Experiments

1. Setting up a fiber optic Analog link and setting up a fiber optic Digital link using LED source.
AIM1: Setting up a fiber optic Analog link
AIM2: Setting up a fiber optic Digital link

2. Measurement of fiber attenuation of a plastic fiber Measurement of Numerical Aperture (NA) of a multimode fiber.
AIM1: Measurement of fiber attenuation.
AIM2: Measurement of Numerical Aperture (NA).

3. Realization of PWM and PPM in fiber optic link.
AIM1: Realization of PWM in fiber optic link.
AIM2: Realization of PPM in fiber optic link.

4. Realization of Analog Time Division Multiplexing in fiber optic link.
AIM: Realization of Analog Time Division Multiplexing in fiber optic link.

5. Realization of Digital Time Division Multiplexing and study of framing in fiber optic link.
AIM1: Realization of Digital Time Division Multiplexing in fiber optic link.
AIM2: Study of framing in fiber optic link.

6. Manchester Coding and Decoding in optical fiber link.
AIM: Study of Manchester Coding and Decoding in optical fiber link.

7. Measurement of Bit Error Rate (BER) and study of Eye Pattern.
AIM1: Measurement of Bit Error Rate (BER) in fiber optic link.
AIM2: Study of Eye Pattern.

8. Realization of Wavelength Division Multiplexing and De-multiplexing in fiber optic communication system.
AIM: Realization of Wavelength Division Multiplexing and De-multiplexing in fiber optic communication system.

9. Excitation of LP modes (LP01, LP11, LP02) and to find their power distributions in the Core and Cladding of optical fiber using Beam-Prop (RSoft) software.
AIM: Excitation of LP modes (LP01, LP11, LP02) and to find their power distributions in the Core and Cladding of optical fiber.

10. Implementation of a Mach-Zehnder electro-optic modulator and plotting of the Power Output vs. Applied Voltage using Beam-Prop (RSoft) software.
AIM: Implementation of a Mach-Zehnder electro-optic modulator and plotting of the Power Output vs. Applied Voltage.

11. Implementation of technique of Manchester Coding and Decoding in optical fiber link using Optisystem (Optiwave) software.
AIM: Implementation of technique of Manchester Coding and Decoding in optical fiber link.

12. Characterization of Erbium Doped Fiber Amplifier (EDFA).
AIM1: Setting up the fiber optic link with EDFA.
AIM2: Measurement of Gain of EDFA.

Textbooks:

T1. "Optical Fiber Communications" G. Keiser, 3/e, McGraw Hill

Ref. Books:

R1. "Introduction to Fiber Optics", Ghatak &Thyagarajan, Cambridge University Press.

COURSE INFORMATION SHEET

Course code: EE261
Course title: Principles of Electrical Machines
Pre-requisite(s): Basic Electrical Engineering
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: Minor in EE
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: EE261	**Title: Principles of Electrical Machines**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1	Electromechanical Energy Conversion: Introduction, flow of energy in electromechanical devices, energy in magnetic systems, singly excited system, determination of mechanical force, mechanical energy, torque equation, doubly excited system, energy stored in magnetic field, electromagnetic torque, generated EMF in machines, torque in machines with cylindrical airgap, general classifications of electrical machines.	
Module-2	Transformers: construction and principle, types & classification, operation at no load and on load, vector diagrams, equivalent circuit, losses, efficiency and regulation, determination of regulation and efficiency by direct load test and indirect test methods, sumpner's test, parallel operation, autotransformer, condition for maximum efficiency, all-day efficiency. star/star, star/delta, delta/delta, delta/Star, delta/zigzag, vector diagram, phase groups, parallel operation of 3-phase transformer.	
Module-3	DC Generator: Parts of generator, armature winding, coil pitch, back pitch, front pitch, resultant pitch, commutator pitch, single-layer winding, two-layer winding, multiplex winding, lap & wave winding, dummy coils, types of generators, equalizer connections, EMF & torque equation, total losses and efficiency, armature reaction, compensating winding commutation, methods for improving commutation, inter-poles, performance characteristics of DC generators.	
Module-4	DC Motor: Principle of motor, comparison of generator and motor action, back Emf, power & torque, shaft torque, performance characteristics of DC motors, losses & efficiency, power stages, speed control of DC motors, electric braking, necessity of a starter, three point & four point starters, starting of DC motors.	
Module-5	Alternators : construction of alternators, operation, armature winding, winding factor, EMF equation, phaser diagram, voltage regulation, ampere-turn method, power/power angle characteristics, effect of change of excitation and mechanical input, hunting.	

Textbooks:

1. Principles of electrical machines- V K Mehta
2. Electrical Machinery Fundamental – Stephen J. Chapman

Reference books:

1. Electrical Machines – D P Kothari and I J Nagrath

COURSE INFORMATION SHEET

Course code: EE252
Course title: Electrical Machine Laboratory - I
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Classes schedule per week:
Class: Minor in EE
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: EE252	**Title: Electrical Machine Laboratory - I**	**L-T-P-C [0-0-3-1.5]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		
Module-2		
Module-3		
Module-4		
Module-5		

COURSE INFORMATION SHEET

Course code: MA311
Course title: Numerical Techniques
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: Minor in M&C
Semester / Level: VIII/ IV
Branch: PHYSICS

Code: MA311	**Title: Numerical Techniques**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1		
Module-2		
Module-3		
Module-4		
Module-5		

COURSE INFORMATION SHEET

Course code: PH535
Course title: Advanced mathematical methods
Pre-requisite(s): Mathematical Physics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH535	**Title: Advanced mathematical methods**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	learn path integral formalism.	
2	learn representation theory of groups.	
3	learn representation theory of groups.	
4	learn basics of topology	
5	learn one of the most powerful tools of theoretical physics that is renormalization methods and group.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Apply learn path integral formalism.	
2.	Apply representation theory of groups to solve physical problems.	
3.	Understand and apply the language to approach physics problems.	
4.	Understand topological features of physical systems.	
5.	Apply RG methods to solve physical problems especially regarding critical phenomena.	
Syllabus		
Module-1	Path integral formalism: Feynman path integral, in real time, in phase space, Euclidian PI, Tunneling, Spontaneous symmetry breaking, Coherent state PI for spins, bosons and fermions, Grassman variables, Generating functions.	**10**
Module-2	Representation of finite groups, Unitary matrices, Character table, Reducible and irreducible representations, Symmetries of regular geometrical objects, Countably infinite groups, Lie groups, Rotation, Translation, Unitary groups, Young-Tableaux, Casimir invariant, Applications.	**10**
Module-3	Differential geometry: Manifolds, vector fields, Tangent bundle Tensors, Exterior algebra, Exterior forms, differentiation, Integration, Stokes theorem, Maxwell's equation, Lie derivative.	**10**
Module-4	Elements of Topology, Continuity of functions, Topological spaces, Homotopy theory, Homology, Betti numbers, Torsion.	**10**
Module-5	Renormalisation group: introduction, RG be decimation, Stable and unstable fixed points, Wilson strategy, Critical phenomena, Landau theory, Widom scaling, Kadanoff's block spins, Wilson's RG program, The Beta function, RG of non-relativistic fermions.	**10**

Textbooks:

1. A physicists introduction to algebraic structure, Palash B. Pal, CUP (2019)
2. Quantum field theory and condensed matter, R. Shankar, CUP (2017)
3. The geometry of physics, Theodore Frankel, CUP (2012)

Reference:

https://ncatlab.org/nlab/show/HomePage

COURSE INFORMATION SHEET

Course code: PH504
Course title: Numerical Methods for Physicists
Pre-requisite(s): Mathematical Physics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH504	**Title:**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To learn about optimization techniques	
2	To understand the concepts of functional approximations	
3	To know about algebraic eigenvalue problems	
4	To gain knowledge on integral equations	
5	To gain familiarity with the numerical solutions of partial differential equations	
Course Outcomes: After the completion of this course, students will be		
1.	Able to perform optimization via coding	
2.	Able to do construct programs on functional approximations	
3.	Solving eigenvalue problems numerically	
4.	Comfortable in dealing with integral equations	
5.	Numerically able to solve partial differential equations	
Syllabus		
Module-1	**Optimization** Golden Section Search, Brent's Method, Methods Using Derivative, Minimization in Several Dimensions, Quasi-Newton Methods, Direction Set Methods, Linear Programming	**10**
Module-2	**Functional Approximations** Choice of Norm and Model, Linear Least Squares, Nonlinear Least Squares, Discrete Fourier Transform, Fast Fourier Transform (FFT), FFT in Two or More Dimensions, Functional Approximations	**10**
Module-3	**Algebraic Eigenvalue Problems** Introduction, Power Method, Inverse Iteration, Eigenvalue Problem for a Real Symmetric Matrix, QL Algorithm for a Symmetric Tridiagonal Matrix, Algebraic Eigenvalue Problem	**10**
Module-4	**Integral Equations** Introduction, Fredholm Equations of the Second Kind, Expansion Methods, Eigenvalue Problem, Fredholm Equations of the First Kind, Volterra Equations of the Second Kind, Volterra Equations of the First Kind.	**10**
Module-5	**Partial Differential Equations** Wave Equation in Two Dimensions, General Hyperbolic Equations, Elliptic Equations, Successive Over-Relaxation Method, Alternating Direction Method, Fourier Transform Method, Finite Element Methods, Algorithms for Vector and Parallel Computers	**10**

References

1. "Numerical methods for Scientists and Engineers" by H. M. Antia, Springer Science and Business Media.
2. "Numerical Recipes in C" by William H. Press, Saul A. Teukolsky, William T. Vetterling & Brian P. Flannery, Cambridge University Press.
3. "Programming in C# A Primer" by E Balagurusamy, McGraw Hill Education.

COURSE INFORMATION SHEET

Course code: PH505
Course title: Theory of Solids
Pre-requisite(s): Condensed Matter Physics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH505	**Title:**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To become familiar with classification of solids using band theory.	
2	To be familiarized with the change in density of states as a function of physical dimension of solids.	
3	To become familiar with the electrical behaviour of dielectric materials and understand the field charge induced by dielectrics.	
4	To become familiar with the theory behind the magnetic properties of materials.	
5	To understand the different optical processes and photophysical properties of solids.	
Course Outcomes: After the completion of this course, students will be		
1.	Able to classify materials as metals, insulators and semiconductors and sketch the band diagram for each.	
2.	Able to classify material as 0D, 1D, 2D and 3D on the basis of density of states and correlate the physical properties with physical dimensions.	
3.	Able to describe the different dielectric properties and be familiar with the experimental methods for investigation of dielectrics.	
4.	Able to apply the theories to estimate the magnetic properties of materials.	
5.	Able to correlate the results of different optical experiments with the theory.	
Syllabus		
Module-1	**Band Theory** Review of Concepts: (Bloch theorem and Bloch function, Kronig Penney model), Construction of Brillouin zones (1 and 2 dimensions), Extended, reduced and periodic zone scheme, Effective mass of an electron, nearly free electron model, Tight binding approximation, Orthogonalized plane wave method, Pseudo-potential method, Classification of conductor, semiconductor and insulators.	**10**
Module-2	**Electron Statistics** Fermi-Dirac distribution, Fermi energy, Density of States, Classification of solids (0D, 1D, 2D, 3D) on the basis of density of states and k-space, effect of temperature on Fermi distribution function.	**08**
Module-3	**Dielectrics** Matter in a.c. field, Propagation of e.m. wave in matter on the basis of Maxwell's equation, Relaxations and resonances, Kramer's-Kronig relation, Mechanical analogue of relaxation, Debye relation, Argand diagram, Influence of local field and d.c. conductivity and multiple relaxation times, Special diagram (cole-cole arc), Heterogeneous dielectrics (Maxwell-Wagner effect), Dipole relaxation of defects in crystal lattices, Space charge polarization and relaxation, Resonances: Linear oscillator model and one dimensional polar lattices, Ferroelectricity, Microscopic theory of Ferroelectricity, Phase transition of ferroelectrics (1^{st}, 2^{nd} and relaxor kind), Hysteresis loop, Recoverable energy, Piezoelectricity and transducers.	**12**

Module-4	**Magnetism** Magnetic interactions, Exchange interaction, Direct exchange, Indirect exchange, Double exchange, Helical order, Frustration, Spin glasses, Landau theory of ferromagnetism, Heisenberg and Ising models, Excitations, Magnons, Bloch $T^{3/2}$ law, Measurement of spin waves, Magnetism of the electron gas, Spin density waves, Kondo effect.	**10**
Module-5	**Optical properties** Classification of optical process, optical coefficient, complex refractive index, propagation of light in a dense optical medium, atomic oscillator, vibrational oscillator, free electron oscillator, dipole oscillator model, inter band absorptions, excitons, concept of excitons, free excitons, free excitons in external field, luminescence, light emission from solids, interband luminescence, photoluminescence, electroluminescence, luminescence centres, phonons, optical properties of metals.	**10**

Textbooks

1. Introduction to Solid State Physics 8th Edition , Charles Kittel, John Wiley and Sons, 2005.
2. Solid State Physics, Neil W. Ashcroft, N. David Mermin, Saunders College Publishing, 1976

References:

1. Optical properties of Solids: Anthony Mark Fox, Oxford Master Series in Physics, Oxford University Press (2001).
2. Magnetism in Condensed Matter, Oxford Master Series in Condensed Matter Physics 4, Stephen Blundell, Oxford University Press (2001).

COURSE INFORMATION SHEET

Course code: PH506
Course title: Functional Materials
Pre-requisite(s): Condensed Matter Physics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH506	**Title: Functional Materials**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
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Course Outcomes: After the completion of this course, students will be able to		
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Syllabus		
Module-1	Introduction to Metals, Alloys, Ceramics, Polymers and Composites, Phase rules Fe-C phase diagram, Steels, cold, hot working of metals, recovery, recrystallization and grain growth, Structure, properties.	**08**
Module-2	Processing and applications of ceramics. Classification of polymers, polymerization, structure, properties, additives, products, processing and applications. Quasicrystals, Conducting Polymers; Properties and applications composites.	**12**
Module-3	Advanced Materials: Smart materials, ferroelectric, piezoelectric, biomaterials (some basic information), superalloys, aerospace materials, shape memory alloys, optoelectronic materials, Materials for photodiode, light emitting diode (LED), Photovoltaic/Solar cell and meta materials.	**10**
Module-4	Nanostructured Materials: Nanomaterials classification (Gleiter's Classification)–property changes done to size effects, Quantum dot, wire and well, synthesis of nanomaterials, ball milling.	**08**
Module-5	Liquid state processing -Sol-gel process, Vapour state processing –CVD, MBE, Aerosol processing, fullerene and tubules, formation and characterization of fullerenes and tubules, single wall and multiwall carbon tubules, electronic properties of tubules, applications: optical lithography, MOCVD, super hard coating.	**12**

Textbooks:

1. T1: Structure and properties of engineering materials, fifth edition, Henkel and Pense, McGraw Hill, 2002
2. T2: Biomaterials Science, An Introduction to Materials in Medicine , Edited by B.D. Ratner, A.S. Hoffman, F.J. Sckoen, and J.E.L Emons, Academic Press, second edition, 2004

COURSE INFORMATION SHEET

Course code: PH507
Course title: Fiber and Integrated Optics
Pre-requisite(s): Waves and Optics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH507	**Title:**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To understand the light propagation phenomenon through fiber optic cable	
2	To understand various loss mechanism of signal while travelling through an optical fiber.	
3	To understand the basic working principle of waveguides and its design parameters.	
4	To identify waveguides for applications in fiber optics communication systems	
5	To understand the principle of working of fiber based sensors for various application purposes.	
Course Outcomes: After the completion of this course, students will be		
1.	Able to illustrate the principle of fiber optics communications.	
2.	Able to distinguish between various loss mechanism in fiber optics communication system.	
3.	Able to utilize the idea of waveguide for different application purpose.	
4.	Able to categorize different waveguides for the utilization in optics communication system	
5.	Able to interpret different fiber sensors and their respective application and can recommend this technique for other new application.	
Syllabus		
Module-1	Principle of light propagation in fibers, step-index and graded index fibers; single mode, multimode and W-profile fibers. Ray optics representation, meridional and skew rays. Numerical aperture and acceptance angle.	**05**
Module-2	Dispersion, combined effects of material and other dispersions - RMS pulse widths and frequency response, birefringence. Attenuation in optical fibers. Material dispersion and waveguide dispersion in single-mode fibers, Inter and intramodal dispersion in graded-index fibers.	**10**
Module-3	Theory of optical waveguides, planar, rectangular, symmetric and asymmetric waveguides, channel and strip loaded waveguides. Anisotropic and segmented waveguides. Step-index and graded index waveguides.	**10**
Module-4	Wave guide couplers, transverse couplers, grating couplers, tapered couplers, prism couplers, fiber to waveguide couplers. Multilayer planar waveguide couplers, dual channel directional couplers, Butt coupled ridge waveguides, Branching waveguide couplers. Directional couplers, optical switch; phase and amplitude modulators, filters, etc.	**12**
Module-5	Fiber optics sensors, intensity modulation, phase modulation sensors, fiber Bragg grating sensors. Measurement of current, pressure, strain, temperature, refractive index, liquid level etc. Different fiber fabrication methods- chemical vapor deposition method, axial vapor deposition, plasma enhanced modified CVD.	**13**

References:

1. Introduction to Fiber Optics: A.K. Ghatak and K. Thayagarajan, Cambridge University press.
2. Integrated Optics: Theory and Technology; R. G. Hunsperger; Springer (2002)
3. Optical Fiber Sensors, John Dakin and Brain Culshaw, Arctech House Inc.
4. Essentials of optoelectronics, Alan Rogers, 1st Ed., Chapman & Hall.
5. Semiconductor Optoelectronics Devices, P. Bhattacharya, PHI.
6. Optoelectronics and Photonics, principles and practices S. O. Kasap, Prentice Hall

COURSE INFORMATION SHEET

Course code: PH521
Course title: Photonics and Optoelectronic Devices
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH521	**Title:**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To explain the properties of optoelectronic material and optical processes in semiconductor.	
2	To understand underlying principle & working of liquid crystal displays, optical modulator, and switches.	
3	To understand principle & working of light sources and photodetectors.	
4	To know the working of optical nonlinear devices and understand its significance for optical computing.	
5	To acquire the knowledge of the function and working of photonic switches and interconnects	
Course Outcomes: After the completion of this course, students will be		
1.	Able to identify suitable optoelectronic materials and explain optical phenomena occurring in semiconductor	
2.	Able to recognize parameters for optimizing the performance of liquid crystal displays, optical modulator, and switches & solve related numerical problems.	
3.	Able to identify the parameters for optimizing the performance of light sources and detectors.	
4.	Able to define the role of different nonlinear optical devices in optical computing.	
5.	Able to select appropriate photonic switch and interconnect for different operations under different working condition.	
Syllabus		
Module-1	**Optical processes in semiconductors:** Electron-hole pair formation and recombination, Direct and indirect bandgap semiconductors, structural property of crystalline, polycrystalline, amorphous materials, optoelectronic materials, Liquid crystals, compound semiconductors, absorption in semiconductors, Stark effects in quantum well structures, Absorption and emission spectra, excitonic effects.	**10**
Module-2	**Displays, optical modulators, and switches:** Liquid crystal cells (principle), Passive and Active matrix liquid crystal displays, Electro-optic modulator, Magneto-optic modulator, Acousto-optic modulator. Electro-absorption modulators, Mach-Zehnder Electrorefraction (Electro-optic) modulators, optical switches.	**08**
Module-3	**Optical sources and detectors:** Light emitting diodes, surface- and edge- emitting configuration. Injection laser diodes, gain and index guided lasers, PIN and avalanche photodiodes, Photoconductors, Phototransistors, noise in photodetector. Solar cells (spectral response, conversion efficiency), Charge-coupled devices, Characteristics and applications.	**12**
Module-4	**Optical computing:** Digital optical computing: Nonlinear devices, optical bistable devices, SEED devices, Optical phase conjugate devices, integrated devices, spatial light modulators (SLM), Optical Memory: Holographic data storage.	**10**
Module-5	**Photonic switching and interconnects:** Kerr gates, Nonlinear Directional couplers, Nonlinear optical loop mirror (NOLM), Soliton logic gates, Free-space optical interconnects, wave-guide interconnects, holographic inteconnections.	**10**

References

1. Essentials of optoelectronics, Alan Rogers, 1st Ed., Chapman & Hall.
2. Introduction to Fiber Optics, Ghatak & Thyagarajan, Cambridge University press.
3. Optoelectronics: An Introduction to Materials and Devices, Jasprit Singh, The McGraw-Hill Companies.
4. Semiconductor Optoelectronics Devices, P. Bhattacharya, PHI.
5. Optoelectronics and Photonics, principles and practices S. O. Kasap, Prentice Hall
6. Photonic switching and Interconnects; Abdellatif Marrakchi, Marcel Dekker, Inc.
7. Optical Computing, an Introduction, Mohammad A. Karim and Abdul A. S Awwal, John Wiley & Sons Inc

COURSE INFORMATION SHEET

Course code: PH509
Course title: Instrumentation and Control
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH509	**Title: Instrumentation and Control**	**L-T-P-C [4-0-0-4]**
Course Objectives:		
1	Course on *Instrumentation and control* intends to impart knowledge of measurement, data acquisition and control for experiments.	
2	The first module of the course addresses basics of measurements like range, resolution, reproducibility, accuracy and precision.	
3	Module-2 of the course introduces various types of sensors and their working to record changes in the different physical parameters.	
4	The techniques of signal conditioning and noise reductions for acquired data are subject of Module-3.	
5	Last two units covers working and theory of different types of correction and regulating elements used in control systems.	
Course Outcomes:		
1.	Learners would develop understanding of various experimental parameters of measurements like range, resolution, reproducibility and precision.	
2.	Through this course, students would develop an insight into fundamentals of sensors/t ransducers, data acquisition and processing, noise minimization and control systems for automation.	
3.	This course is expected to enable students to design and understand hardwares used for developing equipment for data acquisition, data conditioning and control.	
4.	Course would enable students to grasp understanding of instrumentation for automation of various physical process monitoring and control.	
Syllabus		
Module-1	**Measurement basics:** Range, resolution, linearity, hysteresis, reproducibility and drift, calibration, accuracy and precision.	**05**
Module-2	**Sensors** Sensor Systems, characteristics, Instrument Selection, Measurement Issues and Criteria, Acceleration, Shock and Vibration Sensors, Interfacing and Designs, Capacitive and Inductive Displacement Sensors, Magnetic Field Sensors, Flow and Level Sensors, Load Sensors, Strain gauges, Humidity Sensors, Accelerometers, Photosensors, Thermal Infrared Detectors, Contact and Non-contact Position sensors, Motion Sensors, Piezoresistive and Piezoelectric Pressure Sensors, Sensors for Mechanical Shock, Temperature Sensors (contact and non-contact)	**10**
Module-3	**Signal conditioning** Types of signal conditioning, Amplification, Isolation, Filtering, Linearization, Classes of signal conditioning, Sensor Signal Conditioning, Conditioning Bridge Circuits, D/A and A/D converters for signal conditioning, Signal Conditioning for high impedance sensors Grounded and floating signal sources, single-ended and differential measurement, measuring grounded signal sources, ground loops, signal circuit isolation, measuring ungrounded signal sources, system isolation techniques, errors, noise and interference in measurements, types of noise, noise minimization techniques	**15**

Module-4	**Actuators** Correction and regulating elements used in control systems, pneumatic, hydraulic and electric correction elements.	**04**
Module-5	**Control System** Open loop and closed loop (feedback) systems and stability analysis of these systems, Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of linear time invariant (LTI) control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional- Integral-Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.	**16**

Textbooks:

1. Electronic Instrumentation -H. S. Kalsi, Tata McGraw-Hill Education, 2010
2. Electronic Instrumentation -W. Bolton
3. Instrumentation: Electrical and Electronic Measurements and Instrumentation -A. K. Sawhney
4. Modern Electronic Instrumentation & Measurement Techniques -Helfrick & Cooper

COURSE INFORMATION SHEET

Course code: PH510
Course title: Physics of Low dimensional Semiconductors Devices
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH510	Title: Physics of Low dimensional Semiconductors Devices	L-T-P-C [4-0-0-4]
Course Objectives:		
1	Course on "Physics of Low dimensional Semiconductors" contains information about functionality and working of devices with miniaturized size.	
2	The first module includes introduction to various types of semiconductor nanostructures and effect of dimension on their properties.	
3	The properties, growth and band-engineering of heterostrcutres is planned to be covered in Unit-2.	
4	Unit-3 contains Quantum wells and Low-dimensional systems, while Unit-4 addresses physics of Tunneling transport and Low-dimensional systems.	
5	The electronic and optical properties of Two-dimensional electron gas (2DEG) and their applications is subject of Unit-5.	
Course Outcomes:		
1.	Learners would gain knowledge about working and application of various Low-dimensional Semiconductors.	
2.	An understanding about Heterostructures, Quantum wells: Low-dimensional systems, Tunneling transport, Quantum-Hall effect and their electronic and optical applications would update learners with recent electronic and optical technologies in use.	
3.	Knowledge about Physics and applications of Two-dimensional electron gas (2-DEG) would enable them to grasp the pace of advancing field of 2D-Semiconductors and their applications for ultrathin devices.	
Syllabus		
Module-1	**Introduction to Semiconductor Nanostructures** Introduction, Semiconductor quantum dot and quantum wire, Density of states for 0-D, 1D and 2D nanostructures. Two- dimensional semiconductors.	**06**
Module-2	**Hetrostructures** General properties and growth of hetrostructures, Band engineering, Layered structures, Quantum wells and barriers, Doped hetrostructures, Wires and dots, Optical confinement, Effective mass approximation and Effective mass theory in hetrostructures.	**08**
Module-3	**Quantum wells and Low-Dimensional Systems** Infinite deep square well, square well of finite depth, parabolic well, triangular well, Low-dimensional systems, Occupation of subbands, Quantum wells in hetrostructures.	**12**
Module-4	**Tunneling transport and Quantum Hall effect** Potential step, T-Matrices, Resonant tunneling, Superlattices and minibands, Coherent transport in many channels, Tunneling in hetrostructures, Schrodinger equation with electric and magnetic fields, Quantum Hall effect.	**12**
Module-5	**Two-Dimensional electron gas (2DEG)** Revision of approximate methods, scattering rates: the golden rule, Absorption in a quantum well, electronic structure of a 2DEG, Optical properties of quantum wells: Kane model, bands in a quantum well, Interband and intersubband transitions in a quantum well, Optical gain and lasers, Excitons.	**12**

Text Book

1. John H. Davies, The Physics of Low-Dimensional Semiconductors an Introduction, Cambridge University Press.
2. Thomas Heinzel, Mesoscopic electronics in solid state nanostructures, Wiley-VCH
3. Jan G. Korvink, Andreas Greiner, Semiconductors for micro and Nanotechnology – An Introduction for Engineers. Wiley-VCH

COURSE INFORMATION SHEET

Course code: PH511
Course title: Introduction to Plasma Physics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH511	**Title: Introduction to Plasma Physics**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To impart the knowledge about the fundamental and basics of Plasma Physics.	
2	To learn about the charged particle motion in electric and magnetic field.	
3	To provide the knowledge about the ionization process and diffusion.	
4	To learn about the basic Plasma Diagnostic Methods.	
5	To learn how to use plasma for various application.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Will have an idea about the basis of Plasma (Fourth State of Matter).	
2.	Will be able to visualize the motion of charged particles in electric and magnetic field.	
3.	Will have knowledge about the ionization and diffusion of Plasma.	
4.	Will be able to measure the different plasma parameters.	
5.	Will be familiar with different applications of Plasma.	
Syllabus		
Module-1	The fourth state of matter, collective behavior, charge neutrality, space and time scale, concept of plasma temperature, Classification of Plasma, Debye shielding, Debye length, plasma frequency, plasma parameters and criteria for plasma state.	**10**
Module-2	Single particle dynamics, charged particle motion in electric field, magnetic field and in combined electric and magnetic field, Basics of $E \times B$ drift, Drift of guiding centre, gradient drift, curvature drift and magnetic mirror.	**10**
Module-3	Ionization by collision, Townsends theory of collision ionization, The breakdown potential, Thermal ionization and excitation, concepts of diffusion, mobility and electrical conductivity, Ambipolar diffusion.	**10**
Module-4	Basic plasma diagnostics, Single probe method, Double probe method, Optical emission spectroscopy (basic idea), Abel inversion.	**10**
Module-5	Controlled Thermonuclear fusion, Tokamak, Laser Fusion, MHD Generator, Industrial applications of plasma.	**10**

References:

1. Introduction to Plasma Physics and Controlled Fusion, Francis, F. Chen, Plenum Press, 1984.
2. Fundamental of Plasma Physics, J, A. Bittencourt, Springer-Verlag New York Inc., 2004.
3. The Fourth State of Matter- Introduction to Plasma Science, S. Eliezer and Y. Eliezer, IoP Publishing Ltd.,, 2001.
4. Elementary Plasma Physics, L. A. Arzimovich, Blaisdell Publishing Company, 1965.
5. Plasmas- The Fourth State of Matter, D. A. Frank- Kamenetskii, Macmillan Press, 1972.

COURSE INFORMATION SHEET

Course code: PH512
Course title: Plasma Processing of Materials
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T: 0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: IX / V
Branch: PHYSICS

Code: PH512	**Title: Plasma Processing of Materials**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	Define plasma and its parameters	
2	Outline the design principles of high and low-pressure plasma torches.	
3	Identify the processes of measurement of plasma parameters.	
4	Outline the industrial applications of low temperature plasma	
5	Explain arc plasma-based systems and illustrate their industrial applications	
Course Outcomes: After the completion of this course, students will be able to		
1.	Define plasma, classify it into various types in terms of the plasma parameters and explain the various types of reactions involved in a plasma.	
2.	Demonstrate the construction and working of high and low-pressure plasma torches.	
3.	Illustrate the various processes of measurement of plasma parameters.	
4.	Outline various plasma processes, such as, plasma etching, plasma ashing, plasma polymerization, etc., and their associated techniques such as, sputtering, nitriding, etc.	
5.	Illustrate arc plasma based applications like, plasma spraying, plasma waste processing, plasma cutting, etc.	
Syllabus		
Module-1	Plasma-the fourth state of matter, Plasma Parameters, Debye length, Plasma oscillations & frequency, Plasma Sheath, Interaction of electromagnetic wave with plasma, Concept about plasma equilibrium, Industrial Plasmas, Cold and thermal plasma, Plasma Chemistry, Homogeneous and Heterogeneous reaction, Reaction rate coefficients, Plasma Surface interaction.	**10**
Module-2	Design principles and construction of plasma torches and thermal plasma reactors, Efficiency of plasma torches in converting electrical energy in to thermal energy, Designing aspects of low pressure plasma reactors.	**08**
Module-3	Measurements of Plasma parameters, Electrical probes, Single and double Langmuir probe, Magnetic probe, Calorimetric measurements, Enthalpy Probes, Spectroscopic techniques.	**08**
Module-4	Plasma Etching Anisotropic etching, plasma cleaning, surfactants removal, plasma ashing, plasma polymerization, Plasma sputtering and PECVD Thin film coatings, magnetron sputtering, RF PECVD, MW PECVD, plasma nitriding.	**15**
Module-5	Plasma Spraying Non-transferred plasma torches, powder feeder, optimization of spraying processes, spherodization, Arc plasmas, Plasma torches, plasma waste processing, Synthesis of materials and metallurgy in arc plasmas, Plasma cutting and Welding.	**09**

Textbooks:

1. Introduction to Plasma Physics and Controlled Fusion, Francis, F. Chen, Plenum Press, 1984
2. Fundamental of Plasma Physics, J, A. Bittencourt, Springer-Verlag New York Inc., 2004
3. The Fourth State of Matter- Introduction to Plasma Science, S. Eliezer and Y. Eliezer, IoP Publishing Ltd., 2001.

Reference books:

1. Elementary Plasma Physics, L. A. Arzimovich, Blaisdell Publishing Company, 1965
2. Plasmas- The Fourth State of Matter, D. A. Frank- Kamenetskii, Macmillan Press, 1972

COURSE INFORMATION SHEET

Course code: PH516R1
Course title: Nonlinear Dynamics and Chaos
Pre-requisite(s): Classical Dynamics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH516R1	**Title:**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	Train students to calculate fixed points and do stability analysis of various systems motivated from physics/biology.	
2	Give a clear concept of bifurcation and some examples of the phenomenon.	
3	Teach them to plot limit cycles of various differential equations on computer using C language.	
4	Teach properties of limit cycles taking examples from physics.	
5	Train students to solve problems on chaos.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Model physical or biological systems computationally and obtain their fixed points, saddle points, attractors, etc.	
2.	Compute the evolution of phase space as various parameters are changed.	
3.	Visualize limit cycles of various nonlinear systems graphically.	
4.	Solve problems related to oscillators, viz., relaxation oscillators, weakly nonlinear oscillators, etc.	
5.	Solve simple models of chaotic systems.	
Syllabus		
Module-1	**Flows on the Line & Circle** Fixed Points and Stability, Population Growth, Linear Stability Analysis, Existence and Uniqueness, Impossibility of Oscillations, Potentials, Solving Equations on the Computer, Uniform Oscillator, Nonuniform Oscillator, Overdamped Pendulum, Fireflies, Superconducting Josephson Junctions.	**12**
Module-2	**Bifurcations** Saddle-Node Bifurcation, Transcritical Bifurcation, Laser Threshold, Pitchfork Bifurcation, Overdamped Bead on a Rotating Hoop, Imperfect Bifurcations and Catastrophes, Insect Outbreak.	**09**
Module-3	**Phase Plane** Phase Portraits, Existence, Uniqueness, and Topological Consequences, Fixed Points and Linearization, Rabbits versus Sheep, Conservative Systems, Reversible Systems, Pendulum, Index Theory.	**10**
Module-4	**Limit Cycles** Ruling Out Closed Orbits, Poincare-Bendixson Theorem, Lienard Systems, Relaxation Oscillators, Weakly Nonlinear Oscillators.	**09**
Module-5	**Chaos** Logistic Map: Numerics and Analysis, Liapunov Exponent, Lorenz equation and its properties, chaos on a strange attractor, Lorenz map.	**10**

Text books:

T1: Nonlinear dynamics and Chaos: with applications to physics, biology, chemistry, and engineering by Steven H. Strogatz, CRC Press.

T2: "Stability and Complexity in Model Ecosystems" by Robert M May, Princeton University Press.

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH532
Course title: NONEQUILIBRIUM STATISTICAL PHYSICS
Pre-requisite(s): Advanced Statistical Mechanics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH532	**Title: NONEQUILIBRIUM STATISTICAL PHYSICS**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	learn about stochastic processes and their applications.	
2	get familiarized with stochastic differential equations and stochastic calculus.	
3	understand linear response theory and its applications.	
4	get used to thermodynamics for small systems and its macroscopic limit.	
5	to know the basic tools of quantum thermodynamics.	
Course Outcomes: After the completion of this course, students will be able to		
1.	take up new problems in stochastic processes and stochastic calculus.	
2.	understand pioneering journal publications in this field.	
3.	propose simple examples where stochastic thermodynamics would be useful.	
4.	get the essence of mixed states and imperfect measurements/non-unitary evolutions in quantum statistical mechanics.	
5.	Apply basic tools of quantum thermodynamics.	
Syllabus		
Module-1	**Stochastic processes I:** Markov processes; Relation between random walk and diffusion; Characteristic functions and cumulants; Langevin equation; Chapman-Kolmogorov equation; Fokker-Planck equation.	**10**
Module-2	**Stochastic processes II:** Kramer's escape rate; Master equation; First passage time and survival probability; Renewal equation.	**08**
Module-3	**Irreversible Thermodynamics:** Affinities and fluxes; Onsager's regression hypothesis; Onsager reciprocity; Entropy in terms of affinities and fluxes; Response functions; Kubo formula; Fluctuation-dissipation theorem.	**11**
Module-4	**Stochastic thermodynamics:** Need for stochastic thermodynamics; Definitions of heat, work, internal energy and entropy for stochastic trajectories; Feynman's ratchet and pawl; Jarzynski equality; Crooks fluctuation theorem.	**10**
Module-5	**Quantum thermodynamics:** Density matrix and its properties; Density matrix for pure and mixed states; von Neuman equation; Definitions of quantum work, heat and entropy; Lindblad equation.	**11**

Text books:

1. *Handbook of Stochastic Methods for Physics, Chemistry and the Natural Sciences* by C. W. Gardiner (Springer-Verlag) .
2. *Stochastic Energetics* by K. Sekimoto (Springer)
3. *The Theory of Open Quantum Systems* by H. P. Breuer and F. Petruccione (Oxford University Press)

References:

1. *Thermodynamics and an Introduction to Thermostatistics* by H. B. Callen (John WIley & Sons)
2. *Statistical Mechanics* by F. Schwabl (Springer)
3. *Nonequilibrium Statistical Mechanics* by R. Zwanzig (Oxford University Press)
4. *Introduction to the theory of stochastic processes and Brownian motion problems* by J. L. Garcia Palacios, arxiv: cond-mat/0701242

COURSE INFORMATION SHEET

Course code: PH536
Course title: Gravitation and cosmology
Pre-requisite(s): MATHEMATICAL PHYSICS
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH536	Title: Gravitation and cosmology	L-T-P-C [4-0-0-4]
Course Objectives: This course enables the students to		
1	review field theory in Minkowski space.	
2	understand spacetime can be described by geometry.	
3	quantify curvature of spacetime.	
4	derive solutions to Einstein field equations.	
5	introduce the concepts of cosmology.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Understand the conceptual approach on field theory.	
2.	Develop conceptual understanding of spacetime as a geometry.	
3.	Understand how curvature of spacetime implies gravity.	
4.	Solve Einstein equation and understand the physical features of the solutions e.g. whether it is a black hole or expanding spacetime.	
5.	Start doing research in the field of cosmology.	
Syllabus		
Module-1	Review of Special relativity, Scalar and electromagnetic fields in special relativity, Classical scalar field, Electromagnetic field, Maxwell's equations, Energy and momentum of the electromagnetic field, Radiation from an accelerated charge.	**10**
Module-2	Gravity and spacetime geometry, Gravity as a scalar field, Second rank tensor theory of gravity, The principle of equivalence and the geometrical description of gravity, Metric tensor, geodesics and covariant derivative, Covariant derivative, Parallel transport.	**10**
Module-3	Curvature of spacetime, curvature tensor, Physics in curved spacetime, Geodesic congruence and Raychaudhuri's equation, Einstein's field equations, The weak field limit, energy-momentum pseudo-tensor, Energy conditions.	**10**
Module-4	Spherically symmetric geometry, Vaidya metric, Black holes, Schwarzschild metric, Kruskal–Szekeres coordinates, Penrose–Carter diagrams, Rotating black holes, Gravitational waves, Generation, Effects in binary systems, Detection.	**10**
Module-5	Relativistic cosmology, Friedmann spacetime, de Sitter spacetime, Brief thermal history of the universe, Gravitational lensing, Killing vectors and the symmetries of the space, CMBR.	**10**

Textbooks:

GRAVITATION: Foundations and Frontiers, T. PADMANABHAN, CUP (2010)

Gravitation and cosmology, S. Weinberg, (2008)

An introduction to general relativity: spacetime and geometry, S. Carroll (2004)

Reference:

https://phys.libretexts.org/Bookshelves/Relativity/General_Relativity_(Crowell)/00%3A_Front_Matter/03%3A_Table_of_Contents

COURSE INFORMATION SHEET

Course code: PH537
Course title: QUANTUM FIELD THEORY
Pre-requisite(s): Quantum Mechanics, Special Relativity
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH537	**Title: QUANTUM FIELD THEORY**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	know the basics of classical field theory such as how to describe free and interacting fields.	
2	know how to quantize classical fields and learn about Feynman diagrams.	
3	know the Dirac equation and how it is used to describe spin-1/2 fermion field quantum mechanically.	
4	know how to incorporate Maxwell's equations in quantum mechanics and to couple the photon field to the electron field (Quantum Electrodynamics).	
5	know the basics of quantum electrodynamics and use it for real world problems.	
Course Outcomes: After the completion of this course, students will have		
1.	Expertise in Lagrangian and Hamiltonian formalism of field theory	
2.	Ability to construct interacting field theories	
3.	Analytical expertise on spin ½ field theory	
4.	Fluency in use of Feynman Diagrams in QFT calculations	
5.	ability to compute scattering amplitudes of elementary QED processes	
Syllabus		
Module-1	**Classical Field Theory:** Lorentz Invariance, Symmetries, The Hamiltonian Formalism, Free Fields, Canonical Quantization, Free Scalar Field, The Vacuum, Particles, Complex Scalar Fields, Heisenberg Picture, Propagators, Non-Relativistic Fields.	**10**
Module-2	**Interacting Fields:** First Look at Scattering, Wick's Theorem, Feynman Diagrams, Examples of Scattering Amplitudes, Cross Sections and Decay Rates, Green's Functions.	**10**
Module-3	**The Dirac Equation:** Spinor Representation, Chiral Spinors, Weyl Equation, Parity, Majorana Fermions, Symmetries and Conserved Currents, Plane Wave Solutions.	**10**
Module-4	**Quantizing the Dirac Field:** Fermi-Dirac Statistics, Dirac's Hole Interpretation, Propagators, The Feynman Propagator, Yukawa Theory, Feynman Rules for Fermions.	**10**
Module-5	**Quantum Electrodynamics:** Maxwell's Equations, Quantization of the Electromagnetic Field, Coupling to Matter, QED, Feynman Rules, Scattering in QED.	**10**

Textbooks:

1. An Introduction to Quantum Field Theory, Peskin and Schroeder (1995).
2. Quantum theory of fields. Foundations. Volume 1, S. Weinberg (1995)

Reference books:

1. Quantum Field Theory in a Nutshell, A. Zee (2010)
2. Quantum Field Theory and the Standard Model, M. D. Schwartz (2013)
3. Quantum field theory, M. Srednicki (2007)

COURSE INFORMATION SHEET

Course code: PH519
Course title: Physics of Thin Films
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH519	**Title: Physics of Thin Films**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	Define vacuum and compare various vacuum pumps and gauges.	
2	Outline the thermodynamics of thin films.	
3	Illustrate the mechanism of thin film formation.	
4	Explain various techniques of thin film formation.	
5	Summarize various properties of thin films.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Demonstrate various types of pumps and gauges, inspect leak in vacuum and can design a vacuum system.	
2.	Define the thermodynamical parameters of thin films and can outline interdiffusion in thin films.	
3.	Demonstrate the stages of thin film formation and can outline the conditions for the formation of amorphous, crystalline and epitaxial films.	
4.	Illustrate and compare physical vapour deposition (PVD) and chemical vapour deposition (CVD) techniques.	
5.	Define various thin film properties and outline the techniques of their determination.	
Syllabus		
Module-1	**Vacuum Science & Technology:** Classification of vacuum ranges, Kinetic theory of gases, gas transport and pumping, Conductance and Throughput, Classification of vacuum pumps, single stage and double stage rotary pump, diffusion pump, turbomolecular pump, cryopump and Classification of gauges, Mechanical gauges: McLeod gauge, Thermal conductivity gauges: Pirani gauge and thermocouple gauge, Ionization gauges: Bayard-Alpert gauge, Penning gauge, leak detection.	**09**
Module-2	**Basic Thermodynamics of Thin Films** Solid surface, interphase surface, Surface energies: Binding energy and Interatomic Potential energy, latent heat, surface tension, Liquid surface energy measurement by capillary effect, by zero creep, magnitude of surface energy, General concept, jump frequency and diffusion flux, Fick's First law, Nonlinear diffusion, Fick's second law, calculation of diffusion coefficient, interdiffusion and diffusion in thin films.	**09**
Module-3	**Mechanisms of Film Formation** Stages of thin film formation: Nucleation, Adsorption, Surface diffusion, capillarity theory of nucleation, statistical theory of nucleation, growth and coalescence of islands, grain structure and microstructure of thin films, diffusion during film growth, polycrystalline and amorphous films, Theories of epitaxy, role of interfacial layer, epitaxial film growth, super lattice Structures.	**09**
Module-4	**Methods of Preparation of Thin Films:** Physical vapour deposition: Vacuum evaporation-Hertz- Knudsen equation, evaporation from a source and film thickness uniformity, Glow discharge and plasmas-Plasma structure, DC, RF and microwave excitation; Sputtering processes-Mechanism and sputtering yield, Sputtering of alloys; magnetron sputtering, Reactive sputtering; vacuum arc: cathodic and anodic vacuum arc deposition. Chemical vapour deposition: Thermodynamics of CVD, gas transport, growth kinetics, Plasma chemistry, plasma etching mechanisms; etch rate and selectivity, orientation dependent etching; PECVD.	**15**

Module-5	**Characterization of thin films**: Deposition rate, Film thickness and uniformity, Structural properties: Crystallographic properties, defects, residual stresses, adhesion, hardness, ductility, electrical properties, magnetic properties; optical properties.	**08**

Textbooks:

1. The Material Science of Thin Films by Milton Ohring, Academic Press, Inc., 1992.
2. Handbook of Thin Films by Maissel and Glang
3. Thin Film Phenomena by K. L. Chopra (McGraw Hill, 1969)

Reference books:

1. Thin Film Deposition: Principles & Practice by Donald L. Smith (McGraw Hill, 1995)
2. Coating Technology Handbook by D. Satas, A. A. Tracton, Marcel Dekkar Inc. USA.
3. Arc Plasma Technology in Material Science, P. A. Gerdeman and N. L. Hecht, Springer Verlag, 1972.

COURSE INFORMATION SHEET

Course code: PH520
Course title: Theory of Dielectrics and Ferroics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH520	**Title: Theory of Dielectrics and Ferroics**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To become familiar with the concept of polarization in ideal and non-ideal dielectrics.	
2	To be familiarized with electrochemical impedance spectroscopy.	
3	To become familiar with the theory of ferroelectricity using domain theory and understand different type of phase transition in ferroelectric materials.	
4	To acquire an understanding of the theory of ferromagnetism and know about the different types of magnetic ordering.	
5	To become familiar with the concept of multiferroics and different types of mechanisms by which multiferroics can be formed.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Able to differentiate between different type of dielectrics, ferroelectrics and able to interpret the experimental results with different theoretical models.	
2.	Able to apply the concept of relaxation, resonance and dispersion in dielectrics using frequency and time domain method.	
3.	Able to differentiate between different types of ferroelectric materials and able to calculate the recoverable energy, efficiency from the hysteresis loop.	
4.	Able to identify and compare different kinds of magnetic ordering.	
5.	Able to categorize different types of multiferroics based on the different mechanisms of their origin.	
Syllabus		
Module-1	Macroscopic theory of dielectrics: Polarization in dielectrics, Clausius-Mossotti relation for ideal dielectrics, Lorentz field, Debye correction to Clausius-Mossotti equation, frequency and temperature dependency of dielectrics, Temperature coefficient of dielectrics, dielectric losses. The double well potential model for polarization and determination of depth of potential wells.	**10**
Module-2	Dielectric spectroscopy: introduction to impedance spectroscopy, physical models for equivalent circuit elements, dielectric relaxation in materials with single time constant, distribution of relaxation time, interface and boundary conditions, grain boundary effects. Elementary idea of measurement technique in frequency and time domain methods.	**10**
Module-3	Ferroelectricity: Ferroelectricity, Microscopic theory of Ferroelectricity, Landau primer of ferroelectricity, Phase transition of ferroelectrics (1^{st}, 2^{nd} and relaxor kind), soft optical phonons, hysteresis loop, Recoverable energy, Piezoelectricity and energy harvesting, transducer.	**10**
Module-4	Ferromagnetism: Weiss model of a ferromagnet, magnetic susceptibility, effect of a magnetic field, origin of the molecular field, Weiss model of antiferromagnet, magnetic susceptibility, effect of a strong magnetic field, types of antiferromagnetic order, ferrimagnetism, helical order, spin glasses, frustration.	**10**

Module-5	Multiferroics: Ferroic, magnetoelectric, multiferroic, magnetodielectric, magnetoelectric coupling, Type I and Type II Multiferroics, charge-order driven multiferroicity, examples of charge-ordered driven multiferroicity, lone-pair electron multiferroic systems, geometric ferroelectricity, frustrated magnetism triggered ferroelectricity, applications of multiferroics: magnetoelectric switching, multiferroics for spintronics.	**10**

Textbooks:

1. Applied Electromagnetism and Materials by Andre Moliton, Springer, 2007
2. Magnetism in Condensed Matter, Oxford Master Series in Condensed Matter Physics 4, Stephen Blundell, Oxford University Press, 2001.
3. Multiferroic Materials: Properties, Techniques and Applications, Junling Wang, CRC Press, Taylor and Francis group, 2017.

COURSE INFORMATION SHEET

Course code: PH517
Course title: Nonconventional Energy Materials
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH517	**Title: Nonconventional Energy Materials**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To define the current scenario of the conventional sources of energy and importance of sustainable energy sources.	
2	To explain the basic of PN Junction solar cell.	
3	To define the solar cell characterization.	
4	To illustrate the various solar cell technologies.	
5	To explain the other nonconventional energy sources	
Course Outcomes: After the completion of this course, students will be able to		
1.	Explain the current status of conventional sources of energy and list the various sustainable energy sources.	
2.	Define various properties of the semiconducting materials, formation of PN junction and generation of photo-voltage and photo-current of PN Junction solar cell.	
3.	Demonstrate the measurement of solar cell parameters and solar cell design for high Isc, design for high Voc, design for high FF.	
4.	Explain the fabrication of wafer based solar cells, thin film solar cell, organic solar cells, dye-sensitized solar cell, GaAs solar cells, Thermo-photovoltaics and multijunction solar cells.	
5.	Discuss the concepts of wind energy, bio energy, tidal power, fuel cells, and solar thermal.	
Syllabus		
Module-1	Energy sources and their availability, conventional sources of energy: Fossil fuel, Hydraulic energy, nuclear energy: nuclear fission, nuclear fusion, Environmental impact of conventional sources of energy, Need for sustainable energy sources, Nonconventional energy sources, Current status of renewable energy sources.	**5**
Module-2	Structure of solar cell materials, direct and indirect band gap semiconductor, carrier concentration and distribution, drift and diffusion current densities, P-N Junction: space charge region, energy band diagram, carrier movements and current densities, carrier concentration profile; P-N junction in non-equilibrium condition, I-V Relation, P-N Junction under Illumination, Generation of photovoltage, Light generated current, I-V equation of solar cells.	**10**
Module-3	Solar Cell Characteristics and Cell parameters: short circuit current, open circuit voltage, fill factor, efficiency; losses in solar cells, Solar Cell Design: design for high Isc, design for high Voc, design for high FF; Solar spectrum at the Earth's surface, solar simulator: I-V measurement, quantum efficiency measurement, minority carrier lifetime and diffusion length measurement.	**10**
Module-4	Wafer-based Si solar cell fabrication: saw damage removal and surface texturing, P-N Junction formation, ARC and surface passivation, metal contacts—pattern defining and deposition. High efficiency solar cells, Thin Film Solar Cell Technologies: advantages of thin film technologies, thin films solar cell structures, thin film crystalline, microcrystalline, polycrystalline, and amorphous Si solar cells. Emerging solar cell technologies: working principle of organic solar cells, material properties and structure of organic solar cells; Dye-sensitized Solar Cell: working principle, materials and their properties; GaAs solar cells, Thermo-photovoltaics, multijunction solar cells.	**15**

Module-5	Other nonconventional Energy Sources: Wind Energy: Classification of windmills, advantages and disadvantage of wind energy; Bio Energy: Biogas and its compositions, process of bio gas, generation – wet process, dry process, utilization and benefits of biogas technology. Tidal Power: Introduction, classification of tidal power plants, factors affecting the suitability of the site for tidal power plant, advantages and disadvantages of tidal power plants. Fuel Cells: Introduction, working of fuel cell, types of fuel cells, advantages of fuel cell technology. Solar Thermal: Solar collectors, solar cookers, solar water heater.	**10**

Text / Reference Books:

1. Solar cells: Operating principles, technology and system applications by Martin A Green, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Semiconductor for solar cells, H J Moller, Artech House Inc, MA, USA, 1993.
3. Solis state electronic device, Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.
4. Direct energy conversion, M.A. Kettani, Addision Wesley Reading, 1970.
5. Handbook of Batteries and fuel cells, Linden, Mc Graw Hill, 1984.

COURSE INFORMATION SHEET

Course code: PH531
Course title: TOPOLOGICAL QUANTUM MATERIALS
Pre-requisite(s): Condensed Matter Physics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH531	**Title: TOPOLOGICAL QUANTUM MATERIALS**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	Exposure to recent topic/research trend in condensed matter physics.	
2	Basic ideas of topology in condensed matter systems.	
3	Know about topological insulators and semimetals.	
4	Know about material candidates.	
5	Know about related experimental techniques and results.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Understand the basic ideas of topology in the context of condensed matter systems.	
2.	Understand the physics and properties of topological insulators.	
3.	Overview of topological materials.	
4.	Compare between theoretical predictions and experimental measurements.	
5.	Prepare for potential research topics (PhD and Post-doc).	
Syllabus		
Module-1	**Review of basics and building blocks** - Review of band structure (Bloch waves, tight-binding models, k-p model, graphene) - Wannier orbitals, modern theory of polarization. - Berry phase (application to Dirac semimetal - graphene, absence ofbackscattering, anomalous velocity). - open v/s periodic boundary conditions, local density of states, edge states(Silicon graphene), surface states. - (atomic) spin-orbit coupling, Rashba spin-orbit coupling. - Crash course in linear response theory, Kubo formula. - Discrete symmetries, introduction to Dirac to Weyl Hamiltonians.	**16**
Module-2	**Quantum Hall Effect** - Classical Hall effect. - Quantum Hall effect – Carbino disc, Chern number. - Measurement of Hall systems, transverse conductivity. - Basic notion of topology, elementary mathematical description of topologyand differential geometry (homotopy, homology and cohomology).	**12**
Module-3	**Topological insulators I:** - Quantum spin Hall systems — Kane-Mele model. - 3D topological insulators with inversion symmetry. - 3D topological insulators without inversion symmetry. - Material candidates (graphene, transition metal dichalcogenides) and related experimental studies.	**09**

Module-4	**Topological insulators II:** - Strong and weak topological insulators. - Topological invariants. - First look at classification table.	**05**
Module-5	**Current status, challenges and outlook** - Overview of experimental methods (growth and characterization): comparison of growth techniques, magnetoresistance, STM, ARPES, etc. - What obscures measurement? — A general discussion - Material candidates for topological insulators — exposure to recentexperimental results – Outlook and open problems. -	**08**

Textbooks:

Solid-state Physics by Aschcroft and Mermin (Chapters 10-13) Condensed Matter Field

Theory by A. Altland and B. Simons (Chparter 9)

Band structure and Electronic Properties of Solids by J. Singleton, Oxford Masters Series (Chapter 2,4-6)

Topological insulators and superconductors by A. Bernevig and T. HughesTopological

insulators by J. Asboth

Reference books/links:

An introduction to topological insulators. M. Fruchart and D. Carpentier, C R Physique **14**, 779 (2013).Topology in Condensed Matter --- 'TopoCondMat' course by TU Delft. [https://topocondmat.org/] Bernevig, Hughes and Zhang, Science **314**, 1757 (2006).

Experiment: Koenig et al, Science **318**, 766 (2007).

Fu and Kane, PRB **76**, 045302 (2007).

Hsieh *et al.*, Nature **452**, 907 (2008).

Zhang *et al.*, Nature Physics **5**, 438 (2009).

Xia et al, Nature Physics **5**, 398 (2009).

Chen et al Science **325**, 178 (2009).

COURSE INFORMATION SHEET

Course code: PH533
Course title: Physics of Solid State Devices
Pre-requisite(s): Solid State Physics, Elements of Modern Physics
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH533	**Title: Physics of Solid State Devices**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	identify semiconductor properties important for understanding and calculating device characteristics.	
2	know the basic device building blocks that serves as the foundation of the physics of semiconductor devices.	
3	learn the transistor family, its operation and distinction between the field-effect transistors and potential-effect transistors (bipolar junction transistors).	
4	apply the theory of junctions and conduction processes to microwave and power devices.	
5	learn the fabrication process, importance of thin film technology in realizing modern devices.	
Course Outcomes: After the completion of this course, students will be able to		
1.	understand the characteristics, operation, and limitations of semiconductor devices.	
2.	understand the operation of MOSFET - most-important device for advanced integrated circuits, and important component in microprocessors and memories.	
3.	understand different types of transistors, their operational principles, and applications.	
4.	understand existing devices, so that their studies of electronic circuits and systems will be meaningful.	
5.	develop the understanding with which they can later learn about any future development in devices and applications.	
Syllabus		
Module-1	**Crystal Properties and Growth of Semiconductors** – semiconductor materials, crystal lattices, planes and directions, bulk crystal growth, epitaxial growth. **Energy Bands and Charge Carriers in Semiconductors** – bonding forces and energy bands in solids, charge carriers in semiconductors, effective mass, carrier concentration, Fermi level, space charge neutrality, drift of carriers in electric and magnetic fields. **Excess Carriers in Semiconductors** – optical absorption, luminescence, recombination, steady state carrier generation, quasi-Fermi level, diffusion of carriers, diffusion and drift of carriers, continuity equation.	**11**
Module-2	**Junctions**– p-n Junction, Equilibrium Condition, Space-Charge at a Junction, Contact Potential, Qualitative Description of Current Flow, Forward and Reverse Biased Junction, Steady State Conditions, Reverse Bias Breakdown, Capacitance of a p-n Junction, Deviation from Simple Theory – Effect of Carrier Injection, Varactor Diode, Metal-Semiconduction Junction – Schottky Barriers, Ohmic Contacts, Heterojunctions.	**08**

Module-3	**Field Effect Transistors** – Transistor Operation, Junction FET – Pinch-off and Saturation, Gate Control, Current-Voltage Characteristics, Metal-Semiconductor FET, Metal-Insulator-Semiconductor FET. **Metal-Oxide-Semiconductor FET (MOSFET)** – Basic Operation, Ideal MOS Capacitor, Effect of Real Surfaces, Threshold Voltage, Capacitance-Voltage Analysis, Current-Voltage Characteristics of MOS Gate Oxides, MOSFET Output and Transfer Characteristics, Mobility Models, Short Channel effect, Control of Threshold Voltage, Body Effect, Subthreshold Characteristics, MOSFET Scaling and Hot Electron Effects, Drain-Induced Barrier Lowering, Short Channel and Narrow Width Effects, Gate-Induced Drain Leakage, Advanced MOSFET Structures – Strained Si FETs, SOI MOSFETs and FinFETs. **Bipolar Junction Transistor (BJT)** – Fundamentals of BJT Operation, Amplification with BJT, Minority Carrier Distribution and Terminal Current, Biasing, Switching, Other Important Effects and Frequency Limitation.	**18**
Module-4	**Fabrication of MOSFET** – Materials, Bulk Crystal Growth, Doping, Epitaxy, Oxidation, Diffusion, Ion Implantation, Lithography – Optical and e-Beam, Etching processes. **Integrated circuits**– Introduction and Evolution, Monolithic Device Elements, Charge Transfer Devices, Memory Devices, Testing, Bonding and Packaging.	**08**
Module-5	**High-Frequency and High-Power Devices**– Tunnel Diodes and Devices, IMPATT Diode, Transferred Electron Mechanism, Gunn Diode, Nanoelectronic Devices.	**05**

Textbooks:

T1. Streetman, B.G. and Banerjee, S.K., Solid State Electronic Devices, 6th Edition, (PHI, 2005).

T2. Sze, S.M. and Kwok, K.Ng., Physics of Semiconductor Devices, 3rd Edition, (Wiley-Interscience, 2006).

Reference books:

R1. Neamen, D. A., Semiconductor Physics and Devices: Basic Principles, Third Edition, (McGraw-Hill, 2003).

R2. Quinn, J. J. and Yi, K.-S., Solid State Physics: Principles and Modern Applications, 1st Edition (Springer, 2009).

R3. Millman, J. and Halkias C. C., Integrated Electronics: Analog and Digital Circuits and Systems, 2nd Edition (Tata McGraw Hill, 2017).

COURSE INFORMATION SHEET

Course code: PH522
Course title: Holography and Applications
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH522	**Title: Holography and Applications**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To understand the basics of holograms and able to differentiate between holography and photography	
2	To acquire the knowledge of different types of holograms.	
3	To understand different materials used for hologram recordings and its merits and demerits.	
4	To have an idea of using holographic technique in varieties of diverse applications	
5	To acquire knowledge in holographic optical elements and to estimate how these optical elements can be utilized.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Able to identify the parameters which differentiate holograms from photographs	
2.	Able to distinguish between various types of holograms.	
3.	Able to analyze the different parameters of holographic recording materials.	
4.	Able to utilize holographic interferometric technique in various new applications	
5.	Able to experiment with holographic elements for various applications.	
Syllabus		
Module-1	**Basics of Holography:** Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms, In line Hologram, off axis hologram, Fourier Hologram, Lenses Fourier Hologram, Image Hologram, Fraunhofer Hologram. Holographic interferometer, double exposure hologram, real-time holography, digital holography, holographic camera.	**10**
Module-2	**Theory of Hologram:** Coupled wave theory, Thin Hologram, Volume Hologram, Transmission Hologram, Reflection Hologram, Anomalous Effect.	**08**
Module-3	**Recording Medium:** Microscopic Characteristics, Modulation transfer function, Diffraction efficiencies, Image Resolution, Nonlinearities, S/N ratio, Silver halide emulsion, Dichromated gelatin, Photoresist, Photochrometics, Photothermoplastics, photorefractive crystals.	**12**
Module-4	**Applications**: Microscopy, interferometry, NDT of engineering objects, particle sizing, holographic particle image velocimetry; imaging through aberrated media, phase amplification by holography; Optical testing; Information storage.	**12**
Module-5	**Holographic Optical Elements (HOE):** multifunction, holographic lenses, holographic mirror, holographic beam splitters, polarizing, diffuser, interconnects, couplers, scanners; Optical data processing, holographic solar connectors; antireflection coating, holophotoelasticity.	**08**

Textbooks:

1. Optical Holography, Principle Techniques and applications: P. Hariharan, Cambridge University Press
2. Holographic Recording materials; H.M.Smith, Springer Verlag

Reference books:

1. Lasers and Holography P C Mehta and V V Rampal, World Scientific

COURSE INFORMATION SHEET

Course code: PH524R1
Course title:
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH524R1	**Title:**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1		
2		
3		
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Course Outcomes: After the completion of this course, students will be able to		
1.		
2.		
3.		
4.		
5.		
Syllabus		
Module-1	**Nanophotonics:** Foundations for Nanophotonics: similarities and differences of photons and electrons and their confinement. Propagation through a classically forbidden zone: tunnelling. Localization under a periodic potential: Band gap. Cooperative effects for photons and electrons. Nanoscale optical interactions, axial and lateral nanoscopic localization, scanning near-field optical microscopy. Nanoscale confinement of electronic interactions: Quantum confinement effects, nanoscale interaction dynamics, nanoscale electronic energy transfer. Cooperative emissions.	**10**
Module-2	**Quantum confined materials**: Quantum wells, quantum wired, quantum dots, quantum rings and superlattices. Quantum confinement, density of states, optical properties. Quantum confined stark effect. Dielectric confinement effect, Core-shell quantum dots and quantum-dot-quantum wells. Quantum confined structures as lasing media. Organic quantum-confined structures.	**10**
Module-3	**Photonic crystals*:*** Electronic Vs Photonic Crystals, Band-Gap in Photonic Crystals, Theoretical Modeling of Photonic Crystals (1D Photonic Crystal), Dispersion in 1D Photonic Crystals, Detail derivation for 1-D Photonics Crystal for obtaining Band Diagram, Defects in photonics crystals, properties of Photonics Crystals, Fabrication Techniques for Photonic Crystals, Fiber Bragg-grating, Applications of Photonic Crystals: Photonic Components using 2D Photonic Crystals, Micro-cavity Effect in 3D Photonic Crystals, Photonic Crystal Optical Fibers.	**12**
Module-4	**Plasmonics:** Optical properties of solids, Drude-Sommerfeld theory, Interband transitions, Plasmons on planar metal surface, Surface plasmons in a spherical metal nanoparticle and nanoshells, Applications of Plasmonics: Biosensor, waveguide, Surface Enhanced Raman Scattering, Metal Enhanced Fluorescence.	**10**

Module-5	**Nanocontrol of excitation dynamics:** Excited states in atoms and molecules (homo- and hetero-atomic molecules), meaning of excitation dynamics, control of excitation dynamics in small organic molecules, Excitation dynamics in d-block element atoms/ions, linear and nonlinear optical processes: energy up-conversion, photon avalanche, and quantum cutting).	**08**

Textbooks:

1. Nanophotonics by Paras N. Prasad, Publisher: John Wiley & Sons.
2. Photonics crystals: Molding the flow of light by J. D. Joannopoulos, S. G. Johnson, J. N. Winn and R. D. Meade, Publisher: Princton University Press.
3. Plasmonics: Fundamentals and Applications by Stefan Alexander Maier, Publisher: Springer.

COURSE INFORMATION SHEET

Course code: PH508
Course title: Quantum and Nonlinear Optics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH508	**Title: Quantum and Nonlinear Optics**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To identify the phenomenon of the nonlinear optical interaction of light with matter	
2	To examine higher harmonic generations, two-photon absorption and stimulated scattering phenomenon	
3	To formulate nonlinear optics in two-level approximations	
4	To analyze intensity dependent phenomenon	
5	To identify nonlinear optical phenomenon for applications in optical devices	
Course Outcomes: After the completion of this course, students will be able to		
1.	Able to judge non-linear optical phenomenon	
2.	Apply knowledge of nonlinear optical phenomena in higher harmonic generations, two-photo absorption and stimulated scattering phenomenon	
3.	To solve nonlinear optical interaction problem in two-level system	
4.	To evaluate intensity dependent material properties like refractive indices and self-focusing	
5.	To design non-linear optical devices	
Syllabus		
Module-1	Nonlinear Optical Phenomena: Introduction to nonlinear optics, description of nonlinear optical interaction, phenomenological theory of nonlinearity, nonlinear optical susceptibilities. Sum and difference frequency generation, second harmonic generation, coupled wave equation.	**10**
Module-2	Manley-Rowe relations, phase matching of SHG, quasi phase matching, electric field induced SHG (EIFISH), optical parametric amplification, third harmonic generation, two-photon absorption. Stimulated Raman scattering and stimulated Brillouin scattering.	**10**
Module-3	Two level atoms: nonlinear optics in two level approximations, density matrix equation, closed and open two-level atoms, steady state response in monochromatic field, Rabi oscillations, dressed atomic state, optical wave mixing in two level systems, photon echo, self-induced transparency, optical nutation, free induction decay.	**10**
Module-4	Intensity dependent phenomena: intensity dependent refractive index, self-focusing, self-phase modulation, spectral broadening, optical continuum generation by short optical pulse. Optical phase conjugation, application of OPC in signal processing. Self-induced transparency, spatial and temporal solitons, solitons in Kerr media, photorefractive and quadratic solitons, Soliton pulses, optical vortices. Pulse compression.	**12**
Module-5	Nonlinear guided wave optical devices: nonlinear planar waveguide, nonlinear channel waveguide, nonlinear directional coupler, nonlinear mode sorter, nonlinear Mach-Zehnder interferometer and logic gate, Nonlinear loop mirror.	**8**

Textbooks:

Fundamentals of Nonlinear Optics; P.E.Powers, CRC Press Francis and Taylor (2011)
Principles of Nonlinear Optics; Y.R.Shen
Nonlinear Optics: Robert Boyd, Academic press

Recommended Texts:

Physics of Nonlinear Optics: Guang- Sheng –He and So ng-Hao Lin; World Scientific.
Two Level Resonances in Atoms; Allen and J.H. Emberly, John Wiley.

COURSE INFORMATION SHEET

Course code: PH523
Course title: Quantum photonics and applications
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH523	**Title: Quantum photonics and applications**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To assess light-matter interaction at the nanoscale (1-100 nm) in terms of photon statistics for identification of single photon sources.	
2	To Identify various plasmonic nanoantenna (nanoparticles, nanorods) for enhanced electromagnetic Interaction.	
3	To identify a source of single photons and discuss a method to detect the single photons efficiently.	
4	To design chip scale devices for propagation of single photons for quantum communications.	
5	To assess the present status and future applications of single photons in quantum technology.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Able to identify semiconducting quantum dot as a single photon source.	
2.	To develop skills of designing a suitable metal nanoantenna for enhanced light-matter interaction, thus making single photon source faster and brighter.	
3.	To characterize (theoretically) whether a given source of the photon, is a single photon source.	
4.	To design (theoretically) photonic circuits for the propagation of single photons on semiconductor and metallic platform.	
5.	To understand the modern and future scope of quantum communication.	
Syllabus		
Module-1	Classical optical communications and their limitations, quantum optical communications, Semiconducting quantum dots, quantum dot single photon sources, classification of light states and photon statistics. Photon detection and correlation function. Single-Photon Pulses and Indistinguishability of Photons.	**12**
Module-2	Plasmonic nanoantennas, fabrications, characterizations and applications in quantum communications devices.	**08**
Module-3	Single photon sources for quantum information: Fabrication and characterizations, Han burry Brown and Twiss measurements (single photons characterization), The Hong–Ou–Mandel effect (indistinguishability test).	**12**
Module-4	Resonant excitation of single photon sources, Integrated quantum photonic circuits and devices, semiconductor, metallic platform, single photon filtering and multiplexing. .	**08**
Module-5	Principles of quantum key distribution (QKD), Implementing QKD, Fiber-based QKD, Free-space QKD, Diamond-based single-photon sources and their application in quantum key distribution, Quantum repeaters	**10**

Reference:

1. Michler, P. (Ed.). (2009). Single semiconductor quantum dots (Vol. 28). Berlin: Springer.
2. Novotny, L. & Hecht, B., Principles of nano-optics, Cambridge university press, 2006
3. Lounis, B., &Orrit, M. (2005). Single-photon sources. Reports on Progress in Physics, 68(5), 1129.
4. Prawer, Steven, and Igor Aharonovich, eds. Quantum information processing with diamond: Principles and applications. Elsevier, 2014.
5. Briegel , H.-J. , Dürr , W. , Cirac , J. I. and Zoller , P. (1998) ‘ Quantum repeaters: The role of imperfect local operations in quantum communication ’, Phys Rev Lett , 81 , 5932 – 5935.

COURSE INFORMATION SHEET

Course code: PH525
Course title: Microprocessor and Microcontroller Applications
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH525	**Title: Microprocessor and Microcontroller Applications**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	The first module introduces architecture of 8085 and 8086 Microprocessor.	
2	The module-2 is compilation of information about I/O communication Interface.	
3	Microcontrollers (8051), its architecture and working is subject of module-3	
4	The 4th module contains Real time control sequences and programming of 8051-microcontroller.	
5	The AVR RISC microcontroller architecture is covered in module-5.	
Course Outcomes: After the completion of this course, students will be able to		
1.	The course intends to impart knowledge of Microprocessors and microcontrollers to enable learners gain the knowledge of basics of Modern computation.	
2.	Knowledge of 8085/8086 architecture would make learners rich about working and design of microprocessors and microcontrollers.	
3.	The course also includes information about microcontrollers, real time control of 8051 and AVR RISC microcontroller architecture. This would enable learners to understand fundamentals of microcontrollers and implement it to design / use microcontroller for new environments.	
Syllabus		
Module-1	**8086 Architecture** Introduction to 8085 Microprocessor, 8086 Architecture-Functional diagram. Register Organization, Memory Segmentation. Programming Mode. Memory addresses. Physical memory organization. Architecture of 8086, signal descriptions of 8086-common function signals. Minimum and Maximum mode signals. Timing diagrams. Interrupts of 8086. Instruction Set and Assembly Language Programming of 8086: Instruction formats, addressing modes, instruction set, assembler directives, macros, simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations.	**15**
Module-2	**I/O and Communication Interface:** 8255 PPI various modes of operation and interfacing to 8086. Interfacing keyboard, display, stepper motor interfacing, D/A and A/D converter. Memory interfacing to 8086, Interrupt structure of 8086, Vector interrupt table, Interrupt service routine, Introduction to DOS and BIOS interrupts, Interfacing Interrupt Controller 8259 DMA Controller 8257 to 8086. Communication interface: Serial communication standards, Serial data transfer schemes. 8251 USART architecture and interfacing, RS-232, IEEE-4-88, Prototyping and trouble shooting.	**15**
Module-3	**Introduction to Microcontrollers:** Overview of 8051 microcontroller. Architecture. I/O Ports. Memory organization, addressing modes and instruction set of 8051, simple programs.	**06**
Module-4	**8051 Real Time Control:** Interrupts, timer/ Counter and serial communication, programming Timer Interrupts, programming external hardware interrupts, programming the serial communication interrupts, programming 8051 timers and counters.	**07**

Module-5	**The AVR RISC microcontroller architecture:** Introduction, AVR Family architecture, Register File, The ALU. Memory access and Instruction execution. I/O memory. EEPROM. I/O ports. Timers. UART. Interrupt Structure.	**07**

TEXTBOOKS:

1 D. V. Hall. Microprocessors and Interfacing, TMGH. 2'1 edition 2006.

2 Kenneth. J. Ayala. The 8051 microcontroller, 3rd edition, Cengage learning, 2010

REFERENCE BOOKS:

1 Advanced Microprocessors and Peripherals -A. K. Ray and K.M. Bhurchandani, TMH, 2nd edition 2006.

2 The 8051 Microcontrollers, Architecture and programming and Applications -K. Uma Rao, Andhe Pallavi, Pearson, 2009.

3 Microcomputer System 8086/8088 Family Architecture. Programming and Design -By Liu and GA Gibson, PHI, 2nd Ed.,

4 Microcontrollers and application, Ajay. V. Deshmukh, TMGH. 2005

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH526
Course title: Integrated Electronics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH526	**Title: Integrated Electronics**	**L-T-P-C [4-0-0-4]**
Course Objectives:		
1	First module of the course contains information about various type of circuitry to achieve logic processing for digital devices.	
2	The second module of the course would introduce the learners to the processes currently being followed in foundry for fabrication of Integrated devices.	
3	The learners should explain different nanoscale devices.	
4	The working and construction of nanoscale electronic devices is covered in Module-4.	
5	The final module, module-5 contains an account of functional thin films, nanostructures and their applications. Information contained in this module bridges ongoing research with the course taught.	
Course Outcomes:		
1.	This course would introduce students about designing and making process of integrated devices.	
2.	The various fabrication process taught in module-II would enrich their knowledge to various foundry fabrication processes enabling them with skills of nanofabrication.	
3.	Knowledge of functioning and construction of nanoscale electronic devices would cater the need to keep them update with recent technologies in the field.	
4.	Knowledge of functioning and construction of nanoscale optoelectronic devices would cater the need to keep them update with recent technologies in the field.	
5.	Knowledge of various types of functional thin films, nanostructures and their applications would enable learners understand working of presently used various type of sensors and devices.	
Syllabus		
Module-1	**Logic Families** Diode Transistor Logic, High Threshold Logic, Transistor-transistor Logic, Resistor- transistor Logic, Direct Coupled Transistor Logic, Comparison of Logic families.	**5**
Module-2	**Integrated Chip Technology** Overview of semiconductor industry, Stages of Manufacturing, Process and product trends, Crystal growth, Basic wafer fabrication operations, process yields, semiconductor material preparation, yield measurement, contamination sources, clean room construction, substrates, diffusion, oxidation and photolithography, doping and depositions, implantation, rapid thermal processing, metallization. patterning process, Photoresists, physical properties of photoresists, Storage and control of photoresists, photo masking process, Hard bake, develop inspect, Dry etching Wet etching, resist stripping, Doping and depositions: Diffusion process steps, deposition, Drive-in oxidation, Ion implantation, CVD basics, CVD process steps, Low pressure CVD systems, Plasma enhanced CVD systems, Vapour phase epitoxy, molecular beam epitaxy. Design rules and Scaling, BICMOS ICs: Choice of transistor types, pnp transistors, Resistors, capacitors, Packaging: Chip characteristics, package functions, package operations.	**20**

Module-3	**Nanoelectronic devices** Effect of shrinking the p-n junction and bipolar transistor; field-effect transistors, MOSFETs, Introduction, CMOS scaling, the nanoscale MOSFET, vertical MOSFETs, electrical characteristics of sub-100 nm MOS transistors, limits to scaling, system integration limits (interconnect issues etc.), heterostructure and heterojunction devices, ballistic transport and high-electron-mobility devices, HEMT, Carbon Nanotube Transistor, single electron effects, Coulomb blockade. Single Electron Transistor, Resonant Tunneling Diode, Resonant Tunneling Transistor, applications in high frequency and digital electronic circuits and comparison with competitive devices.	**15**
Module-4	**Nano-Optoelectronic devices** Direct and indirect band gap semiconductors, QWLED, QW Laser, Quantum Cascade Laser Integrated Micromachining Technologies for Transducer Fabrication.	**5**
Module-5	**Applications of Functional Thin Films and Nanostructures** Functional Thin Films and Nanostructures for Gas Sensing, Chemical Sensors, Applications of Functional Thin Films for Mechanical sensing, Sensing Infrared signals by Functional Films.	**5**

Textbooks and Reference Books:

1 Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, McGraw-Hill, 1977

2 S.M. Sze, Ed, Modern Semiconductor Device Physics, Wiley, New York

3 S.M. Sze and K.K. Ng, Physics of Semiconductor Devices, 3rd Ed, Wiley, Hoboken.

4 S. Wolf and R.N. Tauber, Silicon Processing, vol. 1, (Lattice Press)

5 S.Wolf and R. N. Tauber, Silicon Processing for the VLSI Era. (Lattice Press, 2000)

6 Streetman, B.G. Solid State Electronic Devices, Prentice Hall, Fifth Edition, 2000

7 R. D. Doering and Y. Nishi, Handbook of Semiconductor Manufacturing Technology, CRC Press, Boca Raton.

8 W. R. Fahrner (Editor), Nanotechnology and Nanoelectronics, Materials, Devices, Measurement Techniques

9 Anis Zribi, Jeffrey Fortin (Editors), Functional Thin Films and Nanostructures for Sensors Synthesis, Physics, and Applications.

COURSE INFORMATION SHEET

Course code: PH527
Course title: Microwave Electronics
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH527	Title: Microwave Electronics	L-T-P-C [4-0-0-4]
Course Objectives: This course enables the students to		
1	Module-1 contains information about Transmission lines and wave-guides.	
2	The design and working of various types of micro-wave sources is covered in module-II.	
3	Module-III contains information about various types of stripline, microstrip lines and Network analysis.	
4	Knowledge about Micro-wave passive components and methods to measure various microwave parameters are planned to be covered in Module-IV.	
5	Module-V contains information about design, fabrication and working of microwave integrated circuit technology.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Leaner would gain knowledge about working, design and application of microwave frequency electronics.	
2.	The course is intended to enrich the learner about Microwave transmission lines and waveguides. Through it students would be able to understand the propagation of microwave through transmission lines and Waveguides.	
3.	Learner would gather understanding of devices used for microwave generation, detection and microwave network analysis	
4.	Learner would also enrich their knowledge in terms of various microwave passive components, microwave parameters and microwave integrated circuit technology	
Syllabus		
Module-1	**Transmission lines and Waveguides** Introduction of Microwaves and their applications. Types of Transmission lines, Characterization in terms of primary and secondary constants, Characteristic impedance, General wave equation, Loss less propagation, Propagation constant, Wave reflection at discontinuities, Voltage standing wave ratio, Transmission line of finite length, The Smith Chart, Smith Chart calculations for lossy lines, Impedance matching by Quarter wave transformer, Single and double stub matching. Rectangular Waveguides: TE and TM wave solutions, Field patterns, Wave impedance and Power flow.	**12**
Module-2	**Microwave Sources** Microwave Linear-Beam (O type) and Crossed-Field tubes (M type), Limitations of conventional tubes at microwave frequencies, Klystron, Multicavity Klystron Amplifiers, Reflex Klystrons, Helix Travelling-wave tubes, magnetron Oscillators. Tunnel diode, TED ¬Gunn diode, Avalanche transit time devices IMPATT (also TRAPAT) and parametric devices.	**7**

Module-3	**Stripline and microstrip lines and Network analysis** Dominant mode of propagation, Field patterns, Characteristic impedance, Basic design formulas and characteristics. Parallel coupled striplines and microstrip lines-Even-and odd-mode excitations. Slot lines and Coplanar lines. Advantages over waveguides. Microwave Network Analysis: Impedance and Admittance matrices, Scattering matrix, Parameters of reciprocal and Loss less networks, ABCD Matrix, Scattering matrices of typical two-port, three-port and four-port networks, Conversion between two-port network matrices.	**11**
Module-4	**Microwave Passive Components and measurements** Waveguide Components: E-plane and H-plane Tees, Magic Tee, Shorting plunger, Directional couplers, and Attenuator. Stripline and Microstrip line Components: Open and shorted ends. Half wave resonator, Lumped elements (inductors, capacitors and resistors) in microstrip. Ring resonator, 3-dB branchline coupler, backward wave coupler, Wilkinson power dividers and rat-race hybrid ring. Low pass and band pass filters. Microwave Measurements: Detection of microwaves, Microwave power measurement, Impedance measurement, Measurement of reflection loss (VSWR), and transmission loss in components. Passive and active circuit measurement & characterization using network analyzer, spectrum analyzer and noise-figure meter.	**14**
Module-5	**Microwave Integrated Circuit Technology** Substrates for Microwave Integrated Circuits (MICs) and their properties. Hybrid technology – Photolithographic process, deposited and discrete lumped components. Microwave Monolithic Integrated Circuit (MMIC) technology-Substrates, MMIC process, comparison with hybrid integrated circuit technology (MIC technology).	**6**

RECOMMENDED BOOKS:

1 Electromagnetic Waves and Radiating Systems – E.C. Jordan & K.G. Balmain, Prentice Hall, Inc.

2 Microwave Devices and Circuits -S. Y. LIAO, PHI

3 Introduction to Microwave Theory and Measurements – L. A. Lance, TMH

4 Transmission lines and Networks – Walter C. Johnson, McGraw Hill, New Delhi

5 Networks Lines and Fields – John D. Ryder

6 Microwave Engineering: Passive Circuits -Peter A. Razi, Prentice Hall of India Pvt. Ltd, New Delhi.

7 Waveguides – H.R.L. Lamont, Methuen and Company Limited, London

8 Foundations for Microwave Engineering – Robert E. Collin, McGraw Hill Book Company, New Delhi

9 Microwave Engineering – Annapurna Das, TMH, New Delhi

COURSE INFORMATION SHEET

Course code: PH528
Course title: Theory of Plasmas
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH528	**Title: Theory of Plasmas**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students to		
1	To learn about the similarity of plasma with fluid.	
2	To learn about the diffusion and mobility of plasma.	
3	To learn about the resistivity and single fluid MHD equation of plasma.	
4	To learn about the Boltzmann and the Vlasov equation.	
5	To learn about the different type of discharges.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Be familiar about the method by which plasma can be treated as a fluid.	
2.	Be familiar with the diffusion and mobility process.	
3.	Be able to derive the set of single fluid MHD equation.	
4.	Be able to describe plasma with Boltzmann and Vlasov equation.	
5.	Be familiar with the different type of electrical discharges.	
Syllabus		
Module-1	Relation of plasma physics to ordinary electromagnetic field, Fluid equation of motion, Fluid drifts perpendicular to B, Fluids drifts parallel to B, Plasma approximation.	**10**
Module-2	Diffusion and mobility in weakly ionized gases, Decay of a plasma by diffusion, steady state solution, Recombination, diffusion across a magnetic field, collision in fully ionized plasma.	**10**
Module-3	Mechanics of coulomb collisions, Physical meaning of resistivity, Numerical value of resistivity, Single fluid MHD equations, Diffusion in fully ionized plasma, Bohm diffusion and Neoclassical diffusion.	**10**
Module-4	Concepts of elementary kinetic theory of plasmas, The meaning of distribution function, Boltzmann and Vlasov equation.	**10**
Module-5	Electrical discharges, Electrical breakdown in gases, glow discharge, Self-sustained discharges, Paschen curve, High frequency electrical discharge in gases, electrode less discharge, capacitively and inductively coupled plasmas, ECR Plasmas, Electrical arcs.	**10**

References

1. Gas Discharge Physics, Y. P. Raizer, Springer, 1997.
2. Introduction to Plasma Physics and Controlled Fusion, Francis, F. Chen, Plenum Press, 1984.
3. Fundamental of Plasma Physics, J. A. Bittencourt, Springer-Verlag New York Inc., 2004.
4. Plasma Physics (Plasma State of Matter) S. N. Sen, Pragati Prakashan, 1999.

COURSE INFORMATION SHEET

Course code: PH529
Course title: Plasma Confinement
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH529	Title: Plasma Confinement	L-T-P-C [4-0-0-4]
Course Objectives: This course enables the students to		
1	To learn about the fundamental and basics of plasma confinement.	
2	To learn about the Magnetic confinement scheme and related heating mechanism.	
3	To learn about the transport of plasma.	
4	To learn about plasma-surface interaction.	
5	To learn about the Magnetohydrodynamics generator.	
Course Outcomes: After the completion of this course, students will be able to		
1.	Will be familiar with the plasma confinement for thermonuclear fusion.	
2.	Will have an idea how plasma can be confined magnetically.	
3.	Be familiar with the transport of plasma and its role in thermonuclear fusion.	
4.	Be familiar with plasma surface interaction and its role in fusion.	
5.	Be familiar with the energy generation by MHD generator.	
Syllabus		
Module-1	Nuclear Fusion and plasma physics: Fusion as energy source, Fusion reactions, Controlled thermonuclear fusion and fusion reactor, Lawson criterion, Ignition, Fuel resources, Reactor economics, Plasma confinement schemes, Magnetic confinement, Inertial confinement, Laser-Fusion.	**10**
Module-2	Magnetic confinement: Larmor orbits, particle drifts, Magnetic mirror, Z-pinch, Theta-pinch, spheromak, Tokamak, safety factor, plasma beta, Aspect-ratio, Flux surfaces, plasma current, Grad-Shafranov equation, collisions, kinetic equation, Fokker-Planck equation, collision times, resistivity, plasma heating, Ohmic heating, RF heating, Neutral beam heating.	**10**
Module-3	Collisional Transport: Classical transport – minimal dissipation, diffusion, random walk estimate, heat conductivity, Fluid evolution in a torus – transport closure, radial fluxes, neoclassical transport, Surface flows, Axis symmetric fluxes.	**10**
Module-4	Plasma-surface interaction: Plasma surface interactions, Boundary layer, Recycling, Atomic and molecular processes, Desorption and wall cleaning, Sputtering, Arcing, Limiters, Divertors, Heat flux, Evaporation and heat transfer, Tritium inventory. Radiation from Plasma.	**10**
Module-5	MHD Generator: Magnetohydrodynamic Generator, Basic theory, Principle of working, The fuel in MHD, Magnet in MHD Generator.	**10**

References

1. Plasma Physics (Plasma State of Matter) S. N. Sen, Pragati Prakashan, 1999.
2. Magnetic Fusion Technology, T. J. Dolan, 2014.
3. Plasma Physics and Fusion energy, J. P. Freidberg Cambridge University Press, 2008.
4. Tokamaks, J. Wessen, Oxford Science Publication, 1987.

<u>**COURSE INFORMATION SHEET**</u>

Course code: PH530
Course title: Waves and Instabilities in Plasma
Pre-requisite(s):
Co- requisite(s):
Credits: 4 L: 4 T:0 P: 0
Classes schedule per week: 4
Class: I.M.Sc.
Semester / Level: X / V
Branch: PHYSICS

Code: PH530	**Title: Waves and Instabilities in Plasma**	**L-T-P-C [4-0-0-4]**
Course Objectives: This course enables the students		
1	To learn the fundamental and basics of Plasma waves.	
2	To learn about the electromagnetic waves.	
3	To learn about the Landau Damping.	
4	To learn about the different type of instabilities.	
5	To learn about the MHD stability.	
Course Outcomes: After the completion of this course, students		
1.	Will be familiar with the plasma waves.	
2.	Will be able to handle electromagnetic waves mathematically.	
3.	Will be able to derive mathematically Landau damping related concept.	
4.	Will be familiar with the different type of instabilities.	
5.	Will be able to handle MHD stability mathematically.	
Syllabus		
Module-1	Representations of waves, group velocity, Plasma Oscillations, Electron plasma waves, sound waves, ion waves, validity of plasma approximations, comparison of ion and electron waves, electrostatic electron oscillations perpendicular to B.	**10**
Module-2	Electrostatic ion waves perpendicular to B, The lower hybrid frequency, electromagnetic waves with B=0, Experimental applications, electromagnetic waves perpendicular to B, Cutoffs and resonances, electromagnetic waves parallel to B, Whistler mode, Faraday rotation.	**10**
Module-3	Hydromagnetic waves, Magnetosonic waves, Alfven waves, Plasma oscillations and Landau damping, A physical derivation of Landau damping.	**10**
Module-4	Equilibrium and stability, Hydromagnetic equilibrium, Diffusion of magnetic field into a plasma, Classification of instabilities, two stream instability, The gravitational instability, Resistive drift waves.	**10**
Module-5	MHD stability, Energy principle, Kink instability, Internal kink, tearing modes, Resistive layer, Tearing stability, Mercier criterion, Ballooning modes, Beta limit.	**10**

<u>**References**</u>

1. Tokamaks, J. Wessons, 1987, Oxford Science Publication.
2. Introduction to Plasma Physics, F. F. Chen.
3. The theory of plasma waves, T. H. Stix, 1962, McGraw-Hill New York.
4. Fundamental of Plasma Physics, J. A. Bittencourt, Springer-Verlag New York Inc., 2004