M.Sc. PHYSICS

LOCF SYLLABUS – 2021

SCHOOLS OF EXCELLENCE

WITH CHOICE BASED CREDIT SYSTEM (CBCS)

DEPARTMENT OF PHYSICS
SCHOOL OF PHYSICAL SCIENCES
ST.JOSEPH'S COLLEGE (AUTONOMOUS)
Special Heritage Status Awarded by UGC
Accredited at A^{++} Grade (IV Cycle) by NAAC
College with Potential for Excellence by UGC
DBT-STAR & DST-FIST Sponsored College
Tiruchirappalli - 620 002, Tamil Nadu, India

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS)
POSTGRADUATE COURSES

St. Joseph's College (Autonomous), a pioneer in higher education in India, strives to maintain and uphold the academic excellence. In this regard, it has initiated the implementation of five "Schools of Excellence" from the academic year 2014 – 15, to meet and excel the challenges of the 21st century.

Each School integrates related disciplines under one roof. The school system enhances the optimal utilization of both human and infrastructural resources. It also enhances academic mobility and enriches employability. The School system preserves the identity, autonomy and uniqueness of every department and reinforces Student centric curriculum designing and skill imparting. These five schools adhere to achieve and accomplish the following objectives.

Optimal utilization of resources both human and material for the academic flexibility leading to excellence.

Students experience or enjoy their choice of courses and credits for their horizontal mobility.

The existing curricular structure as specified by TANSCHE and other higher educational institutions facilitate the Credit-Transfer Across the Disciplines (CTAD) - a uniqueness of the choice based credit system.

Human excellence in specialized areas

Thrust in internship and / or projects as a lead towards research and

The multi-discipline nature of the School System caters to the needs of stake-holders, especially the employers.

Credit system:

Weightage to a course is given in relation to the hours assigned for the course. Generally one hour per week has one credit. For viability and conformity to the guidelines credits are awarded irrespective of the teaching hours. The credits and hours of each course of a programme is given in the table of Programme Pattern. However, there could be some flexibility because of practical, field visits, tutorials and nature of project work.

For PG courses, a student must earn a minimum of 110 credits as mentioned in the programme pattern table. The total number of minimum courses offered by the Department is given in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)
LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

OBE is an educational theory that bases each part of an educational system around goals (outcomes). By the end of the educational experience, each student should have achieved the goal. There is no single specified style of teaching or assessment in OBE; instead, classes, opportunities and assessments should all help the students achieve the specific outcomes

Outcome Based Education, as the name suggests depends on Outcomes and not Inputs. The outcomes in OBE are expected to be measurable. In fact each Educational Institute can state its own outcomes. The ultimate goal is to ensure that there is a correlation between education and employability

Outcome –Based Education (OBE): is a student-centric teaching and learning methodology in which the course delivery, assessment are planned to achieve, stated objectives and outcomes. It focuses on measuring student performance i.e. outcomes at different levels.

Some important aspects of the Outcome Based Education

Course: is defined as a theory, practical or theory cum practical subject studied in a semester.

Course Outcomes (COs): are statements that describe significant and essential learning that learners have achieved, and can reliably demonstrate at the end of a course. Generally three or more course outcomes may be specified for each course based on its weightage.

Programme: is defined as the specialization or discipline of a Degree.

Programme Outcomes (POs): Programme outcomes are narrower statements that describe what students are expected to be able to do by the time of graduation. POs are expected to be aligned closely with Graduate Attributes.

Programme Specific Outcomes (PSOs):

PSOs are what the students should be able to do at the time of graduation with reference to a specific discipline.

Programme Educational Objectives (PEOs): The PEOs of a programme are the statements that describe the expected achievement of graduates in their career, and also in particular, what the graduates are expected to perform and achieve during the first few years after Graduation.

Some important terminologies repeatedly used in LOCF.

Core Courses (CC)

A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course. These are the courses which provide basic understanding of their main discipline. In order to maintain a requisite standard certain core courses must be included in an academic program. This helps in providing a universal recognition to the said academic program.

Discipline Specific Elective Courses (DSE)

Elective course may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective (DSE). These courses offer the flexibility of selection of options from a pool of courses. These are considered specialized or advanced to that particular programme and provide extensive exposure in the area chosen; these are also more applied in nature.

DSE: Four courses are offered, one course in each semester.

Note: To offer **one DSE**, a minimum of two courses of equal importance / weightage is a must.

One DSE Course in semester two is offered as interdisciplinary/common course among the departments in a School (Common Core Course) at the PG level.

Generic Elective Courses

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

Generic Elective courses are designed for the students of **other disciplines**. Thus, as per the CBCS policy, the students pursuing particular disciplines would have to opt Generic Elective courses offered by other disciplines, as per the basket of courses offered by the college. The scope of the Generic Elective (GE) Courses is positively related to the diversity of disciplines in which programmes are being offered by the college.

Two GE Courses are offered, one each in semesters II and III. The GE course offered in semester II is within the school level and the GE in semester III is Between Schools level

The Ability Enhancement Courses (AEC)

One Main discipline related Ability Enhancement Course for 3 credits is offered for a PG programme by the Department.

Skill Enhancement Courses (SECs)

These courses focus on developing skills or proficiencies in the student, and aim at providing hands-on training. Skill enhancement courses can be opted by the students of any other discipline, but are highly suitable for students pursuing their academic programme.

One SEC is offered in semester II as a compulsory course on Soft Skills, offered by the Department of Human Excellence, common to all the students of PG programme.

Self–paced Learning: It is a course for two credits. It is offered to promote the habit of independent/self learning of Students. Since it is a two credit course, syllabus is framed to complete within 45 hours. It is not taught in the regular working hours.

Comprehensive Examinations: A detailed syllabus consisting of five units to be chosen from the courses offered over the five semesters which are of immense importance and those portions which could not be accommodated in the regular syllabus.

Extra Credit Courses: In order to facilitate the students, gaining knowledge/skills by attending online courses MOOC, credits are awarded as extra credits, the extra credit are at three semesters after verifying the course completion certificates. According to the guidelines of UGC, the students are encouraged to avail this option of enriching their knowledge by enrolling themselves in the Massive Open Online Courses (MOOC) provided by various portals such as SWAYAM, NPTEL and etc.

Course Coding:

The following code system (10 alphanumeric characters) is adopted for Post Graduate courses:

21	PXX	N	XX	NN/NNX
Year of Revision	PG Department Code	Semester number.	Part Category	running number/with choice

N:- Numerals X :- Alphabet

Part Category

CC - Core Theory

CP- Core Practical

IS- Internship

SP- Self Paced Learning

CE- Comprehensive Examination

PW- Project Work & viva-voce

Electives Courses

ES – Department Specific Electives

EG- Generic Electives

EC - Additional core Courses for Extra Credits (If any)*

Ability Enhancement Courses

AE – Ability Enhancement Course

SE – Skill Enhancement Course – Soft skills

CW - SHEPHERD & Gender Studies (Outreach)

CIA AND SEMESTER EXAMINATION

Continuous Internal Assessment (CIA):

Distribution of CIA Marks	
Passing Minimum: 50 Marks	
Library Referencing	5
3 Components	35
Mid-Semester Test	30
End-Semester Test	30
CIA	100

MID-SEM & END-SEM TEST

Centralised – Conducted by the office of COE

1. Mid-Sem Test & End-Sem Test: (2 Hours each); will have Objective and Descriptive elements; with the existing question pattern PART-A; PART-B; PART-C and PART D.
2. One of the CIA Component II/III for UG & PG will be of 15 marks and compulsorily a online objective multiple choice question type.
3. The online CIA Component must be conducted by the Department / faculty concerned at a suitable computer centre.
4. The one marks of PART-A of Mid-Sem and End-Sem Tests will comprise only: OBJECTIVE MULTIPLE CHOICE QUESTIONS.
5. The number of hours for the 5 marks allotted for Library Referencing/ work would be 30 hours per semester. The marks scored out of 5 will be given to all the courses (Courses) of the Semester.

Duration of Examination must be rational; proportional to teaching hours 90 minute-examination / 50 Marks for courses of 2/3 hours/week (all Part IV UG Courses) 3-hours examination for courses of 4-6 hours/week.

Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No.	Level	Parameter	Description
1	K1	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision
6	K6	Synthesis /Creating	The learner creates a new product or point of view

WEIGHTAGE of K – LEVELS IN QUESTION PAPER

(Cognitive Level)	Lower Order Thinking			Higher Order Thinking			Total
K- LEVELS	K1	K2	K3	K4	K5	K6	%
SEMESTER EXAMINATIONS	15	20	35	30			**100**
MID / END Semester TESTS	12	20	35	33			**100**

QUESTION PATTERN FOR SEMESTER EXAMINATION	
SECTION	**MARKS**
SECTION–A (No choice ,One Mark) **THREE** questions from each unit **(**15x1 =15)	**15**
SECTION-B (No choice ,2-Marks) **TWO** questions from each unit (10x2 =20)	**20**
SECTION-C (Either/or type) (7- Marks) **ONE** question from each unit (5x7 =35)	**35**
SECTION-D (3 out of 5) (10 Marks) **ONE** question from each unit (3x10 =30)	**30**
Total	**100**

BLUE PRINT OF QUESTION PAPER FOR SEMESTER EXAMINATION							
DURATION: 3. 00 Hours.							**Max Mark : 100**
K- LEVELS / **SECTIONS**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total Marks**
SECTION–A (One Mark, No choice) (15x1 =15)	15						**15**
SECTION-B (2-Marks, No choice) (10x2=20)		10					**20**
SECTION-C (7- Marks) (Either/or type) (5x7=35)			5				**35**
SECTION-D (10 Marks) (3 out of 5) (3x10=30) Courses having only **K4** levels				3			**30**
Courses having **K4** and **K5** levels **One K5 level question is compulsory**				2	1		
(Courses having **all the 6** cognitive levels **One K5 and K6 level questions can be compulsory**				1	1	1	
Total	**15**	**20**	**35**	**30**			**100**

QUESTION PATTERN FOR MID/END TEST		
SECTION		**MARKS**
SECTION–A (No choice, One Mark)	(7x1 =7)	**7**
SECTION-B (No choice , 2-Marks)	(6x2 =12)	**12**
SECTION-C (Either/or type) (7- Marks)	(3x7 =21)	**21**
SECTION-D (2 out of 3) (10 Marks)	(2x10=20)	**20**
	Total	**60**

BLUE PRINT OF QUESTION PAPER FOR MID/END TEST							
DURATION: 2. 00 Hours.							**Max Mark: 60.**
K- LEVELS / **SECTIONS**	**K1**	**K2**	**K3**	**K4**	**K5**	**K6**	**Total Marks**
SECTION –A (One Mark, No choice) (7 x 1 = 7)	7						**07**
SECTION-B (2-Marks, No choice) (6 x 2 = 12)		6					**12**
SECTION-C (Either/or type) (7-Marks) (3 x 7 =21)			3				**21**
SECTION-D (2 out of 3) (10 Marks) (2x10=20) Courses having only **K4** levels				2			**20**
Courses having **K4** and **K5** levels **One K5 level question is compulsory**				1	1		
Courses having **all the 6** cognitive levels **One K6 level question is compulsory**					1	1	
Total Marks	**07**	**12**	**21**	**20**			**60**
Weightage for 100 %	**12**	**20**	**35**	**33**			**100**

Assessment pattern for two credit courses.

S. No.	Course Title	CIA	Semester Examination	Total Marks
1	Self Paced Learning Course	25 + 25 = 50	50 Marks MCQ (COE)	100
2	Comprehensive Examinations	25 +25 = 50	50 Marks (MCQ) (COE)	100
3	Internship	100	--	100
4	Field Visit	100	--	100
5	Ability Enhancement Course (AEC) for PG (3 credits)	50 (Three Components)	50 (COE) Specific Question Pattern	100
Assessment Pattern for Courses in Part - IV				
6	Value Education Courses and Environmental Studies	50	50 Marks (For 2.00 hours) (COE)	100
7	Skill Enhancement Courses(SECs)	50 marks (by Course in-charge) 50 Marks (by an External member from the Department)		100
8	SEC: SOFT SKILLS (For UG and PG)	100	(Fully Internal)	100

EVALUATION

GRADING SYSTEM

Once the marks of the CIA and the end-semester examination for each of the courses are available, they will be added and converted as final mark. The marks thus obtained will then be graded as per the scheme provided in Table-1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by semester Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA) respectively. These two are calculated by the following formulae:

$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$	$WAM\,(Weighted\,Average\,Marks) = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$
Where, C_i is the Credit earned for the Course i G_i is the Grade Point obtained by the student for the Course i M_i is the marks obtained for the course i and n is the number of Courses **Passed** in that semester.	

CGPA: Average GPA of all the Courses starting from the first semester to the current semester.

CLASSIFICATION OF FINAL RESULTS:

i) The classification of final results shall be based on the CGPA, as indicated in Table-2.

ii) For the purpose of Classification of Final Results, the candidates who earn the CGPA 9.00 and above shall be declared to have qualified for the Degree as 'Outstanding'. Similarly the candidates who earn the CGPA between 8.00 and 8.99, 7.00 and 7.99, 6.00 and 6.99 and 5.00 and 5.99 shall be declared to have qualified for their Degree in the respective programmes as 'Excellent', 'Very Good', 'Good', and 'Above Average' respectively.

iii) A Pass in SHEPHERD will continue to be mandatory although the marks will not count for the calculation of the CGPA.

iv) Absence from an examination shall not be taken an attempt.

Table-1: Grading of the Courses

Marks Range	Grade Point	Corresponding Grade
90 and above	**10**	**O**
80 and above and below 90	**9**	A+
70 and above and below 80	**8**	**A**
60 and above and below 70	**7**	**B+**
50 and above and below 60	**6**	**B**
Below 50	**0**	**RA**

Table-2: Final Result

CGPA	Corresponding Grade	Classification of Final Result
9.00 and above	**O**	**Outstanding**
8.00 to 8.99	A+	Excellent
7.00 to 7.99	**A**	**Very Good**
6.00 to 6.99	**B+**	**Good**
5.0 0 to 5.99	**B**	**Above Average**
Below 5.00	**RA**	**Re-appearance**

Credit based weighted Mark System is adopted for the individual semesters and cumulative semesters in the column 'Marks secured' (for 100)

Declaration of Result

Mr./ MS. _____ has successfully completed the Post Graduate in _____ programme. The candidate's Cumulative Grade Point Average (CGPA) is _____ and the class secured is _____ by completing the minimum of 110 credits.

The candidate has also acquired _____ (if any) extra by attending MOOC courses.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

The Programme Outcomes(POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight 3 and the weakest is 1. This relation is defined by using the following table.

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

Mean Scores of COs = $\frac{\text{Sum of values}}{\text{Total No.of POs \& PSOs}}$		**Mean Overall Score =** $\frac{\text{Sum of Mean Scores}}{\text{Total No.of COs}}$	
Result	**Mean Overall Score**	**< 1.2**	**# Low**
		≥ 1.2 and < 2.2	**# Medium**
		≥ 2.2	**# High**

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

Relationship matrix for Course outcomes, Programme outcomes /Programme Specific Outcomes

The Programme Outcomes (POs)/Programme Specific Outcomes(PSOs) are the qualities that must be imbibed in the graduates by the time of completion of their programme. At the end of each programme the PO/PSO assessment in done from the CO attainment of all curriculum components. The POs/PSOs are framed based on the guidelines of LOCF. There are five POs UG programme and five POs for PG programme framed by the college. PSOs are framed by the departments and they are five in numbers.

For each Course, there are five Course Outcomes to be achieved at the end of the course. These Course outcomes are framed to achieve the POs/PSOs. All course outcomes shall have linkage to POs/PSOs in such a way that the strongest relation has the weight 3 and the weakest is 1. This relation is defined by using the following table.

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		≥ 1.2 and < 2.2	**# Medium**
		≥ 2.2	**# High**

If the mean overall score is low then the course in charge has to redesign the particular course content so as to achieve high level mean overall score.

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value-driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

- Graduates will be able to accomplish professional standards in the global environment.
- Graduates will be able to uphold integrity and human values.
- Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Gained the ability to identify and analyse complex Physics problems using the principles of Physics with suitable mathematical tools.
2. Acquired skills which will put the learners at an advantage in careers as drivers to associate with different subjects.
3. Moulded to adopt, absorb and develop innovative ideas
4. Developed skills to communicateeffectively with peers , professionals and society at large and demonstrate professional ethics
5. Exhibited effective individual talent,andengagedthemselves in lifelong learning and dissemination

M.Sc PHYSICS					
PROGRAMME STRUCTURE					
Sem	Specification	No. of Courses	No. of Hours	Credits	Total Credits
I-IV	Core Courses : Theory	8	46	45	45
I-IV	Core Courses : Practicals	04	32	24	24
II	Self-paced learning	1	-	2	02
IV	Comprehensive Examination	1	-	2	02
IV	Project work & Viva Voce	1	06	5	05
I- IV	Discipline Specific Elective	4	21	16	16
I	Ability Enhancement Course	1	4	3	03
II	Skill Enhancement Course (Soft Skills)	1	4	3	03
II	Generic Elective IDC (WS)	1	4	3	03
III	Generic Elective IDC (BS)	1	4	3	03
II-IV	Online courses (MOOC)	3	-	(6)	(06)
I-IV	Outreach Programme	1	-	04	04
I-IV	Total	30	121*	110	110(6)

***One hour outside the regular class time**

M.Sc PHYSICS							
PROGRAMME PATTERN							
Course Details					**Scheme of Exams**		
Sem	**Course Code**	**Course Title**	**Hrs**	**Cr**	**CIA**	**SE**	**Final**
I	21PPH1CC01	Classical Mechanics	6	6	100	100	100
	21PPH1CC02	Mathematical Physics	6	6	100	100	100
	21PPH1CP01	Physics Practical-I	8	6	100	100	100
	21PPH1ES01A	**DSE-1:** Analog and Digital Electronics	6	4	100	100	100
	21PPH1ES01B	**DSE-1:** Physics of Semiconductor Devices					
	21PPH1AE01	**AEC:** Framework for Physics Innovation and Entrepreneurship	4	3	50	50	50
		Total	**30**	**25**			
II	21PPH2CC03	Quantum Mechanics	5	5	100	100	100
	21PPH2CC04	Mathematical Methods of Computational Physics and Python Programming	5	5	100	100	100
	21PPH2CP02	Physics Practical-II	8	6	100	100	100
	21SPS2ES02B	**DSE-2 :** Methods of Spectroscopy	5	4	100	100	100
	21PPH2SP01A	**Self-Paced Learning:** Medical Physics	-	2	50	50	50
	21PPH2 SP01B	**Self-Paced Learning:** Physics of Crystal Growth and Thin films					
	21PPH2SP01C	**Self-Paced Learning:** Ultrasonics					
	21PPH2SP01D	**Self-Paced Learning:** Nanoscience and Technology					
	21PSS2SE01	**SEC:** Soft skills	4	3	100	-	100
	21PPH2EG01A	**GE-1 (WS):**Solar Energy and Utilization	4	3	100	100	100
	21PPH2EG01B	**GE-1(WS):**Renewable Energy Resources					
		Extra Credit Courses (MOOC)-1	-	(2)			
	***One hour out side the regular class time**	**Total**	**31***	**28(2)**			
III	21PPH3CC05	Condensed Matter Physics	6	6	100	100	100
	21PPH3CC06	Electromagnetic Theory	6	6	100	100	100
	21PPH3CP03	Physics Practical-III	8	6	100	100	100
	21PPH3ES03A	**DSE-3:** Materials Science	6	4	100	100	100
	21PPH3ES03B	**DSE-3:** Techniques of Materials Characterisation					
	21PPH3EG02A	**GE-2 (BS):**Physics for Competitive Exams	4	3	100	100	100
	21PPH3EG02B	**GE-2 (BS):** Nano Science					
		Extra Credit Courses (MOOC)-2		(2)			
		Total	**30**	**25(2)**			
IV	21PPH4CC07	Nuclear and Particle Physics	6	6	100	100	100
	21PPH4CC08	Statistical Mechanics and Thermodynamics	6	5	100	100	100
	21PPH4CP04	Physics Practical-IV	8	6	100	100	100
	21PPH4ES04A	**DSE-4:** Microcontroller based Physics Instrumentations	4	4	100	100	100
	21PPH4ES04B	**DSE-4:** Physics of Sensors and Transducers					
	21PPH4PW01	Project work and Viva Voce	6	5	100	100	100
	21PPH4CE01	Comprehensive Exam	-	2	50	50	50
		Extra Credit Courses (MOOC)-3	-	(2)			
		Total	**30**	**28(2)**			
I-IV	21PCW4OR01	Outreach programme (SHEPHERD)		4			
		Total	**120**	**110(6)**			

*The courses with a scheme of Exam 50 in CIA and SE will be converted to 100 for grading.

GENERIC ELECTIVE -1: 2nd Semester Within school (WS)- Offered to students belong to other Departments in the School							
Course Details					**Scheme of Exams**		
School	**Course Code**	**Course Title**	**Hrs**	**Cr**	**CIA**	**SE**	**Final**
SBS	21PBI2EG01	Herbal Technology	4	3	100	100	100
	21PBT2EG01	Medical Biotechnology	4	3	100	100	100
	21PBO2EG01	Medicinal Botany	4	3	100	100	100
SCS	21PCA2EG01	Applied Statistics using R	4	3	100	100	100
	21PMA2EG01	Mathematical Foundations	4	3	100	100	100
	21PCS2EG01	Mobile Adhoc Networks (MANET)	4	3	100	100	100
SLAC	21PEN2EG01A	Indian Literature in Translation	4	3	100	100	100
	21PEN2EG01B	English Literature For Competitive Examinations					
SMS	21PCO2EG01	Supply Chain Management	4	3	100	100	100
	21PEC2EG01	Labour Economics	4	3	100	100	100
	21PHR2EG01	Organizational Behaviour	4	3	100	100	100
	21PCC2EG01	Stress Management	4	3	100	100	100
SPS	21PCH2EG01	Industrial Products	4	3	100	100	100
	21PPH2EG01A	Solar Energy and Utilization	4	3	100	100	100
	21PPH2EG01B	Renewable Energy Resources	4	3	100	100	100

GENERIC ELECTIVE -2: 3rd Semester Between schools (BS)- Offered to students in the Departments belong to other Schools (Except the school offering the course)							
Course Details					**Scheme of Exams**		
School	**Course Code**	**Course Title**	**Hrs**	**Cr**	**CIA**	**SE**	**Final**
SBS	21PBI3EG02	First Aid Management	4	3	100	100	100
	21PBT3EG02	Food Technology	4	3	100	100	100
	21PBO3EG02	Horticulture and Landscaping	4	3	100	100	100
SCS	21PCA3EG02	Web Design	4	3	100	100	100
	21PMA3EG02	Operations Research	4	3	100	100	100
	21PCS3EG02	Advances in Computer Science	4	3	100	100	100
	21PDS3EG02	Deep Learning	4	3	100	100	100
SLAC	21PEN3EG02	English for Effective Communication	4	3	100	100	100
SMS	21PCO3EG02	Basics of Taxation	4	3	100	100	100
	21PEC3EG02	Managerial Economics	4	3	100	100	100
	21PHR3EG02	Counselling and Guidance	4	3	100	100	100
	21PCC3EG02	Dynamics of Human Behaviour in Business	4	3	100	100	100
SPS	21PCH3EG02	Health Science	4	3	100	100	100
	21PPH3EG02A	Physics for Competitive Exam	4	3	100	100	100
	21PPH3EG02B	Nano Science	4	3	100	100	100

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1CC01	CORE-1: CLASSICAL MECHANICS	6	6

CO No.	CO-Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire knowledge about conservation laws, constraints, relativistic mechanics, Lagrangian and Hamiltonian dynamics.	K1
CO-2	understand Kepler problem, rigid body dynamics, relativistic mechanics Lagrangian and Hamilton's formulation.	K2
CO-3	analyse the Euler's equations and apply them for rigid body dynamics.	K3 & K4
CO-4	evaluate the concepts of inertial, non-inertial frames of references and rotating coordinate system in relativistic mechanics.	K5
CO-5	apply and formulate the Lagrangian and Hamiltonian to solve problems in mechanics and relativistic mechanics.	K3 & K6

Unit-I: Fundamental Principles and Lagrangian Formulation (18 Hours)

Mechanics of a particle and system of particles - conservation laws - constraints - generalized coordinates - D'Alembert's principle and Lagrange's equation - applications on Lagrangian formulation: Atwood's machine - simple pendulum - compound pendulum- linear harmonic oscillator - Lagrange's equations in presence of non-conservative forces - generalized potential - Lagrangian of a charged particle in the presence of electromagnetic field - Hamilton's principle - Lagrange's equation of motion from Hamilton's principle - conservation theorems and symmetry properties.

Unit-II: Two-Body Central Force Problems (18 Hours)

Reduction to equivalent one - body central force problem - central force and motion in a plane - equation of motion and first integrals - differential equation for an orbit - the equivalent one - dimensional problem and classification of orbits - The Kepler problem: inverse square law of force - The Laplace - Runge - Lenz vector - scattering in a central force field - scattering in laboratory and centre of mass frames.

Unit-III: Hamilton's Formulation (18 Hours)

Hamiltonian - Hamilton's canonical equations of motion - physical significance of H-Cyclic coordinates - Hamilton's equations from variational principle - Applications on Hamilton's formulation: simple pendulum - compound pendulum - linear harmonic oscillator - particle in a central field of force - Δ-variation - principle of least action- statement and its proof - other forms of the action principle (Jacobi's form).

Canonical transformations - Legendre's transformations - generating functions - The Harmonic oscillator - infinitesimal constant transformations - Lagrange Brackets - Poisson brackets - relation between Lagrange's and Poisson brackets - Hamilton - Jacobi method - action angle variables – Kepler problem in action angle variables.

Unit-IV: Rigid Body Dynamics, Non-Inertial Frames and Oscillatory Motion (18 Hours)

Euler angles - Euler's theorem on the motion of the rigid body - infinitesimal rotations-rate of change of vector - moments and products of inertia - Euler's equations - symmetrical top - applications - non inertial frame of reference - pseudo force - centrifugal force - uniform rotating frames - coriolis force - free fall of a body on earth's surface - Foucault's pendulum - theory of small oscillations and normal modes - frequencies of free vibration and normal coordinates - Linear tri-atomic molecule.

Unit-V: Relativistic Mechanics **(18 Hours)**

Algebra of tensors - quotient law - fundamental tensor - Cartesian tensors - basic postulates of special theory of relativity - Lorentz transformations in real four dimensional spaces - covariant four dimensional formulations - force and energy equations in relativistic mechanics - Lagrangian and Hamiltonian formulation of relativistic mechanics - Relativistic Lagrangian and Hamiltonian of a charged particle in an electromagnetic field.

Books for Study

1. Herbert Goldstein, Charles P. Poole, John L. Safko, Classical Mechanics, 3rd Edition, Pearson Education, 2002.
2. Gupta, Kumar, Sharma, Classical Mechanics, Pragathi Prakashan Publications, 27th edition, 2012.
3. J.C. Upadhyaya, Classical Mechanics, Himalaya publishing house, 2nd revised edition (re-print), 2017.

Unit	Book	Chapters	Sections
I	1	1	1.1-1.4, 1.6, 2.1, 2.3, 2.6
	2	2	2.9-1, 2.9-2, 2.9-9
	3	2	2.9, 2.10
II	1	3	3.1, 3.3, 3.5, 3.7, 3.9, 3.10
	3	4	4.2
III	1	8,9,10	8.2, 8.5, 9.1, 9.2, 9.3, 9.5, 9.6, 9.7, 10.1, 10.6, 10.7, 10, 8
	2	3	3.1, 3.3, 3.5, 3.9-1, 3.9-2, 3.9-4, 3.9-6, 3.20
	3	5,7	5.10, 5.11, 5.12, 7.2, 7.3, 7.4
IV	1	4,5,6	4.4, 4.6, 4.8, 4.9, 5.3, 5.5, 5.7, 6.1-6.4
	3	11	11.1-11.6
V	1	5,7	5.2, 7.4, 7.5
	2	7	7.1, 7.2, 7.3-7.6
	3	13	13.12

Books for Reference

1. Rana, N.C. and Joag, P. S.: Classical Mechanics, (New Delhi, Tata McGraw Hill, 1998 (Units I, II & III).
2. Madhumangal Pal, A course on Classical Mechanics, Narosa publishing house, New Delhi, 2009.
3. Matrices & Tensors in physics by AW Joshi - Weiley Eastern, 2001.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1CC01	CORE-1: CLASSICAL MECHANICS	6	6

Course Outcomes (COs)	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	2	2	2	3	3	2	1	2.3
CO-2	3	3	3	2	2	2	2	2	2	2	2.3
CO-3	3	2	2	2	2	2	2	3	2	2	2.2
CO-4	2	2	2	2	2	3	2	2	2	2	2.1
CO-5	2	3	3	2	2	3	2	2	2	2	2.3
Mean Overall Score											2.24 (High)

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1CC02	CORE-2: MATHEMATICAL PHYSICS	6	6

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge about different mathematical methods like vector and matrix algebra, partial derivatives, complex functions, special functions, Fourier series and integral transforms for solving different physics problems.	K1 & K2
CO-2	solve partial differential equations, identify complex-differentiable functions, construct Fourier series and integral transforms and special functions.	K3
CO-3	compute Eigen values and Eigen vectors, line integrals using Cauchy's integral theorem for different physics problems, apply method of separation of variable in different coordinate systems	K4
CO-4	apply matrix spaces, partial differential equations, integral transforms, special functions to obtain the solution for complex physics problems.	K4
CO-5	analyse the solutions obtained by various mathematical methods.	K5 & K6

Unit-I: Mathematical Tools of Vector and Matrix Spaces (18 Hours)

The Hilbert space and wave functions: Dirac Notation - Operators: Hermitian, Projection, commutator algebra, uncertainty relation between 2 operators, functions of operators, Eigenvalues and Eigenvectors of an operator, infinitesimal and finite unitary transformations. **Representation in Discrete bases:** Matrix representation of Kets, Bras and operators, change of bases and unitary transformations, Matrix representation of the Eigenvalues problems. **Representation in Continuous bases:** General treatment, position, momentum, connection representations.

Unit-II: Partial Differential Equations (18 Hours)

First-Order equations: general PDEs, more than two independent variables - Second–Order equations: classes of PDEs, more than two independent variables - boundary conditions - Separation of variables: Cartesian coordinates, circular & cylindrical coordinates, spherical & polar coordinates - Laplace and Poisson equations - Wave equations: D'Alembert's solution - Diffusion PDE.

Unit-III: Complex Analysis (18 Hours)

Cauchy - Riemann conditions - Cauchy's integral theorem - applications to multiply connected region - Cauchy's II integral theorem - derivatives of analytic complex function - singular points and their classification - Laurent series - Cauchy's residue theorem - calculation of residue at a point - evolution of definite integrals: (i) around the unit circle, (ii) around a semi-circular contour, and (iii) integral of the form.

Unit-IV: Fourier Series and Integral Transforms **(18 Hours)**

Fourier series: Dirichlet's condition - determination of coefficient - function having arbitrary period - Fourier series for square wave and half wave.
Fourier Transform: FT of a time dependent function - some important theorems: Parseval's, linearity, derivatives, shifting of origin and convolution, use of FT in solving partial differential equation for heat conduction.
Laplace transform: Theorems - inverse transform - solution to ordinary differential equations - solving equations for LCR circuit.

Unit-V: Special Functions **(18 Hours)**

Gamma and Beta functions - properties and their basic relations - DE and series solution of Legendre and Hermite - their polynomial – Rodrigues' formula - generating function - recurrent relation - orthogonality relations.

Books for Study

1. Nouredine Zettile, "Quantum Mechanics: Concepts and Applications", 2nd Edition, John Wiley & Sons, UK, 2009.
2. Arfken, Weber and Harris, "Mathematical Methods for Physicists", 7th Edition, Academic Press, 2013.
3. AK Mukhopadhyay, "Mathematical Methods for Engineers and Physicists", Wheeler Pub, New Delhi, 1998.
4. H.K Dass and Rama Verma, "Mathematical Physics", S. Chand publications, India 2011.

Unit	Book	Chapters	Sections
I	1	2	2.1-2.10
II	2	9	9.1, 9.2, 9.3, 9.4,9.5, 9.6, 9.7
III	3	14	14.2-14.5
IV	4	11, 45, 46 & 47	11.1-11.4, 11.6, 11.7, 11.10-11.13, 45.6-45.12, 46.1-46.12, 44.14, 47.1-47.6, 47.8, 47.9, 47.12, 47.13
V	4	9, 28 & 30	9.1, 9.8, 28.1-28.9, 30.1-30.5

Books for Reference

1. M. l. Boas, "Mathematical Methods in the Physical Sciences", 3rd Edition. John Wiley & Sons, 2006.
2. E. Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley, 2015.
3. E. M. Stein and R. Shakarchi, "Complex Analysis", Princeton University Press, 2003.
4. A. Pinkus and S. Zafrany, "Fourier Series and Integral Transforms", Cambridge University Press, 2012.
5. W.W. Bell, "Special Functions for Scientists and Engineers", Dover Pub, 2004.
6. P.K. Chattopadhyay, Mathematical Physics, Wiley Eastern Pub, 1990.

Web Resources*

1. https://mathworld.wolfram.com/
2. http://people.math.gatech.edu/~cain/textbooks/onlinebooks.html
3. https://ocw.mit.edu/courses/mathematics/
4. https://nptel.ac.in/courses/115/105/115105097/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1CC02	CORE-2: MATHEMATICAL PHYSICS	6	6

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	3	2	3	3	3	2	2	2.6
CO-2	3	3	2	3	2	3	3	3	2	2	2.6
CO-3	3	3	2	3	2	3	3	3	2	2	2.6
CO-4	3	3	2	3	2	3	3	3	2	2	2.6
CO-5	3	3	2	3	2	3	3	3	2	3	2.7
Mean Overall Score											2.62 (High)

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1CP01	PHYSICS PRACTICAL – I	8	6

Any 15 Experiments

1. Absorption Spectrum of Iodine – spectral parameters
2. Susceptibility - Quincke's method and Guoy's method
3. e/m Magnetron and Thermionic Work function
4. Dielectric Constant Study and determination of Curie temperature - Solid, Liquid (kit)
5. Hall effect in semiconductor
6. Elastic Constants – Elliptic fringes
7. Laser – I: numerical aperture, spot size, absorption coefficient and wavelength
8. Planck's constant - determination
9. Study of Photo sensitive devices
10. Ultrasonic interferometer – velocity and compressibility
11. Electro optic modulation – depth of modulation, frequency range, voltage range
12. Determination of Stefan's constant
13. Characteristics of torque transducer
14. Calibration of thermistor – different range
15. Verification of Norton's, Thevenin's and Max power theorem
16. MOSFET characteristics, amplifier design and switching application
17. UJT – Characteristics and Applications
18. K-map simplification – implementation of logic functions using basic and universal gates by SOP & POS
19. Design and Study of ALU and Scalar
20. Op-amp: I to V, V to I and Square wave
21. Op-amp – Design of Instrumentation amplifier
22. 555 – Monostable, Bistable, Astable multi vibrators and its applications
23. Temperature coefficient using 555 timer
24. Op-amp applications: Phase shift and Wien's Bridge Oscillator:
25. Computational experiment: Experimental statistics, error analysis – Iodine absorption spectrum
26. Computational experiment: Lagrange interpolation and extrapolation
27. Computational experiment: Binding energy calculation for different mass numbers.
28. Computational experiment: Two body central force problem
29. Study of Transistor biasing and stability
30. Design of BJT voltage/power amplifier

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1ES01A	DSE - 1: ANALOG AND DIGITAL ELECTRONICS	6	4

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	describe and discuss functional blocks of Analog and Digital Electronics.	K1 & K2
CO-2	outline semiconductor devices, examine the Analog and digital circuits and identify the states and working characteristics of circuits.	K2, K3 & K4
CO-3	list and use the methods to examine Analog and digital circuit problems.	K1, K3 & K4
CO-4	assess the limitations of Analog and Digital circuits and recommend the solutions.	K5
CO-5	design and construct Analog and Digital circuits for demand.	K6

Unit-I: Semiconductor Devices (18 Hours)

Semiconductor diode: IMPATT - PNPN diodes characteristics and applications - Gunn diode - device operation - negative differential resistance - construction, characteristics and applications of SCR and UJT. Optoelectronic devices: Photo diode - photo transistor - solar cells - photo detectors, LED: Surface and Edge emitting LED - OLED structure and working principle.

Unit-II: Applications of Semiconductor Devices (18 Hours)

Transistor CE Amplifier: Transistor as a two-port network - h-parameter equivalent circuit- Small signal analysis of single stage CE amplifier at low and High Frequencies - Miller's theorems - BJT transistor modelling and parameters - Hybrid-pi CE transistor model at high frequencies - conductance and capacitance - cascaded CE transistor amplifier high frequency analysis - early effect - Gummel plots - transistor switching circuit - JFET, MOSFET -applications.

Unit-III: Op-Amp and its Applications (18 Hours)

Operational amplifiers - analog computation - design of Op-Amp active filters (first order only): low pass - high pass - band pass – comparators - sample and hold circuits - log and antilog amplifiers - signal conditioning - instrumentation amplifier - Phase shift - Wien's Bridge Oscillator - Schmitt trigger - V to I and I to V converter - precision AC/DC converters; DAC: design of Binary weighted - R-2R ladder - ADC: dual slope - SAR method, timing circuits: 555 Timer and applications.

Unit-IV: Combinational Logic Design and Memories (18 Hours)

Standard representation of logic functions (SOP and POS) - minimization Techniques - analysis of combinational logic circuits - synthesis of combinational logic circuits - Quine -McCluskey minimization method - Petrick's algorithm - encoder and decoder design - multiplexer and

demultiplexer design - adder and subtractor design - digital comparator - design of ALU - design of counters - design of synchronous MOD counters - design of random sequence counters.

Unit - V: Sequential Circuit Design (18 Hours)

Models for sequential Circuits - synchronous sequential circuit models - sequential circuit Analysis - synchronous sequential circuit synthesis - state assignment and circuit realization - redundant states - state reduction in completely and incompletely specified circuits - types of asynchronous circuits - analysis and synthesis of pulse-mode asynchronous circuits - analysis and synthesis of fundamental-mode asynchronous circuits - sequential circuits with Programmable Logic Devices.

Books for Study

1. Robert Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall New Jersey, 7th edition.
2. Jacob Millman and Christos C. Halkias, "Microelectronics", 2nd edition, McGraw Hill, New Delhi, 2009.
3. Victor P. Nelson, "Digital logic circuit analysis and design", Prentice Hall, 1995.

Unit	Book	Chapters	Sections
I	1	5, 20, 21	5.7, 5.8, 21.13, 21.3, 21.4, 20.10
II	2	5, 8, 11 & 12	5.3, 8.11, 11.1, 11.2, 11.3, 12.10,
III	2	15 & 16	15.1, 16.5, 16.6, 16.7, 16.11, 16.12, 16.14, 16.15, 16.16
IV	3	2, 3, 4 & 5	2.4, 2.5, 3.9, 3.10, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 5.4
V	3	6, 8, 9 & 10	6.1, 8.1, 8.2, 8.3, 8.4, 9.1, 9.2, 9.3, 10.1, 10.2, 10.3, 10.4, 10.5

Books for Reference

1. Anant Agarwal, Jeffrey H. Lang, "Foundation of analog and digital circuits", Elsevier, 2005.
2. Daniel Adam Steck, "Analog and Digital Electronics", 2017.
3. Hubert Kaeslin, "Digital Integrated Circuit Design", Cambridge University Press, 2003.
4. Thomas L. Floyd, "Digital Fundamental", 11th Edition, Pearson Education. Ltd., 2015.
5. S.M. Sze. "Physics of Semiconductor Devices", Wiley-Interscience, 2007.

Web Resources*

1. https://www.electronicshub.org/analog-circuits-and-digital-circuits/#:~:text=Analog%20Circuits%20and%20Digital%20Circuits%20is%20a%20classic%20way%20of,deals%20with%20discrete%20digital%20signals.
2. https://www.allaboutcircuits.com/video-tutorials/analog-and-digital-electronics/
3. https://www.ece.utoronto.ca/prospective-students/curriculum-streams/digital-analog/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1ES01A	DSE - 1: ANALOG AND DIGITAL ELECTRONICS	6	4

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	3	2	3	2	2	3	2	2.5
CO-2	3	3	2	3	2	3	3	3	3	2	2.7
CO-3	3	3	3	3	2	3	3	3	3	2	2.8
CO-4	3	3	3	2	2	3	3	3	2	2	2.6
CO-5	3	3	3	3	2	3	3	2	3	2	2.7
Mean Overall Score											2.66 (High)

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1ES01B	DSE - 1: PHYSICS OF SEMICONDUCTOR DEVICES	6	4

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	describe and outline structure of Semiconducting materials.	K1 & K2
CO-2	explain and illustrate the semiconductor junction.	K2 & K3
CO-3	examine the semiconducting devices and circuits, explain the working characteristics and use these principles in the complex circuits.	K3 & K4
CO-4	assess the electronic device problems and recommend the solutions.	K5
CO-5	synthesis new materials for semiconductor devices	K6

Unit-I: Electronic Levels in Semiconductors (18 Hours)

Particles in an attractive potential bound state - electrons in crystalline solids - occupation of states - band structure of semiconductor - mobile carriers - doping - doping in polar materials - Tailoring electronic properties - defect states.

Unit-II: Charge Transport in Materials (18 Hours)

Transport under an electric field - carrier transport by transport - carrier transport by diffusion - charge injection and quasi-Fermi levels - PN Junction in equilibrium - PN Diode under bias - solar cell and photo detector – LED.

Unit-III: Semiconductor Junction (18 Hours)

Metal semiconductor junctions - insulator semiconductor junctions - semiconductor hetero junctions - BJT design and device performance parameters - Kirk effect - thermal effect - early effect - avalanche breakdown - design problems.

Unit-IV: Temporal Response of Diodes and Bipolar Transistors (18 Hours)

Small-Signal equivalent circuit of a *p-n* diode - switching characteristics of diodes - high-frequency behaviour of BJT - BJT charge control analysis - bipolar transistor Small-Signal equivalent circuit - Small Signal figures of merit.

Unit-V: Field Effect Transistors and MOSFET (18 Hours)

FET: Current-Voltage characteristics - modulation efficiency - polar materials - n+ Cap layers - small signal characteristics - power-frequency limit.
MOSFET: Capacitance-Voltage characteristics of the MOS structure - operation - depletion and Enhancement MOSFETs - Complementary MOSFETs.

Book for Study

1. Umesh K. Mishra, Jasprit Singh, "Semiconductor Device Physics and Design", Springer, 2008.

Unit	Book	Chapters	Sections
I	1	2	2.1-2.4, 2.6, 2.7, 2.9, 2.10, 2.12
II	1	3, 4	3.1, 3.4, 3.6, 3.7, 4.2, 4.3, 4.8.2, 4.9
III	1	5, 6	5.3-5.6, 6.4, 6.6.1-6.6.3, 6.6.5, 6.8
IV	1	7	7.2, 7.5, 7.4
V	1	8, 9	8.1-8.3, 8.5, 8.6.1, 8.7.1, 8.8.1, 8.8.2, 9.1, 9.4, 9.5

Books for Reference

1. Simon M. Sze & Ming-Kwei Lee, "Semiconductor Devices: Physics and Technology", third edition, JOHN WILEY & SONS, INC., 2010.
2. S. M. Sze and Kwok K. Ng, "Physics of Semiconductor Devices", A JOHN WILEY & SONS, JNC., PUBLICATION, 2007.
3. Marius Grundmann, "The Physics of Semiconductors", third edition, Springer International Publishing, 2016.

Web Resources*

1. https://www.electronics-tutorials.ws/diode/diode_1.html
2. https://physics.info/semiconductors/
3. http://www.fulviofrisone.com/attachments/article/403/The%20Physics%20of%20Semiconductors.pdf

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1ES01B	DSE - 1: PHYSICS OF SEMICONDUCTOR DEVICES	6	4

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	3	2	3	3	3	2	2	2.6
CO-2	3	3	2	3	2	3	3	3	2	2	2.6
CO-3	3	3	3	3	2	3	2	3	2	2	2.6
CO-4	3	3	3	2	2	3	3	3	2	2	2.6
CO-5	3	3	3	2	2	3	3	2	3	2	2.6
Mean Overall Score											2.6 (High)

Semester	Course Code	Title of the Course	Hours	Credit
I	21PPH1AE01	ABILITY ENHANCEMENT COURSE: Framework for Physics Innovation and Entrepreneurship Education	4	3

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	Know the basics of research methodology, information communication technologies, cyber security and the future of physics.	K1
CO-2	understand the fundamentals of intellectual property rights and the role of incubators and public policies.	K2
CO-3	identify and classify various types of reports, ICT tools, ICT services, intellectual properties, agencies, treaties and public policies.	K3
CO-4	utilize search engines for finding research articles, patents, designs, incubator policies and current research topics in physics.	K4
CO-5	evaluate and create new ideas in the situation in cyber security, intellectual property and innovation-incubator system in India.	K5 & K6

Unit-I: Research Methodology **(12 Hours)**

What makes people to do research - importance - research methods and research methodology - types - various stages of research - presenting a scientific seminar - oral report - art of writing a research paper – layout of a research report.

Unit-II: ICT Support and Cyber Security **(12 Hours)**

Technology in teaching Physics: benefits, challenges and solutions.

Information and communications technology, tools and services: Search engines & research papers – shared datasets & codes – connect and communicate with experts and researchers – free digital library – simulation/lab & project management – write and publish research papers.

Cyber space – security challenges – evolution & threats – Indian cyber situation – cyber disruptions - challenges in cyber space domain – 10 steps to cyber security.

Unit-III: The Future Physics **(12 Hours)**

A brief history of Physics – Predicting the next 100 years: Mind over Matter – rise of machines – everything from nothing – perfection and beyond – energy from stars.

Examination skills in Physics - competitive exams towards research - preparation strategy.

Unit-IV: The Role of Incubators and Public Policy **(12 Hours)**

Introducing a framework for Physics Innovation and Entrepreneurship (PIE) education - Examining students' perceptions of innovation and entrepreneurship in physics –National

Innovation & Start-up Policy 2019 for Students and Faculty by MHRD –Tamil Nadu Start-up & Innovation policy 2023.

Concept note on business incubator - Incubation and S&T Innovation-based Entrepreneurship in India - insights from Case Studies: Factors for Favourable Incubator Outcomes

Unit-V: Intellectual Property Rights (12 Hours)

Project concept – project design - Intellectual Property Law Basics - Types of Intellectual Property: Patents, Copyright Trademarks, Industrial Designs and Integrated Circuits, Geographical indications - Agencies Responsible for Intellectual Property Registration - International Organizations, Agencies, and Treaties - Search engines for IPR -The Indian patent act 1970.

Books for Study

Text by department

Books for Reference

1. C. R. Kothari, Research Methodology, 2nd ed. New Age International (P) Ltd. 2004.
2. Deborah E. Bouchoux, Intellectual Property, 4th ed. Cengage Learning, 2013

Web Resources*

1. https://ipindia.gov.in/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credit
I	21PPH1AE01	ABILITY ENHANCEMENT COURSE: Framework for Physics Innovation and Entrepreneurship (PIE) Education							4	3
Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	1	3	3	2	3	2.5
CO-2	3	3	3	2	2	1	3	3	3	3	2.6
CO-3	3	3	3	2	2	1	3	3	3	3	2.6
CO-4	3	3	3	2	2	1	3	3	3	3	2.6
CO-5	3	3	3	2	2	1	3	3	3	3	2.6
Mean Overall Score											2.58 (High)

Semester	Course Code	Title of the Course	Hours	Credits
II	**21PPH2CC03**	**CORE-3: QUANTUM MECHANICS**	**5**	**5**

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	describe the principles and methods of wave mechanics and matrix mechanics based on Dirac notation.	**K1**
CO-2	explain quantum mechanical methods to study angular momentum and various perturbed systems.	**K2**
CO-3	apply the quantum theory to 1D potentials, 3D potentials, rotation & addition of angular momenta, stationary states and time-dependent systems.	**K3**
CO-4	analyse various properties using the quantum theory and compare it with the results of classical physics.	**K4**
CO-5	evaluate and summarize the methods and properties of various quantum mechanical systems.	**K5 & K6**

Unit-I: Basic Postulates and Quantum Systems (15 Hours)

Introduction - The basic postulates of Quantum Mechanics (QM) – The state of a system – observables and operators – Measurement in QM: how measurements disturb systems – expectation values – CSCO – measurement and the uncertainty relation; Time Evolution of the system's state: time evolution operator – stationary states – Schrodinger equation and wave packets – conservation of probability – time evaluation of expectation values; Connecting Quantum Mechanics to Classical Mechanics. Properties of 1D motions: Bound, unbound states, mixed spectrum - The free particle continuous states – the potential step.

Unit-II: One and Three - Dimensional Problems (15 Hours)

The potential barrier & well: E>Vo, E < Vo: Tunelling, tunnelling effect - the infinite square well potential: Asymmetric square – symmetric; the finite square well potential: Scattering solutions (E > Vo), Bound state solution (0 < E < Vo) - Harmonic oscillator: Energy Eigenvalues, Energy Eigen states - 3D problems in Cartesian coordinates: General treatment, free particle- 3D problems in spherical coordinates: central potential, the free particle, the hydrogen atom.

Unit-III: Angular Momentum (15 Hours)

General formalism –Geometrical representation – Spin angular momentum: Experimental evidence of spin, general theory of spin, spin ½ and Pauli Matrices – Eigen functions of orbital angular momentum: Eigen functions and Eigenvalues of L_z, Eigen functions of L^2–Rotations in QM: Infinitesimal, finite, properties, Euler rotations - Addition of Angular Momenta: General formalism, calculation of CG Coefficient, coupling of orbital and spin angular momenta - Isospin.

Unit-IV: Approximation Methods for Stationary States (15 Hours)

Time independent Perturbation Theory: Non-degenerate, Degenerate, Fine structure and the Anomalous Zeeman effect - Variational method - JWKB method: General formalism, bound states for potential wells with NO and ONE rigid walls, tunnelling through potential barrier.

Unit-V: Time Dependent Perturbation Theory (15 Hours)

The different pictures: The Schrodinger, The Heisenberg, The Interaction - Transition probability: Constant and Harmonic perturbation - adiabatic and sudden approximation - interaction of atoms with radiations: classical treatment, Quantization of Electro Magnetic field - Transition rates: Absorption and Emission radiation, within the dipole approximation.

Books for Study

1. Nouredine Zettile, "Quantum Mechanics: Concepts and Applications", 2nd Edition, John Wiley & Sons, 2009.

Unit	Book	Chapters	Sections
I	1	3 & 4	3.1, 3.2, 3.3**,** 3.3.1, 3.3.2,3.4, 3.5, 3.5.1, 3.5.2, 3.5.3, 3.5.4, 3.6, 3.6.1, 3.6.2, 3.6.3, 3.6.4, 3.6.5, 3.8, 3.8.1, 3.8.2, 3.8.3, 4.3, 4.4,
II	1	4 & 6	4.5, 4.5.1, 4.5.2, 4.5.3, 4.6.1, 4.6.2, 4.7, 4.7.1, 4.7.2, 4.8, 4.8.1, 4.8.2, 4.8.3, 6.2.1, 6.2.2, 6.3.1, 6.3.2, 6.3.5
III	1	5 & 7	5.1, 5.2, 5.3, 5.5, 5.6.1, 5.6.2, 5.6.3, 5.7, 5.7.1, 5.7.2, 7.2, 7.2.1, 7.2.2, 7.2.3, 7.2.4, 7.3, 7.3.1, 7.3.2, 7.3.3, 7.3.6 (no subsections)
IV	1	9	9.1, 9.2, 9.2.1, 9.2.3 (all), 9.3, 9.4, 9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5
V	1	10	10.1, 10.2, 10.2.1, 10.2.2, 10.2.3, 10.3, 10.3.1, 10.3.2, 10.3.3, 10.4, 10.4, 10.4.1, 10.4.2, 10.5, 1. 10.5.2, 10.5.3, 10.5.4

Books for Reference

1. R. Shankar, "Principles of Quantum Mechanics", 2nd Edition, Springer, 2014
2. R. Feynman, "Feynman lectures on Physics- Vol 3", new millennium edition, Pearson, 2012
3. E. Merzbacher, "Quantum Mechanics", 3rd Edition, Wiley, 2011.
4. B. Bransden, C. Joachain, "Quantum Mechanics", 2nd Edition, Pearson, 2004
5. M.S. Rogalski and S. B. Palmer, "Quantum Physics", CRC Press, 1999.
6. Leonard I. Schiff, Quantum Mechanics, McGraw Hill, 1968.

Web Resources*

1. Visual quantum mechanics: https://vqm.uni-graz.at/
2. https://ocw.mit.edu/courses/physics/
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=28
4. https://nptel.ac.in/courses/115/106/115106066/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
II	21PPH2CC03	CORE-3: Quantum Mechanics	5	5

Course Outcomes↓ (COs)	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	2	1	3	3	2	2	2	2.3
CO-2	3	3	2	2	1	3	3	2	2	2	2.3
CO-3	3	3	2	2	1	3	3	2	2	2	2.3
CO-4	3	3	2	2	1	3	3	2	2	2	2.3
CO-5	3	3	2	2	2	3	3	2	2	2	2.4
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours	Credit
II	**21PPH2CC04**	**CORE-4: MATHEMATICAL METHODS OF COMPUTATIONAL PHYSICS AND PYTHON PROGRAMMING**	**5**	**5**

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	gain knowledge on the mathematical methods in Tensors, Group Theory and programming Language and comprehend the same for the problems in physics at ease	**K1& K2**
CO-2	apply the knowledge gained in computational and numerical methods to solve problems in physics.	**K3**
CO-3	analyse computationally the given problems in physics by various theoretical models.	**K4**
CO-4	evaluate the complex problems in physics based on specific theories, procedures and tools.	**K5**
CO-5	synthesis the computational methods adapted to produce precise and accurate results on select problems	**K6**

Unit-I: Tensors **(15 Hours)**

Introductory ideas on scalars, vectors and tensors - Co-ordinate transformation: Rotation of the axes and vectors - fundamental ideas and representations - algebra of tensors - curvature of space - time manifold: Metric tensor of the space, Einstein's field equations, Geodesics, curvature of space, Schwarzschild metric -Christoffel's 3-index symbols.

Unit-II: Group Theory **(15 Hours)**

Definition and nomenclature - rearrangement theorem - cyclic groups - subgroups - conjugate elements and class structure - identification of symmetry element and operations - molecular point groups -The Great Orthogonality theorem (Qualitative treatments) - character of representation. Character table - generating symmetry operators - construction of character tables - irreducible representation for C_{2v} and C_{3v}.

Unit-III: Numerical Methods Applied to Physics Problems **(15 Hours)**

Numerical integration: Trapezoidal, Simpson's 1/3 rules - Truncation error - composite trapezoidal and Simpson's 1/3 rules. **ODE:** Fourth-order Runge-Kutta methods for first order ODE.
Interpolation: Newton's interpolation - Linear interpolation - Higher-order polynomials - Divided differences - Gregory - Newton forward and backward interpolation formulae - error in interpolation *(no theory and derivation of formulae in the entire unit)*

Unit-IV: Basics of Python **(15 Hours)**

Installing Python - Launch Python - Python modules - Python expression - objects and their methods - Lists - Tuples - Strings - Loops - Development Tools

Unit-V: Python Structure and Control **(15 Hours)**

SciPy and NumPy - arrays - array operations - scripts - contingent behavior - nesting - importing data - exporting data - visualizing data - Functions - random numbers and simulation - histograms and bar graphs -contour plots and surfaces - matrix library - Interpolation - Fourier Transform - Sparse eigenvalue problem

Books for Study

1. Matrix and Tensors in Physics, A.W. Joshi, New Age, 2010.
2. Group Theory and Quantum Mechanics, Tinkham M, McGraw Hill, 1974.
3. Numerical Methods in Science & Engineering, M.K. Venkataraman, National Pub. Co. Madras, 2013.
4. Jesse M Knder, Philip Nelson, "Python for Physical modelling", Princeton University Press Princeton and Oxford, 2015.
5. https://docs.python.org/3/library/tk.html

Unit	Book	Chapters	Sections
I	1	1 & 2	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8
II	2	1 & 2, 3, 5	1.1, 1.2, 2.1, 2.3, 2.4, 3.2, 3.3, 3.4, 5.2, 5.3, 5.4
III	3	1,3,7	All sections
IV	4	1, 2	1.2-1.4, 2.1, 2.2.1, 2.3, 2.4
V	4,5	2, 3, 5	2.2.2-2.2.10, 2.5-2.8, 3.1-3.3, 5.1-5.4

Books for Reference

1. Pipes, L.A. &Harvill, L.R., Applied Mathematics for Engineers and Physicists. Dover Publications, Inc., 2014.
2. Arfken, Weber, Harris, Mathematical Methods for Physicists, 7 ed. Academic Press, 2013.
3. M. l. Boas, Mathematical Methods in the Physical Sciences, 3rd ed. John Wiley & Sons, 2006.
4. E. Kreyszig, Advanced Engineering Mathematics, 10th ed. Wiley, 2015.
5. R. L. Burden and J. D. Faires, Numerical Analysis, 9th ed. Brooks/Cole, Cengage Learning, 2011.
6. Jamie Chan, "Python for Beginners", 2014.
7. Adam Stewart, "Python Programming", 2016.
8. NumPy-1.17 and SciPy-1.6.1 reference manual.

Web Resources*

1. https://ocw.mit.edu/courses/mathematics/
2. https://nptel.ac.in/courses/115/103/115103036/
3. https://epgp.inflibnet.ac.in/Home
4. https://swayam.gov.in/explorer
5. http://www.learncodingfast.com/python
6. https://www.tutorialspoint.com/python/index.htm
7. https://www.python.org/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2CC04	CORE-4: MATHEMATICAL METHODS OF COMPUTATIONAL PHYSICS AND PYTHON PROGRAMMING	5	5

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	2	2	2	3	2	3	2	2	2.3
CO-2	3	3	2	2	2	3	3	2	2	2	2.4
CO-3	3	2	2	2	3	2	2	2	3	3	2.4
CO-4	3	3	2	2	2	3	3	2	1	2	2.3
CO-5	3	3	2	2	2	2	2	2	1	1	2.0
Mean Overall Score											2.3 (High)

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2CP02	PHYSICS PRACTICAL – II	8	6

Any 15 Experiments

1. Michelson Interferometer – wavelength, separation and thickness of thin sheet
2. Biprism – Optic bench - wavelength, separation and thickness of thin sheet
3. Energy Gap study of a semiconductor
4. Elastic Constants – Hyperbolic fringes
5. Laser: Magneto-striction, Faraday effect and Verdert constant of a given material
6. e-Millikan's oil drop method
7. Ultrasonic diffraction – velocity and compressibility in liquids
8. Determination of e/k using Ge and Si transistors
9. Permittivity of a liquid using RFO
10. Determination of phase transition temperatures of a binary liquid mixture at different concentrations
11. Polarizability of liquids
12. Fermi-Curie plot of the X-ray/ Gamma ray spectrum and determination of end-point energy
13. Determination of transition temperature in liquid crystalline materials
14. Characteristics of laser and tunnel diode
15. Characteristics of LVDT
16. Characteristics of load cell
17. SCR – Characteristics and Applications
18. Study of regulated power supply – monolithic IC
19. Transmission Line Characteristics
20. Shift Registers using Flip-Flop & ICs
21. Design of ROM and RAM using diode / OR gate and flip flop
22. Design of Encoder and Decoder
23. Op-amp: Low, High and band pass Filters
24. Computational experiment: Curve fitting – Least square fitting
25. Computational experiment: Solving Schrodinger equation for hydrogen / LHO
26. Computational experiment: Op-Amp parameter study – Circuit simulation using Proteus
27. Computational experiment: Linear Harmonic Oscillator problem using Hamilton's equation
28. Determination of the wavelength of an unknown light source and the distance between the grooves of a compact disk.
29. Determination of band gap of a semiconductor sample using UV-VIS spectroscopy
30. Study of magnetic hysteresis in ferromagnetic materials

Semester	Course Code	Title of the Course	Hours	Credits
II	21SPS2ES02A	DSE-2: METHODS OF SPECTROSCOPY	5	4

CO No.	CO - Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire knowledge and understand the aspects of various spectroscopic methods like rotational spectroscopy and its techniques.	K1 & K2
CO-2	explain the theory and principles of vibrational spectroscopy and its techniques.	K1 & K2
CO-3	perceive the theory and principles of electronic and X-ray spectroscopy and apply them to describe fluorescence and phosphorescence	K3, K4 & K5
CO-4	comprehend the basics of Raman spectroscopy and evaluate and examine the molecular and atomic structure of different advanced materials.	K4 & K5
CO-5	understand the physics behind NMR and ESR spectroscopy, Mossbauer spectroscopic techniques and apply it examine new materials and to make novel drugs in the field of medicine.	K2, K3 & K6

Unit - I: Microwave Spectroscopy **(15 Hours)**

Characterization of Electromagnetic Radiation - Regions of the Electromagnetic spectrum, Intensity of spectral lines - Rotation of Molecules, Rotational Spectra - A Diatomic Rigid Rotator - Intensity of Spectral lines - Effect of isotopic substitution, the non-rigid rotator, spectrum of a non-rigid rotator - Poly atomic molecules - Linear molecules - symmetry top molecules - asymmetry top molecules.

Unit - II: Infra-Red Spectroscopy **(15 Hours)**

The vibrating diatomic molecule - Simple Harmonic Oscillator - the anharmonic oscillator, the diatomic vibrating rotator, the vibrations of polyatomic molecules - fundamental vibrations and their symmetry - overtones and combination frequencies, Influence of rotation on the spectra of linear polyatomic molecules - parallel vibrations, perpendicular vibrations, influence of nuclear spin.

Unit - III: Raman Spectroscopy **(15 Hours)**

Introduction - Quantum theory of Raman effect - Classical theory of Raman effect - Pure rotational Raman spectra - Linear molecules, symmetry top molecules, asymmetry top molecules - vibrational Raman spectra - Raman activity of vibrations - rule of Mutual Exclusion - Rotational fine structure - Structure determination from Raman and Infra-red spectroscopy Near Infra-red FT-Raman spectroscopy.

Unit - IV: Electronic Spectroscopy of Molecules **(15 Hours)**

Electronic spectra of Diatomic molecules - Born Oppenheimer approximation - vibrational coarse structure, Frank-Condon Principle - Intensity of vibrational - electronic spectra - dissociation

energy and dissociation products - Rotational Fine Structure of Electronic -Vibration Transitions - Molecular photo-electron spectroscopy - X-ray photoelectron spectroscopy.

Unit - V: Spin Resonance Spectroscopy and Mossbauer Spectroscopy (15 Hours)

Spin and an applied field - nature of spinning particles - interaction between spin and a magnetic field - population of energy levels - the Larmor Precession - NMR spectroscopy for Hydrogen Nuclei - Chemical shift - the coupling constant - coupling between several nuclei.
Electron-spin Resonance Spectroscopy - g factor - hyperfine structure due to electron - nucleus coupling - double resonance - fine structure due to electron - electron coupling.
Principles of Mossbauer Spectroscopy - Applications of Mossbauer spectroscopy - chemical shift - quadrupole effect - effect of a Magnetic field.

Book for Study

1. Colin N. Banwell and Elaine M. Mccash, Fundamentals of molecular spectroscopy, 4th edition, Tata mcgraw-hill ltd, 2014.

Unit	Chapters	Sections
I	1,2	1.1, 1.3, 1.7, 2.1, 2.2, 2.3-2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.4-2.4.1, 2.4.2, 2.4.3
II	3,6	3.1-3.1.1, 3.1.3, 3.1.3, 3.2, 3.5-3.5.1, 3.5.2, 3.6-3.6.1, 3.6.2
III	4	4.1- 4.1.1, 4.1.2, 4.2-4.2.1, 4.2.2, 4.2.3, 4.2.3, 4.3-4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5, 4.5, 4.7
IV	5,6	5.2-5.2.1, 5.2.2, 5.2.3, 5.2.4, 6.1-6.1.1, 6.1.2, 6.1.3, 6.1.4, 6.1.5, 6.5-6.5.1, 6.5.2
V	7,9	7.1- 7.1.1, 7.1.2, 7.1.3, 7.1.4, 7.2-7.2.1, 7.2.2, 7.2.3, 7.5-7.5.1, 7.5.2, 7.5.3, 7.5.4, 7.5.5, 9.1, 9.2-9.2.1, 9.2.2, 9.2.3

Books for Reference

1. G. Aruldhas, Molecular Structure and Spectroscopy, (2nd Edition), PHI Learning Private Ltd. 2014.
2. Straughan and Walker, Spectroscopy Volume 1-3 Chaman & Hall Publishers, E-Book, 2nd Jan.2019.
3. Gurdeep R Chatwal and Sham K Anand, Spectroscopy, Himalaya Publishing House, 2009.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credits
II	21SPS2ES02A	DSE-2: METHODS OF SPECTROSCOPY	5	4

Course Outcomes (Cos)	Programme Outcomes (PO)					Programme Specific Outcomes (PCO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	3	2	3	2	3	2	1	2.3
CO-2	3	3	2	2	3	3	2	2	2	1	2.3
CO-3	3	2	2	3	3	2	2	3	2	1	2.3
CO-4	3	2	2	3	3	2	3	3	2	1	2.4
CO-5	3	3	2	3	3	2	2	3	2	1	2.3
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2SP01A	SELF PACED LEARNING: MEDICAL PHYSICS	-	2

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire knowledge about the mechanics of human body, the energy transfer in metabolism, the fluid dynamics of blood flow through vessels, the mechanisms for speaking, hearing, vision and neural communications.	K1
CO-2	measure the temperature, pressure and other physical variables associated with the human body and to diagnose the medical imaging data in clinical use and be aware of the medical treatment and medicine use.	K2
CO-3	understand physics principles, instrumental design, data acquisition strategies and imaging modalities in biomedical imaging.	K2,K3
CO-4	apply physics concepts to human body and physiology.	K4
CO-5	integrate the physics, biology, technology and medicine for sustainable life.	K5, K6

Unit - I: Biomechanics

Motion in the Human machine - the standard human - material components of the body - bone - ligaments and tendons - cartilage - bone shortening - energy storage in tendons and long bones, muscles: skeletal muscles - the structure of muscles - passive muscles - activating muscles - the effect of exercise - levers - the elbow - the hip - the back - elasticity of bone, tissue, visco elasticity. pressures in the body: pressure in the cardiovascular system - hydrostatic pressure - bladder pressure - respiratory pressures - foot pressures - eye and ear pressures - biomechanical measurement - X-ray imaging technique.

Unit - II: Cardiovascular and Respiratory System

Cardiovascular System: circulatory system and cardiac cycle - physics of the circulation system: properties of blood - blood pressure and flow in vessels - capillaries and osmotic pressure - blood flow rates and speeds - consequences of clogged arteries - work done by the heart and the metabolic needs of the heart - blood velocity measurement - The Doppler effect – ECG, lungs and breathing: lungs - alveoli - breathing - volume of the lungs - breathing under usual and unusual conditions - work needed to breathe.

Unit - III: Heat and Energy Transfer in Human Body

Metabolism: energy, heat, work, and power of the body - conservation of energy and heat flow - energy content of body fuel - energy storage molecules - loss of body heat - body temperature - energy requirement - energy from food - regulation of body temperature -resistance to cold - diffusion through membranes thin-film flowmeters - thermistor flowmeters - thermal dilution - thermal conductivity methods - thermography.

Unit - IV: Bio-Acoustics and Bio-Optics

Acoustic Buzzer - voice filtering theory - parameters of voice - energetic speaking. auditory sensitivity - connections to hearing perceptions. structure of the eye - imaging and detection by the eye - transmission of light in the eye - the eye as a compound lens - accommodation ultrasonic imaging - theory and instrumentation.

Unit - V: Electrophysiology and Nuclear Medicine

Biological potentials - the nervous system - neural communication, the interface between ionic conductors: Nernst equation - membranes and nerve conduction - muscle action potentials - neural stimulation - tissue as a leaky dielectric - low-frequency effects: (0.1 Hz-100 kHz)- higher frequencies (>100 kHz) - physiological effects of electricity - electricity in bone. nuclear medicine - MRI - general principles - slice selection - phase encoding - frequency encoding - K space formalism, instrumentation: magnet design - magnetic field gradient coils - RF coils imaging sequences - imaging characteristics - contrast agents functional MRI, applications: brain, liver, skeletal and cardiac systems

Books for Study

1. Irving P. Herman, "Physics of Human Body", 1st Edition, Springer, 2007.
2. Paul Davidovits, "Physics in Biology and Medicine", 3rd Edition, Elsevier, 2008.
3. B.H. Brown, "Medical Physics and Biomedical Engineering", 1st Edition, IOP Publishing, 1999.
4. A.G. Webb, "An Introduction to Biomedical Imaging", 1st Edition, Wiley, 2003.

UNIT	BOOK	CHAPTERS	SECTIONS
I	1	1, 4	1.2, 1.3, 4.1, 4.2.3, 4.2.4, 4.6, 4.7
	2	1, 3, 8, 18	1.1, 3.2, 3.8, 8.5, 8.11, 18.4
	3	1, 2	1.2, 2.2
	4	1	1.3-1.9
II	1	8	8.1, 8.2.1-8.2.6, 9.6
	3	19	19.7.1
III	1	6	6.1-6.6
	2	9, 11	9.6, 11.1, 11.2, 11.9,
	3	19	19.4
IV	1	10, 11	10.2, 10.3, 11.3.1-11.3.3
	2	15	15.7
	4	3	3.1, 3.4-3.8
V	3	8, 16	8.2, 8.5, 8.6, 8.8.1, 16.1.1-16.1.5, 16.5
	2	13	13.3
	4	4	4.1, 4.7, 4.10

Books for Reference

1. M. Maqbool, "An Introduction to Medical Physics", Springer, 2017.
2. H. Jelinkova, "Lasers for Medical applications, diagnostics, therapy and surgery", 1st Edition, Elsevier, 2013.
3. R.S. Khandpur, "Handbook of Biomedical Instrumentation", 3rd Edition, McGraw Hill, 2014.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code			Title of the Course				Hours	Credit
II	21PPH2SP01A			Self-Paced Learning: MEDICAL PHYSICS				-	2
Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	2	2	2	2	2	2	3	2.3
CO-2	3	2	2	2	3	2	2	3	2	2	2.3
CO-3	2	2	2	2	2	3	2	2	2	2	2.1
CO-4	3	3	3	2	3	2	2	2	2	3	2.5
CO-5	2	2	3	2	3	3	2	2	2	2	2.3
Mean Overall Score											2.3 (High)

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2SP01B	Self-Paced Learning: PHYSICS OF CRYSTAL GROWTH AND THIN FILM	-	2

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge about the fundamentals of nucleation and various crystallization theories.	K1
CO-2	understant various crystallization theories, various crystal growth methods and thin film deposition techniques.	K2
CO-3	apply the essential processing prarameters for different crystal growth and thin film deposition techniques.	K3
CO-4	analyze the different growth techniques and choose an appropriate technique to grow crystals and thin films.	K4
CO-5	evaluate the merits and demerits of different growth techniques and design a new growth approach to overcome the existing demerits.	K5 & K6

Unit-I: Nucleation

Primary nucleation - Secondary nucleation - Solubility, super solubility and metastable zone - Crystal growth theories: surface energy theories, adsorption layer theories, kinematic theories, and diffusion reaction theories

Unit–II: Crystal Growth from Melt and Vapour

Czochralski method - Bridgmann - Stockbarger method - Zone Melting Method -Vapour growth: direct vapour transport method, Chemical transport method

Unit - III: Crystal Growth from Solution

Solution and Solubility - Choice of Solvent - Additives - Nucleation - Achievement of Supersaturation - Mason-Jar Method - Holden's Rotary Crystallizer - Temperature Differential Method - growth from silica gel - High temperature solution growth - Flux growth - Top seeded solution growth -Hydrothermal growth

Unit - IV: Thin Film Deposition: Physical Vapour Deposition

Evaporation method: Vacuum evaporation, Electron beam evaporation - DC diode sputtering, Magnetron sputtering, Reactive ion sputtering, RF sputtering - Pulsed Laser Deposition - Molecular Beam Epitaxy

Unit - V: Thin Film: Deposition Chemical Vapour Deposition and Liquid Phase Deposition

Chemical vapour deposition - typical chemical reactions - reaction kinetics - transport phenomena - CVD methods – Metal Organic Chemical Vapour Deposition - Plasma enhanced chemical vapour deposition - Langmuir-Blodgett films - Electrochemical deposition - Sol-gel films.

Books for Study

1. W Mullin, Butterworth-Heinemann, Crystallization, 4th edition, Oxford, 2001.
2. H. L. Bhat, Introduction to crystal growth principles and practice, CRC Press Taylor & Francis Group, New York, 2015.
3. Hartmut Frey, Hamid R. Khan,Handbookof Thin-FilmTechnology, Springer-Verlag Berlin Heidelberg, 2015.
4. Guozhong Cao, Nanostructures and nanomaterials: synthesis, properties and applications, Imperial college press, London, Reprinted 2006

Unit	Book	Chapters	Sections
I	1	3, 5, 6	3.11, 3.12, 5.1, 5.2, 5.3, 6.1
II	2	8, 10	(P. No.) 124, 140, 155, 162, 242, 252
III	2	9	183, 198, 207, 215
IV	3 2	3, 6, 9 11	3.5, 6.4, 6.6, 6.8, 6.9, 9.4 (P.No.) 262, 268
V	4 3	5 9	5.5, 5.5.1, 5.5.2, 5.5.3, 5.5.4, 5.9, 5.10, 5.11 9.4

Books for Reference

1. Crystal growth processes and methods, P. Santhana Raghavan, P. Ramasamy, Kru Publications, Kumbakonam, India, 2000.
2. Handbook of thin film deposition, processes and techniques, Krishna Seshan, Noyes Publication, USA, 2nd edition 2002.
3. Handbook of Thin Film Technology, Leon I. Maissel, Reinhard Glang, McGraw Hill Higher Education, New York, 1970.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2SP01B	Self Paced Learning: PHYSICS OF CRYSTAL GROWTH AND THIN FILM	-	2

Course Outcomes (COs)	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO 3	PSO4	PSO5	
CO-1	3	3	3	2	2	3	2	2	2	3	2.5
CO-2	3	3	2	2	2	3	2	2	2	2	2.2
CO-3	3	3	3	2	2	3	1	2	2	2	2.3
CO-4	3	3	3	2	2	3	1	2	3	2	2.4
CO-5	3	3	3	2	2	3	2	2	2	2	2.4
Mean Overall Score											2.36 (High)

Semester	Course Code	Title of the Course	Hours	Credit
II	**21PPH2SP01C**	**Self-Paced Learning: ULTRASONICS**	**-**	**2**

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge of ultrasound.	**K1**
CO-2	understand the concepts of transducer and its working.	**K2**
CO-3	identify and apply different measurement techniques of ultrasound.	**K3**
CO-4	analyze and discuss the applications of ultrasound.	**K4**
CO-5	evaluate the ultrasound based NDT and design the ultrasonic devices by applying the principles of ultrasound.	**K5 & K6**

Unit-I: Fundamentals of Ultrasound

Introduction - Brief Early History - Underwater Sound (SONAR) - Medical and Biological Ultrasonics - Industrial Ultrasonics - Nondestructive Testing/Evaluation - Ultrasonics in Electronics - Physical Acoustics - Ultrasonic Systems: Transmitters and Receivers - Low-Intensity Applications - High-Intensity Applications - Modern Ultrasonics: An Interdisciplinary Field - Velocity of Sound in Solids - Velocity of Sound in Liquids - Velocity of Sound in Gases - Wave Incident on a Liquid - Solid Plane Interface, Semi-Infinite Media - Reflection, Refraction.

Unit-II: Basics of Ultrasonic Transducers

Piezoelectric Transducers - equivalent circuit of a simple piezoelectric transducer - efficiency of a simple piezoelectric transducer - maximum power transfer between Electronic Power Source and Simple Piezoelectric Transducers - Determining Transformation Factor (α) for the Piezoelectric Transducer Material - Quality Factor (Q) of Piezoelectric Transducers - Piezoelectric Transducers for High-Intensity Applications - Pulse-Type Transducers for Low-Intensity Applications Sensing - Piezoelectric Polymers for Transducers.

Unit-III: Measurement Techniques of Ultrasound

Measurement of Velocity and Attenuation in Isotropic Solids - Measurement of Velocity and Attenuation in Fluids - Methods of Measuring Velocity of Sound - Interferometer Method - Resonance Method - "Sing-Around" Method - Pulse-Superposition Method - Pulse-Echo-Overlap Method - Measurements in Materials of High Attenuation - Measurements at High Temperatures - Measurements at High Pressures - Measuring Torsional Resonant Frequencies of Isotropic Bars.

Unit-IV: Applications of Ultrasound

Electron Acoustic Image Converter - Schlieren Imaging - Liquid Levitation Imaging - Ultrasonic Imaging with Liquid Crystals - Photographic Methods of Imaging by Ultrasonics - Ultrasonic Holography - Acoustic Microscopy - Ultrasonic Arrays - Ultrasound in Process Industries - Monitoring Solidification (Interface Sensing) - Acoustic Time Domain Reflectometry - Three-Phase Reactors - Process Tomography Using Ultrasonic Methods - Ultrasonic Transducers:

Process Industry Applications - Sonochemistry - Depolymerization - Polymerization - Precipitation - Metallurgical Effects.

Unit-V: Ultrasonic Non-Destructive Testing

Resonance Methods - Pulse Methods - Acoustic Emission Technique - Factors Affecting Resolution and Sensitivity - Near-Field Effects - Properties of the Materials - Eddy Sonic Inspection Method - Sonic Analysis - Acoustic Impact Technique - Ultrasonic Spectroscopy - Critical Angle Analysis - Instrumentation - Resonance Methods - Pulse Methods - Acoustic Emission Methods - Phased Arrays Systems - Methods Used to Determine Flaw Size.

Books for Study

1. Dale Ensminger and Leonard J. Bond, Ultrasonics Fundamentals, Technologies and Applications, CRC Press, Taylor & Francis Group, Third Edition ,2011.

Unit	Book	Chapters	Sections
I	1	1,2	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11, 1.12, 2.3.1, 2.3.2, 2.3.3
II	1	5	5.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5, 5.3.7, 5.3.8, 5.3.9, 5.4.2
III	1	6	6.2.1, 6.2.2, 6.3, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.3.6, 6.3.7
IV	1	10,11	10.2.2, 10.2.3, 10.2.4, 10.2.5, 10.2.6, 10.2.7, 10.2.8, 10.2.9, 10.3.1, 10.3.4, 10.3.5, 10.3.6, 10.3.7, 10.3.8, 11.4, 11.4.1, 11.4.2, 11.4.4, 11.5
V	1	7	7.2.1, 7.2.2, 7.2.3, 7.3, 7.3.1, 7.3.2, 7.4.1, 7.4.2, 7.4.3, 7.4.4, 7.4.5, 7.5, 7.5.2, 7.5.3, 7.5.4, 7.5.5, 7.5.7.2,

Books for Reference

1. J. David N. Cheeke, Fundamentals and Applications of Ultrasonic Waves, CRC Press, 2002.

Web Resources *

1. http://hyperphysics.phy-astr.gsu.edu/hbase/Sound/usound.html
2. https://www.sonotec.com/en/column/ultrasonic.html

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course							Hours	Credit
II	21PPH2SP01C	Self-Paced Learning – 1: ULTRASONICS							-	2
Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	3	2	3	2	3	2	1	2.3
CO-2	3	3	2	2	3	3	2	2	2	1	2.3
CO-3	3	2	2	3	2	2	3	3	2	1	2.3
CO-4	3	2	2	3	3	2	2	3	2	1	2.3
CO-5	3	3	2	2	2	2	2	3	3	1	2.3
Mean Overall Score											2.3 (High)

Semester	Course code	Title of the Course	Hours	Credit
II	21PPH2SP1D	Self-Paced Learning: NANOSCIENCE AND NANOTECHNOLOGY	-	2

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	know the fundamental principles of nanoscience and technology and their applications in field of energy and storage, medical, agriculture, space and defense.	K1
CO-2	understand the methods of fabrication of nanostructures and characterization tools for study the properties of nanostructures.	K2
CO-3	apply physics concepts to the nano-scale materials and discuss the applications of nanomaterials.	K3
CO-4	analyze the unique properties of nanomaterials to the reduce dimensionality of the material and evaluate its impact on energy harvesting and storage, medical, agriculture and defense.	K4 & K5
CO-5	design new printed circuits by applying the nanofabrication methods like lithography, micro contact printing and Replica molding.	K6

Unit - I: Introduction to Nanoscience and Nanotechnology

Introduction - History and scope - Nanosize and properties - Classification of nanostructured materials - Fascinating nanostructures - Nanotechnology impact on various fields - Nature: the best nanotechnologist - challenges and future prospects.

Unit - II: Synthesis of Nanomaterials-I

Introduction - Mechanical Methods - High Energy Ball Milling - Melt Mixing - Methods Based on Evaporation - Physical Vapour Deposition - Ionized Cluster Beam Deposition - Laser Vaporization (Ablation) - Sputter Deposition (DC Sputtering) - Chemical Vapour Deposition (CVD) - Ion Beam Techniques (Ion Implantation) - Molecular Beam Epitaxy (MBE).

Unit - III: Synthesis of Nanomaterials-II

Introduction - Colloids and Colloids in Solutions - Interactions of Colloids and Medium - Effect of Charges on Colloids - Stearic Repulsion - Synthesis of Colloids - Nucleation and Growth of Nanoparticles - Synthesis of Metal Nanoparticles by Colloidal Route - Synthesis of Semiconductor Nanoparticles by Colloidal Route – Langmuir - Blodgett (LB) Method - Sol-Gel Method - Hydrothermal Synthesis - Sonochemical Synthesis.

Unit - IV: Lithography in Nanotechnology

Introduction - Lithography Using Photons (Optical Method) - Lithography Using UV Light and Laser Beams - Use of X-rays in Lithography - Lithography Using Particle Beams - Electron Beam Lithography - Ion Beam Lithography - Scanning Probe Lithography - Mechanical Methods - Dip Pen Lithography - Optical Scanning Probe Lithography - Thermo-Mechanical Lithography - Electrical Scanning Probe Lithography - Soft Lithography - Microcontact Printing (μCP) - Replica Molding (REM).

Unit - V: Applications of Nanotechnology

Dye Sensitized Photovoltaic Solar Cell - Organic Photovoltaic Cells - Fuel Cell - Hydrogen Generation and Storage - Hydrogen Storage (and Release) - Hybrid Energy Cells - Automobiles - Medical Field – Imaging - Drug Delivery - Cancer Therapy - Tissue Repair - Agriculture and Food - Space, Defense and Engineering.

Books for Study

1. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday, Textbook of Nanoscience and Nanotechnology, Springer-Universities Press, 2013.
2. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Springer publications, 3rd edition, 2015.

Unit	Book	Chapters	Sections
I	1	1	1.1, 1.2, 1.3 1.4, 1.5, 1.6, 1.7
II	2	3	3.1, 3.2 (3.2.1, 3.2.2), 3.3 (3.3.1, 3.3.2, 3.3., 3.3.4), 3.4 (3.4.1), 3.5, 3.7, 3.8
III	2	4	4.1, 4.2 (4.2.1, 4.2.4, 4.2.5, 4.2.6), 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10
IV	2	9	9.1, 9.2 (9.2.1, 9.2.2) 9.3 (9.3.1, 9.3.2) 9.4 (9.4.1, 9.4.2, 9.4.3, 9.4.4, 9.4.5) 9.5 (9.5.1, 9.5.2)
V	2	12	12.2 (12.2.1, 12.2.2, 12.2.3, 12.2.4, 12.2.5, 12.2.6) 12.7, (12.7.1, 12.7.2, 12.7.3, 12.7.4) 12.8, 12.9, 12.10

Books for Reference

1. Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties & Applications, Imperial College Press, 2004.
2. Edward L. Wolf, Nanophysics And Nanotechnology, Wiley-Vch Publications, 2nd Edition, 2006.
3. K.P. Mathur, Rajat Publications, Nano Science And Nano Technology, New Delhi, 1st Edition 2007.
4. C. N. R. Rao, P. J. Thomas And G. U.Kulkarni, Nanocrystals: Synthesis, Properties And Applications, Springer, 2007.
5.

Web Resources *

1. https://www.nano.gov/nanotech-101
2. https://ee.stanford.edu/spotlight/nanotechnology-nemsmems
3. https://www.hse.gov.uk/nanotechnology/index.htm
4. http://crnano.org/whatis.htm

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course code			Title of the Course						Hours	Credit
II	21PPH2SP1D			Self-Paced Learning: NANOSCIENCE AND NAOTECHNOLOGY						-	2
Course outcomes (COs)	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	3	2	2	2	2	2.4
CO-2	3	3	2	2	2	3	2	2	2	2	2.3
CO-3	3	3	3	2	2	3	2	2	2	2	2.4
CO-4	3	3	3	2	2	3	2	2	2	2	2.4
CO-5	3	3	2	2	2	3	2	2	2	2	2.3
	Mean Overall Score										2.36 (High)

Semester	Course Code	Title of the Course	Hours	Credits
II	21PSS2SE01	SEC: SOFT SKILLS	4	3

Programme Specific outcomes (PSOs)
After the successful completion of the course, students will learn:

- the dynamics of effective and professional communication skills and put them into daily use
- to write a Professional resume using creative methods of online platforms
- the dynamics of interview skills and GD preparations and presentations in public platforms and present the best of themselves as job seekers
- to understand, analyze and express their personality styles and personal effectiveness in various environments
- to learn and update themselves with the required knowledge in Numerical ability and Test of Reasoning for competitive examinations

Course outcomes (COS)
Upon completion of this course, students will:

- be exposed and trained in various nuances of Soft Skills in a Professional manner responding to the requirements of national and international market
- be able to synthesize the knowledge and practical skills learnt to be personal effective in any managerial positions
- be equipped to construct plans and strategies to work for better human society
- be able to illustrate the problems at work and home and design solutions and maintain a balance of work and home• be able to connect on a continuum and maintain growth and sustainability and creativity in employment that increases in productivity, profit for individuals and the society.

Module 1: Effective Communication & Professional communication

Effective communication: Definition of communication, Process of Communication, Barriers of Communication, Non-verbal Communication. JOHARI Window as a tool of effective communication.

Professional Communication: The Art of Listening, The passage, Kinesthetic, Production of Speech, Speech writing , Organization of Speech, Modes of delivery, Conversation Techniques, Good manners and Etiquettes, Different kinds of Etiquettes, Politeness markers.

Module II. Resume Writing & Interview Skills

Resume Writing: Meaning and Purpose. Resume Formats. Types of s Resume. Functional and Mixed Resume**,** Steps in preparation of Resume, Model resumes for an IT professional Chronological, Types of interviews, Creative resumes using online platforms

Interview Skills: Common interview questions, Dos and Don'ts for an interview, Attitude, Emotions, Measurement, Body Language, Facial expressions, Different types of interviews, Telephonic interviews, Behavioral interviews and Mock interviews (Centralized).

Module III: Group Discussion & Team Building

Group Discussion: Group Discussion Basics, GD as the first criterion for selecting software testers, Essentials of GD, Factors that matter in GD, GD parameters for evaluation, Points for GD Topics, GD Topics for Practice, Tips for GD participation. Video shooting of GD presentation & Evaluation (Centralized)

Team Building: Characteristics of a team, Guidelines for effective team membership, Pedagogy of team building, Team building skills. Team Vs Group – synergy, Types of synergy, Synergy relates to leadership ,Stages of Team Formation, Broken Square-Exercise, Leadership, Leadership styles, Conflict styles, Conflict management strategies & Exercises

Module IV: Personal Effectiveness

Personal Effectiveness: Self Discovery: Personality, Characteristics of personality, kinds of self, Personality inventory table, measuring personality, intelligence and Exercises

Self Esteem: Types -High & Low self esteem, Ways of proving self esteem, Hypersensitive to criticism, activities. Goal setting: Goal setting process, Decision making process & Exercises.

Stress Management: Identifying stress, Symptoms of stress, Responding to Stress, Sources of stress, Coping with stress and Managing stress.

Module V: Numerical Ability

Average, Percentage, Profit and Loss**,** Problems of ages, Simple Interest, Compound Interest, , Area, Volume and Surface Area, Illustration, Time and Work, Pipes and Cisterns, Time and Distance**,** Problems on Trains**,** Illustrations, Boats and Streams, Calendars and Clocks.

Module VI: Test of Reasoning

Verbal Reasoning: Number series, letter series, coding and decoding, logical sequence of words, Assertion and Reasoning, Data Sufficiency, Analogy, Kinds of relationships.

Non-Verbal Reasoning: Completion of Series**,** Classification, analogical, Pattern comparison, Deduction of figures out of series, Mirror Reflection Pattern, Hidden figures, Rotation pattern, Pattern completion and comparison, Sense of direction, Blood relations.

Text cum Exercise book

Melchias G, Balaiah John, John Love Joy (Eds), 2018. Winners in the Making: A primer on soft skills. SJC, Trichy.

References

* Aggarwal, R.S. *Quantitative Aptitude, S.Chand & Sons*
*.Aggarwal, R.S. (2010). *A Modern Approach to Verbal and Non Verbal Reasoning*. S.Chand & C0,Revised Edition.
* Covey, Stephen. (2004). *7 Habits of Highly effective people,* Free Press.
* Egan, Gerard. (1994). *The Skilled Helper* (5^{th} Ed). Pacific Grove, Brooks/Cole.
* Khera ,Shiv (2003). *You Can Win.* Macmillan Books , Revised Edition.

Other Text Books

* Murphy, Raymond. (1998). *Essential English Grammar*. 2nd ed., Cambridge University Press.

* Prasad, L. M. (*2000). Organizational Behaviour*, *S.Chand & Sons.*

* Sankaran, K., & Kumar, M. *Group Discussion and Public Speaking* . M.I. Pub, Agra, 5th ed., Adams Media.

* Schuller, Robert. (2010) . *Positive Attitudes*. Jaico Books.

* Trishna's (2006). *How to do well in GDs & Interviews*, Trishna Knowledge Systems.

** Yate, Martin. (2005). H*iring the Best: A Manager's Guide to Effective Interviewing and Recruiting**

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2EG01A	GE – 1 (WS): SOLAR ENERGY AND UTILIZATION	4	3

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquir the principles of solar energy and predict its utilization.	K1
CO-2	understant the concepts of solar insolation and its effects.	K2
CO-3	apply the concepts of solar energy in the characteristics of different materials like flat plate, tubular, Fresnel etc.	K3
CO-4	analyse the differnt energy storage methods.	K4
CO-5	assess annual solar savings and its conversion and design the rechargeable batteries and solar pond.	K5 & K6

Unit - I: Energy Scenario & Solar Energy Option (12 Hours)

Introduction - Survey of production and Reserves of Commercial Energy sources - World - India - Alternate Solar option. Thermal Collection and Storage - Thermal Application - some observation.

Unit - II: Solar Installation (12 Hours)

Solar Spectrum - Effects of Earth's Atmosphere - Measurement of Irradiance - Solar Simulation - Solar Cell Testing Methods - The effect of temperature and illumination on cell efficiency - Loss Analysis.

Unit - III: Solar Thermal Collectors (12 Hours)

Characteristics of the materials - Flat Plate Collectors - Tubular Solar Energy Collectors - Fresnel Reflector and Lenses (parabolic).

Unit - IV: Solar Energy Storage (12 Hours)

Sensible heat Storage - Phase Transition Chemical Storage - Rechargeable Batteries - Solar Pond.

Unit - V: Other Methods of Solar Energy Utilization and Analysis (12 Hours)

Photovoltaic Conversion - Wave Energy - Ocean Thermal Energy conversion - Annular Solar Savings - Concluding remarks.

Books for Study

1. Sukhatme, Nayak, "Solar Energy Principles of Thermal Collection and Storage", Tata McGraw-Hill Publishing Company, 2008.
2. D Yogi Goswami, "Principles of Solar Engineering", CRC press, 2015.
3. Alan L. Fahrenbruch, Richard H. Bube, "Fundamentals of Solar Cells - Photovoltaic Solar Energy Conversion", Academic Press, 1983.
4. Julian Chen, "Physics of Solar energy", Wiley; 1st edition, 2011.

Unit	Book	Chapters	Sections
I	1	1, 2	1.1-1.4, 2.1-2.3
II	3	2, 6	2.1-2.5, 6.4.1, 6.4.2, 6.5
III	2 1	3 6	3.1, 3.3, 3.8, 3.9 6.2
IV	4 1	12 8	12.1, 12.2.1, 12.3, 12.3.1-12.3.4 8.1, 8.2
V	1	9, 10	9.4, 9.5; 10.5, example 10.1-10.4, 10.8

Books for Reference

1. H.P. Garg, "Solar Energy Fundamentals And Applications", Tata Mcgraw-Hill Publishing Company, 2000.

Web Resources*

1. https://www.e-education.psu.edu/earth104/node/950
2. https://www.britannica.com/science/solar-energy
3. https://science.sciencemag.org/content/184/4134/382

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
II	**21PPH2EG01A**	**GE – 1 (WS): SOLAR ENERGY AND UTILIZATION**	**4**	**3**

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	3	2	2	3	3	2	2	2	2.5
CO-2	3	3	2	2	2	3	3	3	2	2	2.5
CO-3	3	3	2	2	2	3	3	3	2	2	2.5
CO-4	3	3	2	2	2	3	3	2	2	2	2.5
CO-5	3	3	2	2	3	3	3	2	2	3	2.6
Mean Overall Score											**2.52 (High)**

Semester	Course Code	Title of the Course	Hours	Credit
II	21PPH2EG01B	GE – 1 (WS) : RENEWABLE ENERGY RESOURCES	4	3

CO No.	CO- Statements	Cognitive Levels (K- Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge of physics of solar radiation.	K1
CO-2	understand the classifications of the solar energy collectors and methodologies of storing solar energy.	K2
CO-3	know the applications of solar energy, wind energy and biomass and other forms of energy sources.	K3
CO-4	analysis the different forms of energy resources based on its economic aspects.	K4
CO-5	assess the generated renewable energies and design the different energy resources.	K5 & K6

Unit - I: Direct Solar Energy **(12 Hours)**

Solar Energy supply - History of solar energy utilization - Technologies based on capture of heat from sunlight - Solar water heating system - Solar cookers - Solar steam generating system for cooking - Passive solar heating / cooling of buildings - Solar air conditioning - Solar refrigeration - Solar desalination - Salt production and solar ponds - Crop drying - Technologies for converting solar energy to electricity - Heat engines: Concentrated solar thermal energy systems - Photovoltaics.

Unit - II: Biomass Energy **(12 Hours)**

Composition of biomass - Sources of biomass for energy generation - Food crops - Hydrocarbon - rich plants - Waste - Weed and Wild growths - Lignocellulosic biomass: Fast -growing greases and woody species - Technical routes for obtaining different types of fuels from biomass - Thermochemical conversion of biomass - Biochemical processing - Emerging technologies.

Unit – III: Wind and Wave Energies **(12 Hours)**

Using the wind and power in the wind - Design of windmills - Summary of wind electric energy systems - Wind turbine sizes - Wind sites and properties - Storage - Wave energy generation - Potential energy - Kinetic energy - Wave energy conversion devices - Wave energy conversion by floats - High-level reservoir wave machine - Dolphin-type wave power machine - other wave machines - Advantage and disadvantages of wave energy.

Unit – IV: Geothermal Energy **(12 Hours)**

Origin and nature of geothermal energy - Energy extraction - High-enthalpy geothermal aquifers - Low-enthalpy reserves - Wet steam systems - Dry steam systems - Limitations.

Unit - V: Storage of Intermittently - Generated Renewable Energy (12 Hours)

Energy storage systems - Storage as electrical energy - Storage as mechanical energy - Storage as chemical energy - Storage as thermal energy.

Book for Study

1. Tasneem Abbasi & S.A. Abbasi, "Renewable Energy Sources", PHI Learning Private Limited New Delhi, 2010.

UNIT	BOOK	CHAPTERS	SECTIONS
I	1	3	3.2, 3.3, 3.4.1-3.4.9, 3.5.1, 3.5.2
II	1	4	4.3, 4.4.1-4.4.5, 4.5.1-4.5.3
III	1	6	6.3.1, 6.4, 6.5.1, 6.5.2, 6.6, 6.9, 6.10
IV	1	7 9	7.2.1, 7.2.2, 7.3.1-7.3.4, 7.4.1, 7.4.2 9.1.1, 9.3.1-9.3.4, 9.5
V	1	12	12.2.1-12.2.4

Books for Reference

1. Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing House, 2007.
2. Ramesh R & Kumar K.U, "Renewable Energy Technologies", Narosa Publishing House, 2004.
3. Rai G.D., "Non-Conventional Energy Sources", Khanna Publishers, 2011.
4. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
II	**21PPH2EG01B**	**GE-1 (WS): RENEWABLE ENERGY RESOURCES**	**4**	**3**

Course Outcomes ↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	3	2	3	2	2	2	1	2.3
CO-2	3	2	3	3	2	3	2	2	2	1	2.3
CO-3	3	3	3	3	2	3	3	3	2	1	2.6
CO-4	3	2	3	2	2	3	3	3	2	1	2.4
CO-5	3	2	3	3	2	3	3	3	2	1	2.5
Mean Overall Score											**2.42 (High)**

Semester	Course Code	Title of the Course	Hours	Credit
III	**21PPH3CC05**	**CORE-5: CONDENSED MATTER PHYSICS**	**6**	**6**

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	Acquire knowledge and understand the behaviour of electrons in solids based on classical and quantum theories.	**K1 & K2**
CO-2	Apply the knowledge and analyse the available semiconducting and superconducting materials	**K3 & K4**
CO-3	Able to differentiate between ferroelectric, anti-ferroelectric, piezoelectric, pyroelectric materials, Plasmons, polaritons and polarons	**K4**
CO-4	Develop and synthesize new materials for a requirement.	**K5 & K6**
CO-5	Create an eco-friendly environment with lifelong development and usage of condensed matters.	**K6**

Unit-I: Semiconductor Crystals **(18 Hours)**

Origin of energy gap-Bloch function - Kronig-Penney model-crystal momentum of an electron-number of orbitals in a band- Effective mass – intrinsic carrier concentration - intrinsic mobility – impurity conductivity - thermal ionization of donors and acceptors –thermoelectric effect-semimetals – superlattice – Bloch oscillator – Wannier Ladder – Zener Tunnelling

Unit-II: Fermi Surfaces and Metals **(18 Hours)**

Reduced zone scheme – periodic zone scheme – construction of fermi surfaces- nearly free electrons- electron orbits, hole orbits and open orbits – calculations of energy bands – Tight binding method for energy bands- Wigner – Seitz method -cohesive energy – Pseudopotential methods- experimental methods in fermi surface studies – quantization of orbits in a magnetic field – De Haas-van Alphen effect – extremal orbits -fermi surface of copper and gold – magnetic break down.

Unit-III: Superconductivity **(18 Hours)**

Thermodynamics of the superconducting transition – London equation – Coherence length – BCS theory of superconductivity – ground state – Flux quantization in a superconducting ring - duration of persistent currents – Type II superconductors – vortex state – estimation of H_{c1} and H_{c2} – single particle tunnelling – Josephson superconductor tunnelling – Dc Josephson effect – Ac Josephson effect – macroscopic quantum interference – High temperature superconductors.

Unit-IV: Magnetic Properties of Solids and Magnetic Resonance (18 Hours)

Langevin diamagnetism equation - quantum theory of diamagnetism – Paramagnetism - quantum theory of Para magnetism - Hund rules - crystal field splitting, paramagnetic susceptibility of conduction electrons – ferromagnetic order - temperature dependence of the saturation magnetization – neutron magnetic scattering - ferrimagnetic order - curie temperature and susceptibility of ferrimagnets - antiferro magnetic order - susceptibility below the Neel temperature - ferromagnetic domains - origin of domains –coercivity and hysteresis -nuclear magnetic resonance – ferromagnetic resonance – antiferromagnetic resonance – electron paramagnetic resonance.

Unit-V: Plasmons, Polaritons, Polarons and Dielectrics (18 Hours)

Dielectric function of electron gas –plasmons – electrostatic screening -polaritons -electron - electron interaction – polarons - Polarization –macroscopic electric field – local electric field at an atom – dielectric constant and polarizability – structural phase transitions – ferroelectric crystals – displacive transitions

Book for Study

1. Charles Kittel, Introduction to solid state physics, 8th edition, John Wiley & Sons, Inc.2004.

UNIT	CHAPTERS
I	Chapter 7 & 8
II	Chapter 9
III	Chapter 10
IV	Chapter 11,12 & 13
V	Chapter 14, 15 & 16

Books for Reference

1. Wahab. M.A, Solid State Physics, 2nd Edition, Narosa, 2010.
2. Rita John, Condensed Matter Physics, 1st EditionTata McGraw Hill Publishers 2014
3. J.P. Srivastava, Elements of Solid-State Physics, 4th Edition, Prentice-Hall of India, 2015.

Web Resources*

1. https://nptel.ac.in/courses/115/106/115106061/
2. https://nptel.ac.in/courses/115/103/115103102/
3. https://nptel.ac.in/courses/115/105/115105099/
4. https://nptel.ac.in/courses/113/104/113104090/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code			Title of the Course				Hours	Credit
III	21PPH3CC05			CORE-5: CONDENSED MATTER PHYSICS				6	6
Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	2	2	3	3	2	2	1	2.3
CO-2	2	2	3	2	2	2	2	2	3	2	2.2
CO-3	3	2	3	1	2	3	2	3	2	2	2.3
CO-4	2	3	2	3	1	2	3	2	3	1	2.3
CO-5	3	2	2	2	1	3	3	2	2	1	2.3
Mean Overall Score											2.28 (High)

Semester	Course Code	Title of the Course	Hours	Credit
III	**21PPH3CC06**	**CORE-6: ELECTROMAGNETIC THEORY**	**6**	**6**

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	impart and describe the knowledge on the concepts in electrostatics, magnetostatics, field equations and electromagnetic waves.	**K1**
CO-2	explain the boundary conditions in electrostatics and magnetostatics, Poynting theorem, propagation of electromagnetic waves.	**K2**
CO-3	apply and analyze the knowledge to solve image problems, magnetic field and potential problems, boundary conditions and radiation reaction.	**K3 & K4**
CO-4	compare and summarize TE, TM, TEM waves, normal and oblique incidences for conductors.	**K5**
CO-5	relate and check the knowledge from symmetry problems, Gauss law and Biot-Savart's law.	**K6**

Unit-I: Electrostatics **(18 Hours)**

Coulomb's law - Electric field - Continuous charge distributions - Field lines, Flux and Gauss's law - Divergence of E - Applications of Gauss's Law - curl of E - Electric potential - Poisson's and Laplace's Equation - Potential of a localized charge distribution - Electrostatic Boundary conditions - Uniqueness theorems - Method of images: Classic image problem - induced surface charge - Force and energy - other image problems - boundary value problems on spherical symmetry, cylindrical symmetry and plane symmetry.

Unit-II: Magnetostatics **(18 Hours)**

Lorentz Force Law - Biot-Savart Law - magnetic field of steady current - The Divergence and Curl of B - Applications of Ampere's Law - magnetic potential - uniform surface current of a long solenoid - torroidal coil - large parallel plate capacitor - magnetic field inside and outside a cylindrical wire - magnetic field inside and outside the slab - Magnetic vector potential - magnetostatic boundary conditions.

Unit-III: Field Equations and Conservation Laws **(18 Hours)**

Ohm's law - Faraday's law - induced electric field - Inductance - Energy in magnetic fields - Maxwell's equations in free space and linear isotropic media - Boundary conditions on fields at interface - continuity equations - Poynting's theorem - Potential formulation - Lorentz and Coulomb Gauge transformations - retarded potentials

Unit-IV: Electromagnetic Waves **(18 Hours)**

Waves in one dimension - Reflection, transmission and polarization - wave equation for E and B - monochromatic plane waves - Energy and momentum in EM waves - Propagation in linear

media - Reflection and transmission at normal and oblique incidence - EM waves in conductors - Absorption, dispersion and reflection at a conducting surface

Unit - V: Guided Waves and Radiation **(18 Hours)**

Wave guides - TE and TM waves in a rectangular wave guide - Coaxial transmission line - Electric dipole radiation - Magnetic dipole radiation - Radiation from an arbitrary source -power radiated by a point charge - Radiation reaction - radiation damping of a charged particle - Physical basis of the radiation reaction

Book for Study

1. David J. Griffiths, Introduction to Electrodynamics, 4th edition, 2018, Pearson.

Unit	Title	Chapters	Sections
I	Electrostatics	1,2,3	1.2-1.4, 2.1-2.4, 3.1, 3.3-3.5
	Potentials	1,2	1.5, 1.6, 2.1-2.4
II	Magnetostatics	1,2,3,4	1.1-1.3, 2.1, 2.2, 3.1-3.3, 4.1, 4.2
III	Electrodynamics	1,2,3	1.1, 2.1-2.4, 3.3-3.6
	Conservation Laws	1	1.1, 1.2
	Potentials and Fields	1,2	1.1-1.3, 2.1
IV	Electromagnetic Waves	1,2,3,4	1.1-1.4, 2.1-2.3, 3.1-3.3, 4.1, 4.2
V	Electromagnetic Waves	5	5.1-5.3
	Radiation	1,2	1.2, 1.3, 2.1-2.3

Books for Reference

1. J.D. Jackson, Classical Electrodynamics, 3rd Edition, John Wiley, New York, 1999.
2. Edward C. Jordan & Keith G. Balmain, Electromagnetic waves and Radiating systems – Second Edition, Prentice Hall of India, New Delhi, 2015.
3. Dr. Sureka Tomar, CSIR – UGC / NET / JRF/SET Physical Sciences, Upkar Prakashan, Agra, 2016.
4. Paul Lorrain and Dale Corson, Electromagnetic fields and waves, Second Edition, CBS Publishers & Distributors, New Delhi, 1986.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course								Hours	Credit
III	21PPH3CC06	CORE-6: ELECTROMAGNETIC THEORY								6	6
Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	3	2	3	2	3	2	2	2.5
CO-2	2	3	2	2	2	3	2	2	3	2	2.3
CO-3	3	2	2	3	2	3	3	2	1	2	2.3
CO-4	3	2	2	2	2	3	3	2	1	2	2.2
CO-5	3	3	2	2	2	3	3	3	1	2	2.4
Mean Overall Score											2.34 (High)

Semester	Course Code	Title of the Course	Hours	Credit
III	21PPH3CP03	PHYSICS PRACTICAL – III	8	6

Any 15 Experiments

1. e/m - Zeeman effect
2. Microwave – Klystron /Gunn diode
3. Design of Multiplexer and De-multiplexer
4. Digital to Analog Converters design
5. Design of Asynchronous Counter
6. Study of Power Amplifier: IC
7. Modulation and De modulation Techniques : PAM, PPM, PWM and PCM
8. Laser III: Brewster angle and related parameters
9. Geiger Muller Counter – study of gamma rays
10. Analysis of XRD spectrum - Determination of lattice parameters of a crystal
11. Analysis of FTIR spectrum - Determination of vibration levels in a compound
12. Solar cell characteristics
13. Charge of an electron by spectrometer
14. Monte Carlo simulation of electronic distribution of hydrogen atom - Scilab
15. Characteristics of tri colour LED and production of different colours
16. Measurement and analysis of Raman Spectra of liquids and solids.
17. Magneto resistance of a semiconductor
18. Thin film preparation and measurement of its thickness
19. Determination of Rydberg constant
20. Study of porosity and grain size of thin film by SEM
21. Brass arc spectrum – emission spectral study
22. UV-Visible spectrometer - Analysis of spectrum - Determination of absorption coefficient and band gap
23. Analysis of rotation and vibration spectrum
24. Computational experiment: Solution of Poison's equation
25. Computational experiment: 2-D Electrostatic Calculation
26. Computational experiment: Chaotic and Non-chaotic dynamics
27. Study characteristics of optocoupler
28. NMR SPECTROMETER – spectral parameters
29. Atomic Scattering power and geometrical structure factor
30. Non-Destructive Testing by Ultrasonics – flaw detection, depth and length

Semester	Course Code	Title of the Course	Hours	Credit
III	21PPH3ES03A	DSE - 3: MATERIALS SCIENCE	6	4

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	Acquire the knowledge and discuss about super capacitor materials, polymer and composite materials, and phase transitions of materials.	K1, K2 & K3
CO-2	Understand and Apply the concepts of alloys and composites	K2 & K3
CO-3	Identify and discuss the supercapacitor and its applications	K4 & K2
CO-4	Identify and analyze different energy conversion materials for conversion process	K2 & K4
CO-5	Categorize and Test different materials for storage device	K4,K5 & K6

Unit - I: Phase Transition in Materials (18 Hours)

Phases - Microstructure - Phase Equilibria - One-Component (or Unary) Phase Diagrams -Binary Isomorphous Systems - Interpretation of Phase Diagrams - Development of Microstructure in Isomorphous Alloys - Mechanical Properties of Isomorphous Alloys - Binary Eutectic Systems - Development of Microstructure in Eutectic Alloys - Materials of Importance - Lead - Free Solders - Equilibrium Diagrams Having Intermediate Phases or Compounds - Eutectoid and Peritectic Reactions - Congruent Phase Transformations - The Gibbs Phase Rule - The Kinetics of Phase Transformations - Metastable Versus Equilibrium States - Isothermal Transformation Diagrams.

Unit - II: Polymers and Composite Materials (18 Hours)

Introduction - Hydrocarbon Molecules - Polymer Molecules - The Chemistry of Polymer Molecules-Molecular Weight-Molecular Shape-Molecular Structure - Molecular Configurations -Thermoplastic and Thermosetting Polymers - Copolymers - Polymer Crystallinity - Polymer Crystals - Fracture of Polymers - Large - Particle Composites - Dispersion - Strengthened Composites - Influence of Fiber Length - Influence of Fiber Orientation and Concentration -The Fiber Phase - The Matrix Phase - Polymer - Matrix Composites - Metal - Matrix Composites - Carbon-Carbon Composites - Hybrid Composites - Laminar Composites.

Unit - III: Super Capacitor Materials (18 Hours)

Supercapacitors Background - Charge Storage Mechanisms - The Electric Double Layer - Helmholtz model - Stern and modern models - Pseudocapacitance Mechanism - Redox reactions - Ion electrosorption – Intercalation - Charge Storage Mechanism - Electric double layer capacitors - Pseudocapacitors - Conducting organic polymers - Hybrid supercapacitors - Nanocomposites and/or hybrid materials - Organic electrolytes - Ionic liquids - Polymeric electrolytes - Aqueous electrolytes - Designing High - Performance Environmental Friendly Supercapacitors

Unit - IV: Materials for Energy Conversion **(18 Hours)**

Materials Requirement: The Ideal Solar Cell - Types of Solar Cell - Silicon - Crystalline silicon solar cells - Si heterojunction solar cells - Gallium Arsenide - Dye sensitized solar cells - Organic and hybrid solar cells - Inorganic and ultra - low-cost cells - Quantum dots cells - Hybrid perovskite cells - Spectral conversion - Nanostructured solar cells based on zinc oxide nanowire arrays - Multijunction or Tandem Solar Cells - N-Type TCOs - P-Type TCOs - TCM Based on Metallic Nanowires - TCM Based on CNT and Graphene - Types of Fuel Cells - Alkaline Fuel Cells - Polymer Electrolyte Membrane Fuel Cells - Phosphoric Acid - Molten Carbonate - Solid Oxide Fuel Cells - Thermodynamic Efficiency - Voltaic Efficiency - Faradaic Efficiency - Heat Efficiency.

Unit - V: Storage Materials **(18 Hours)**

Chronopotentiometry - Chronoamperometry - Cyclic voltammetry - Lead Acid Batteries - Alkaline Rechargeable Batteries - Lithium Rechargeable Batteries - From Li metal to Li-ion- Negative electrodes - Positive electrodes - Electrolytes - Redox Flow Batteries - Conventional Hydrogen Storages - Compressed Gas - Liquid Hydrogen - Carbon Materials - Zeolites- Metal - Organic Frameworks - Metal Hydrides - Elements - AB5 Intermetallic Compounds - AB Intermetallic Compounds - Lithium borohydride: $LiBH_4$ - Magnesium borohydride - Hydrogenation of Li_3N - The Li-Mg-N-H System.

Books for Study

1. William D. Callister, Jr. and David G. Rethwisch, Fundamentals of Materials Science and Engineering an Integrated Approach, John Wiley & Sons, Inc, 2016.
2. Xavier Moya David Muñoz-Rojas,Materials for Sustainable Energy Applications Conversion, Storage, Transmission, and Consumption, Jenny Stanford Publishing, 2016.

UNIT	BOOK	CHAPTERS	SECTIONS
I	1	10,11	10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 10.9, 10.10, 10.11, 10.12, 10.13, 10.14, 10.15, 10.18, 11.3, 11.4, 11.5
II	1	4,15	4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12,9.7, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7, 15.8, 15.9, 15.11, 15.12, 15.14
III	2	8	8.3, 8.4, 8.4.1, 8.4.1.1, 8.4.1.3, 8.4.2, 8.4.2.1, 8.4.2.2, 8.4.2.3, 8.5.1, 8.5.1.1, 8.5.1.2, 8.5.1.3, 8.5.1.5-8.5.1.7, 8.5.2.1, 8.5.2.2, 8.5.2.3, 8.5.2.4, 8.6
IV	2	2,6	2.1.5, 2.2, 2.2.1, 2.2.1.1, 2.2.1.2, 2.2.2, 2.2.4.1, 2.2.4.2, 2.2.4.3, 2.2.4.4, 2.2.4.5, 2.2.4.6, 2.2.4.7, 2.2.5, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 6.3, 6.3.1, 6.3.2, 6.3.3, 6.3.4, 6.3.5, 6.5.1, 6.5.2, 6.5.3, 6.5.4
V	2	7,10	7.1.3.1, 7.1.3.2, 7.1.3.3, 7.2.1, 7.2.2, 7.2.3, 7.2.3.1, 7.2.3.2, 7.2.3.3, 7.2.3.4, 7.4, 10.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.2.3, 10.3, 10.3.1, 10.3.2, 10.3.4, 10.4.1.1, 10.4.1.2, 10.5.1, 10.5.2

Book for Reference

1. William F. Smith, Fundamentals of Materials Science and Engineering, 2004.

Web Resources*

1. https://www.sheffield.ac.uk/materials/department/what-mse
2. https://mse.umd.edu/about/what-is-mse

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code			Title of the Course						Hours	Credit
III	21PPH3ES03A			DSE - 3: MATERIALS SCIENCE						6	4
Course Outcomes↓ (COs)	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	3	2	3	2	3	2	1	2.3
CO-2	3	3	2	2	3	3	2	2	2	1	2.3
CO-3	3	2	2	3	3	2	3	3	2	1	2.4
CO-4	3	2	2	3	3	2	2	3	2	1	2.3
CO-5	3	3	2	2	3	2	2	3	2	1	2.3
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours	Credit
III	21PPH3ES03B	DSE – 3: TECHNIQUES OF MATERIALS CHARACTERIZATION	6	4

CO No.	CO- STATEMENTS	COGNITIVE LEVEL (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge on the fundamental of various characterization techniques.	K1
CO-2	understand the characteristics of crystals, thin films and nanocrystals	K2
CO-3	apply the physics principle and concepts to approach the problems mathematically and develop a skills to solve the problems numerically.	K3
CO-4	identify an appropriate characterization technique to understand the crystal structure, molecular structure, surface analysis and elemental analysis of various materials.	K4
CO-5	evaluate the results of XRD, FTIR, Fluorescence, absorption spectroscopy, Electron microscopy, XPS and thermal analysis and formulate an appropriate interpretation with a detailed justification for a new material.	K5 & K6

Unit - I: Structural Analysis **(18 Hours)**

Powder XRD: determination of crystal structure - crystallites size - lattice parameters - Cubic and non-cubic system - point group and space group - single crystal XRD: determination of crystal systems - point group and space group. G-XRD - analysis of thin films.

Unit - II: Molecular Structure and Electronic Structure Analysis **(18 Hours)**

^{1}H-NMR and ^{13}C-NMR - Chemical structure identification of solids and liquids - case study, Fourier Transform Infrared Spectroscopy - analysis of chemical bonds - case study optical analysis: Fluorescence spectroscopy - electronic structure analysis - case study - Time resolved spectroscopy - Absorption spectroscopy.

Unit - III: Surface Analysis **(18 Hours)**

SEM and FESEM - Morphology analysis, TEM and HR-TEM Morphology - Crystalline nature and structure - Atomic Force Microscope - Surface roughness - Scanning Tunnelling microscopy - Surface Topography - Chemical etching - Microstructure and dislocation - case study.

Unit - IV: Elemental and Thermal Analysis **(18 Hours)**

Elemental analysis: CHN analysis, Energy dispersive spectroscopy, X-ray fluorescence, X-ray photoelectron spectroscopy - case study.

Thermal analysis: TG/DTG and DTA/DSC analysis - phase changes, melting point and thermal decomposition - case study.

Unit - V: Optical and Microhardness Measurements (18 Hours)

Optical Measurements - Nonlinear optics: Second harmonic generation - Phase matching and Kurtz - Perry powder method - Third order nonlinearity - Z-scan technique - Laser damage threshold measurements.

Microhardness measurement: Brinell and Vickers hardness tests.

Books for Study

1. Sam Zhang, Lin Li, Ashok Kumar, Materials Characterization Techniques, Taylor & Francis Ltd. CRC press, 2008.
2. B.D. Cullity, S.R. Stock, Elements of X-Ray Diffraction, 3rd Edition, Pearson Education, Delhi, 2001.
3. C.R. Brundle, Charles A. Evans, Shaun Wilson, Encyclopedia of Materials Characterization, Butterworth-Heinemann, 1992.
4. Richard L Sutherland, Daniel G. McLean, Sean Kirkpatrick, Hand book of Nonlinear Optics, 2nd Edition, Marcel Dekker, Inc, 2003.

Unit	Book	Chapters	Sections
I	1 2	5	5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8 10
II	1 3	9 7	9.1, 9.2 7.1, 8.4
III	1	4, 6, 7	4.2, 4.3, 4.4, 6.1-6.5, 7.1-7.3
IV	1	3, 10	3.3, 3.4, 10.1, 10.4
V	4 4 4	1 4 10	III. A I.A, I.D 1.B

Books for Reference

1. Keshra Sangwal, Etching of Crystals: Theory, Experiment, and Application, 1st Edition, North-Holland physics publishing, Netherland, 1987.
2. B.B. Laud, Lasers and non-linear optics, John Wiley & Sons, 2nd Edition, 1993.
3. Detlev Ristau, Laser-Induced Damage in Optical Materials, Taylor & Francis Group, CRC Press, New York, 2015.
4. Robert W Cahn Frs, Eric Lifshin, Concise Encyclopedia of materials characterization, 1st Edition, Pergamon Press Ltd, Oxford, New York, 1993.
5. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital publishing company, New Delhi, 2007.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
III	21PPH3ES03B	DSE – 3: TECHNIQUES OF MATERIALS CHARACTERIZATION	6	4

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	2	2	3	2	1	2	1	2.0
CO-2	3	3	3	2	2	3	2	1	2	1	2.2
CO-3	2	3	3	2	2	3	3	3	2	1	2.4
CO-4	3	3	3	2	2	2	3	3	2	1	2.4
CO-5	3	3	3	2	2	2	2	3	2	1	2.3
Mean Overall Score											2.26 (High)

Semester	Course Code	Title of the Course	Hours	Credit
III	21PPH3EG02A	GE – 2 (BS) : PHYSICS FOR COMPETITIVE EXAMINATIONS	4	3

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge of the fundamental concept of physics	K1
CO-2	understand the concepts of fundamental physics	K2
CO-3	apply the concept of physics to solve various problems	K3
CO-4	strengthen an appropriate problem-solving approach and assess a step to describe the quantitative analysis.	K4
CO-5	evaluate the results of new analytical problems and develop a correct solutions or conclusions.	K5 & K6

Unit-I: General Mechanics and Properties of Matter (12 Hours)

Physical quantities - SI system of units - dimensions - scalars and vectors (Concepts) - Newton's equations of motion - impulse - principle of conservation of linear momentum - projectile motion - Kepler's laws - Newton's law of gravitation - acceleration due to gravity - escape velocity - angular momentum - banking of roads - simple harmonic motion - viscosity - surface Tension.

Unit-II: Heat and Thermodynamics (12 Hours)

Different scales of temperatures - thermal expansions - calorimetry - specific heat - latent heat - triple point - transmission of heat - heat conductivity - Black body radiation - Stefan Boltzmann law - Wien's displacement law - Gas equation - Boyle's law - Charle's law - Law of equipartition of energy.

Unit-III: Light and Sound (12 Hours)

Reflection and refraction - Snell's law - total internal reflection - polarization - Brewster's Law - Huygen's principle – Young's double slit interference and single slit diffraction - longitudinal and transverse waves - velocity of sound - Newton's formula, Laplace correction, effects of pressure - beats - laws of vibrating strings - open and closed organ pipes - resonance.

Unit-IV: Electricity and Magnetism (12 Hours)

Coulomb's Law - Electric field due to charged particles: a point charge, a dipole, a line of charge - electric flux - Gauss' law and applications – Biot-Savart law, magnetic field due to a current in: a long straight wire, a circular arc of wire - Ampere's Law - magnetic field outside and inside a long straight wire - solenoids and toroids - Faraday's laws and Lenz's law.

Unit-V: Modern Physics **(12 Hours)**

Postulates of Einstein's theory of relativity - Galilean and Lorentz transformation - time dilation - length contraction - Planck's radiation - photoelectric effect - Compton shift, matter waves - Bohr's atomic theory.

Nuclear properties - binding energy and mass defect -radioactive decay - alpha decay, beta decay and gamma decay - Radioactive dating.

Books for Study

1. J. Walker, D. Halliday, R. Resnick, Fundamentals of Physics, 10th Edition, Wiley, United states of America, 2007.
2. H.C Verma, Concept of Physics, (Volume II), 1st Edition, Bharati Bhawan Publishers & Distributors, New Delhi, 2008.
3. H.C Verma, Concept of Physics, (Volume I), 1st Edition, Bharati Bhawan Publishers & Distributors, New Delhi, 2008.

Unit	Book	Chapters	Sections
I	1	1, 3, 4, 5, 9, 11, 13, 14, 15	1.3, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 4.5, 4.6, 5.3, 5.6, 5.8, 9.4, 9.5, 9.6, 9.7,11.7,13.2, 13.4, 13.6, 13.7, 14.8, 15.2, 15.3, 15.4
II	2	23, 24, 25, 27, 28	23.3, 23.4, 23.5, 23.6, 24.7, 25.3, 25.4, 25.6, 27.8, 28.1, 28.5, 28.5, 28.7, 28.9, 28.10
III	1 3	16,17, 33, 35, 36	33.7, 33.8, 33.9, 35.4, 36.4, 36.5, 16.3, 17.3 16.4, 16.9, 16.11
IV	1	21, 22, 23, 29, 30	21.4, 22.4, 22.5, 22.6, 23.2, 23.4, 23.7, 23.8, 23.9, 29.2, 29.3, 29.4, 29.5, 30.3, 30.4
V	1	37, 38, 42	37.2, 37.3, 37.5, 37.6, 38.1, 38.2, 38.3, 38.5, 42.2, 42.3, 42.4, 42.5, 42.6

Books for Reference

1. A Book on Physics for Competitive Examinations, Department of Physics, St. Joseph's College, Tiruchirappalli, 2015.
2. Michael Nelkon, Philip Parker, Advanced Level Physics, 7th Edition, CBS Publishers, India, 1995.
3. D. Young Hugh, A. Freedman Roger, University Physics with Modern Physics, 14th Edition, Pearson Education, India, 2017.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
III	21PPH3EG02A	GE – 2(BS): PHYSICS FOR COMPETITIVE EXAMINATIONS	4	3

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	3	2	2	2	3	2	2	1	1	2.0
CO-2	3	3	2	2	3	3	2	2	2	1	2.3
CO-3	3	3	2	2	3	2	3	3	2	1	2.4
CO-4	3	3	2	2	3	1	3	3	2	1	2.3
CO-5	3	3	2	2	3	1	3	3	2	1	2.3
Mean Overall Score											2.26 (High)

Semester	Course Code	Title of the Course	Hours	Credit
III	**21PPH3EG02B**	**GE –2 (BS) : NANO SCIENCE**	**4**	**3**

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge on fundamentals of nanoscience.	**K1**
CO-2	understand and realize the applications of various nanostructures towards optical and electronic devices.	**K2**
CO-3	apply quantum physics concepts on nanostructures and study the corresponding physical and chemical properties.	**K3**
CO-4	analyse the various processing techniques to fabricate nanodevices.	**K3**
CO-5	evaluate the properties of nanostructures with size and morphology and develop an appropriate conclusion in favour of change in properties.	**K5 & K6**

Unit-I: Fundamentals of Nanoscience **(12 Hours)**

Definition of Nano, influence of nano over micro/macro size - classification of nanostructures - Moore's Law - size effect - amorphous carbon - carbon nanotubes: types carbon tubes - Fullerenes C_{60}, Carbon Nanohorn, nanobuds and Pea pods

Unit-II: Optical Properties and Applications **(12 Hours)**

Quantum effect - optical properties of metal and semiconductor nanoparticles - size and morphology dependent absorption and emission - applications: Lycurgus cup and Glass window.

Unit-III: Nanolithography **(12 Hours)**

Lithography - photolithography - lithography using photons - lithography using particle beam - Scanning probe lithography - soft lithography

Unit-IV: Applications of Semiconductor Nanostructures **(12 Hours)**

Injection lasers - Quantum cascade lasers – Single photon sources - Optical memories - Dye sensitized solar cell.

Unit-V: Electronic Applications **(12 Hours)**

Data storage - displays - organic LEDs - organic field effect transistors - quantum dot LED display - flexible electronics - nanoparticle transistor - Carbon nanotube single electron transistors - Carbon nanotube field effect transistor.

Books for Study

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

2. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Capital publishing company, New Delhi, 2007.
3. Chris Binns, Introduction to Nanoscience and Nanotechnology, John Wiley & Sons, New Jersey, 2010.
4. Satoshi Horikoshi, Nick Serpone, Microwaves in Nanoparticle Synthesis, Fundamentals and Applications, Wiley-VCH Verlag GmbH & Co. Germany,2013.

Unit	Book	Chapters	Sections
I	1 2 3	1,3 9 3	1.1.1, 1.1.2, 3.8.6 9.2, 9.2.1, 9.2.2, 3.1, 3.14, 3.15
II	1 2 4	3 7 1	3.3.1, 3.3.2, 3.3.3, 7.6.1, 7.6.2, 7.6.3 1.1, 1.3, 1.4
III	2	8	8.1, 8.2, 8.3, 8.4, 8.5
IV	1	3	3.8.1, 3.8.2, 3.8.3, 3.8.4
V	1 2	6 5	6.2.2, 6.2.3 5.1, 5.3, 5.4

Books for Reference

1. G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College Press, 2004.
2. R. Fahrner, Nanotechnology and Nanoelectronics, Springer-Verlag Berlin Heidelberg, New York, 2005.
3. T. Pradeep, NANO: The Essentials: Understanding Nanoscience and Nanotechnology, 1st Edition, McGraw Hill Education, India, 2017.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code			Title of the Course				Hours		Credit
III	21PPH3EG02B			GE – 2: NANOSCIENCE				4		3
Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	3	2	3	2	2	2	1	2.3
CO-2	3	2	3	3	2	3	2	2	2	1	2.3
CO-3	3	3	3	3	2	3	3	3	2	2	2.7
CO-4	3	2	3	2	2	3	3	3	2	1	2.4
CO-5	3	2	3	3	2	3	3	3	2	2	2.6
Mean Overall Score											2.46 (High)

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4CC07	CORE-7: NUCLEAR AND PARTICLE PHYSICS	6	6

CO No.	CO –Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	recall and explain a clear picture of nuclear composition, Radio activity, cosmic rays and understand various nuclear models.	K1 & K2
CO-2	understand the working of nuclear detectors and counters, realize the importance of Cosmic rays and its effects on earth	K2
CO-3	apply and Evaluate the applications of Nuclear Physics to Medical field and various other fields related to Physics.	K3 & K5
CO-4	analyse the different types of nuclear particles and particle accelerators.	K4
CO-5	formulate the four-factor formula and compound nuclear theory based on nuclear fission and fusion concepts	K6

Unit-I: Basic Properties of Nucleus (18 Hours)

Nuclear mass and binding energy - atomic masses - systematics of nuclear binding energy - nuclear size - charge radius - potential radius - spin and parity - statistics of nucleus - magnetic dipole moment – electric moments - electric quadrupole moments - isospin - nuclear forces-ground state of the deuteron - wave equation for the deuteron and solution - excited state of deuteron - low energy proton neutron scattering - spin dependence of n-p interaction. Liquid Drop Model - Evidence of Shell Structure - Single Particle Shell Model

Unit-II: Nuclear Decay and Radio Activity (18 Hours)

Theory of alpha disintegration - hindrance and formation factors - fine structure of alpha decay - energetics of beta decay - neutrino hypothesis - Fermi theory of beta decay - selection rules - Sargent diagram - orbital electron capture - parity non conservation - double beta decay - gamma ray spectra and nuclear energy level - radioactive transition in nuclei-nuclear isomerism - internal conversion - resonance fluorescence - angular correlation.

Unit-III: Nuclear Reactions (18 Hours)

Types of nuclear reactions - conservation laws - reaction energetics - Q value - threshold energy - nuclear reaction cross section - level width - compound nuclear theory - Breit Wigner dispersion formula and interpretation - direct reaction - striping and pickup reactions - nuclear fission - energy released in fission - nuclear chain reaction - four factor formula - nuclear reactor - nuclear fusion - Stellar energy.

Unit-IV: Particle Physics (18 Hours)

Production of new particles in high energy reaction - classification of elementary particle - fundamental interaction - quantum numbers - antiparticles - resonances - law in production and

decay process - symmetry and conservation laws - special symmetric groups - Gelman -Neumann theory - Quark model - SU(3) symmetry - unification of fundamental interactions - CPT in variance and applications of symmetry arguments to particle reaction, parity non conservation in week interaction.

Unit-V: Cosmic Rays and Applications of Nuclear Physics (18 Hours)

Nature of Cosmic rays - soft and hard components - Instruments and apparatus used in research of cosmic rays - absorption of cosmic ray - discovery of positron - cosmic ray shower discovery of muons - properties of ì - meson - discovery of Pi meson - Trace Element Analysis - Diagnostic Nuclear Medicine - Therapeutic Nuclear Medicine.

Books for Study

1. S.N. Ghoshal, Nuclear Physics, S. Chand and company Ltd., 2003.
2. Satya Prakash, Nuclear Physics and Particle Physics, First edition, Sultan Chand and sons, 2014.
3. S.L. Kakani, Shubhrakakani, Nuclear Particle and Physics, Second edition, Vivo books (private) Ltd, 2013.
4. Kenneth S. Krane-Introductory Nuclear Physics, 3rd edition, John Wiley and Sons, New York, 1988.

Unit	Book	Chapters	Sections
I	1	2,17	2.1, 2.13, 17.2, 17.3, 17.4, 17.6, 17.8
II	1	4,5,6	4.9-4.12, 5.5-5.7, 5.9, 5.10, 5.12, 5.16, 5.18, 6.8-6.11, 6.16, 6.19
III	2	8,9	8.1, 8.2, 8.4, 8.5, 8.7, 8.10, 8.12, 8.13, 8.15, 8.16, 9.2, 9.4, 9.11, 9.12, 9.13, 9.17, 9.21
IV	2	11	11.4-11.14, 11.15, 11.16
V	3 4	10,20	10.3, 10.4, 10.7-10.12, 10.14 20.1, 20.4, 20.5

Books for Reference

1. Pandya and Yadav-Nuclear and Particle Physics world, Cambridge University Press, Reprint 2004.
2. Bernard L. Cohen -Concepts of Nuclear Physics, Tata McGraw Hill Publishing Co., New Delhi. Reprint 2002.
3. Irwing Kaplan, Nuclear Physics, 2nd edition, Addison-Wesley Pub. Co., Reprint 2001.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4CC07	NUCLEAR AND PARTICLE PHYSICS	6	6

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	93	2	2	3	3	2	2	2	2.4
CO-2	2	2	3	2	2	3	2	2	2	2	2.2
CO-3	3	2	2	2	2	2	2	3	2	2	2.2
CO-4	3	3	2	2	2	2	3	2	2	2	2.3
CO-5	2	2	2	2	2	3	2	2	2	2	2.1
Mean Overall Score											2.2 (High)

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4CC08	CORE-8: STATISTICAL MECHANICS AND THERMODYNAMICS	6	5

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	acquire the knowledge of different laws of thermodynamics.	K1
CO-2	understand about diverse thermodynamic potentials and their importance to deduce reciprocity relations and Bragg-William's approximation.	K2
CO-3	apply the Knowledge about Liouville's theorem and its importance, MB distribution law, BE and FD distribution law.	K3
CO-4	apply and analyse the statistical laws to study transport phenomena	K3 & K4
CO-5	evaluate and check the knowledge from phase transitions of first and second type	K5 & K6

Unit-I: Fundamentals of Statistical Mechanics (18 Hours)

Objectives of statistical Mechanics - Concept of Entropy and disorder - Thermodynamic potentials and reciprocity relations - chemical potential - description of systems of particles system - phase space - volume in phase space - concept of ensembles - micro canonical - canonical - grand canonical - Liouville's theorem - priori Probability - Statistical, thermal, mechanical and particle equilibrium - Gibb's paradox - Gibbs canonical ensemble.

Unit-II: Classical Statistical Mechanics (18 Hours)

Micro and Macro states - classical Maxwell - Boltzmann distribution law - distribution of velocities - principle of equipartition of energy - connection between the partition function and thermodynamic quantities - mean values obtained from distribution law - Boltzmann's entropy relation-perfect gas in micro canonical ensemble - Comparison of ensembles.

Unit-III: Quantum Statistical Mechanics (18 Hours)

Statistical weight - density matrix - Bose - Einstein - Fermi-Dirac - Maxwell - Boltzmann Statistics - black body radiation and Planck's radiation law - Thermodynamic behaviour of ideal Bose and Fermi gas - Bose-Einstein condensation - Liquid Helium - Super fluidity -Tisza's two Fluid model - second sound - electron gas of metals - Free electron model and electronic emission.

Unit - IV: Transport Properties and Fluctuation (18 Hours)

Boltzmann transport equations - Boltzmann transport equations for electrons and Lorentz solution - chambers equation - thermal conductivity of metals - mean square deviation - fluctuations in energy, Probability of one-dimensional random walk - Brownian movement - Fokker Planck equation - Nyquist's theorem.

Unit-V: Phase Transitions and its Models **(18 Hours)**

Phase transitions - first and second kind - critical exponent - YANG and LEE theory - phase transition of second kind - Ising model: Bragg-Williams approximation - one dimensional model - adiabatic demagnetisation.

Book for Study

1. Gupta S.L & Kumar V., Statistical Mechanics, Pragati Prakashan, Meerut ED, 2006.

Unit	Book	Chapters	Sections
I	1	1	1-3, 7, 1.1, 1.1-1, 1.3, 1.7, 1.9, 1.10-1.13, 3.0-3
II	1	2,3	2.1, 2.7, 2.10, 2.12, 2.14, 2.15, 2.16, 3.0-2
III	1	5,6,8,9	5.8, 5.10, 6.2-6.4, 6.10, 8.0, 8.2, 9.0, 8.4, 8.4-1, 9.3
IV	1	10,12	10.1, 10.2, 10.3, 10.5, 12.1, 12.5, 12.6, 12.10
V	1	13	13.1-13.7

Books for Reference

1. Satya Prakash and JP Agarwal, Statistical Mechanics, Pragati Prakahan, 2002.
2. K. Huang, Introduction to Statistical Mechanics.
3. Surekha Tomar, CSIR-UGC NET/JRF/SET Physical Sciences, 3rd Edition (for problems).
4. B.K. Agarwal and Melvin Eisner, Statistical Mechanics, Third edition New Age International (P)ltd, 2013.

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course					Hours				Credit
IV	21PPH4CC08	CORE-8: STATISTICAL MECHANICS AND THERMODYNAMICS					6				5
Course Outcomes↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	2	3	3	2	3	2	3	2	2	2.5
CO-2	2	3	2	2	2	3	2	2	3	2	2.3
CO-3	3	2	2	3	2	3	3	2	1	2	2.3
CO-4	2	2	2	2	2	3	3	2	1	2	2.1
CO-5	2	3	2	2	3	3	3	3	1	2	2.4
Mean Overall Score											2.32 (High)

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4CP04	PHYSICS PRACTICAL – IV	8	6

Any 15 Experiments

1. AlO Band – spectral parameters
2. Laser IV: Fiber Optics cable parameters
3. Op-amp: Solving I order Simultaneous Equation
4. Analog to Digital Converter design
5. Design of Synchronous Counter
6. Digital Modulation: ASK, FSK and PSK
7. Four Probe and two probe Method
8. Optical constants of dielectric and metal films
9. Electron Spin Resonance Spectrometer
10. Determination of Fermi energy of copper
11. Measurement of radiant flux density and luminous intensity of emission source
12. Surface morphological characterization of nanomaterial by TEM
13. Jamin's interferometer - refractive index of air
14. Measurement of thermoelectric power
15. Computation through Origin: Mathematical functions
16. Computation through Origin: Curve Fitting
17. Computational experiment: Origin - Signal processing
18. Basic programs – Arduino
19. Frequency and humidity measurement - Arduino
20. Light intensity and distance measurement - Arduino
21. Pressure and density measurement - Arduino
22. Density and viscosity measurement - Arduino
23. Design of LCR meter - Arduino
24. Measurement and control of temperature - Arduino
25. Weather and astronomy related image processing using Python
26. Fast Fourier Transform using Python
27. Sound measurement – Arduino
28. Ellipsometer – Determination of n and k of a material
29. Design of MOSFET power inverter
30. Hydrogen Spectrum and Rydberg Constant

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4ES04A	DSE - 4: MICROCONTROLLER BASED PHYSICS INSTRUMENTATION	4	4

CO No.	CO- Statements	Cognitive Levels (K-Levels)
	On the successful completion of the course, student will be able to	
CO-1	describe and discuss the architecture of Microcontroller, Arduino and IoT.	K1 & K2
CO-2	list and outline the features of Arduino IDE, syntax and algorithm and use this to solve the problems.	K1, K2 & K3
CO-3	use professional ethics on using sensors to rate modern society.	K3 & K5
CO-4	investigate and explain the automatic electronic devices and plan self-sustainability, employability and over all personality	K4 & K6
CO-5	identify the applications of Arduino, recommend the methods, design and construct various physics Instruments.	K6

Unit-I: Microcontroller and Architecture of Arduino (12Hours)

Microprocessor and Microcontroller - ATmega328/P: Introduction - Feature - Description - Block Diagram - Pin Configurations - Pin Descriptions

Arduino: Block diagram - Architecture - Pin functions - features - I/O Ports - Timers - interrupts - serial port - variants - Introduction to Arduino IDE - writing, saving, compiling and uploading sketches

Unit-II: Arduino Language Reference and Programming (12 Hours)

Language Reference: Variables - Operators - Control structures - Time and math functions Libraries and library management - Board management - digital I/O: blinking LED - interfacing Switch and 4x4 matrix keyboard - Interfacing LCD - simple programs.

Unit-III: Programing with Analog I/O for Physical Parameters (12 Hours)

ADC - AnalogRead - AnalogReference - Pulse Width Modulation PWM - control of DC motor - Serial Communication - Inter Integrated Circuit I2C- Serial Peripheral Interface SPI- Ethernet shield.

Unit-IV: Microcontroller Instruments Design (12 Hours)

Pressure meter - thermometer - lux meter - Ultrasonic range finder - humiditymeter - density meter - viscometer - dielectric meter - LCR meter

Unit-V: Internet of Things (IoT) **(12 Hours)**

Introduction - Block diagram - Networking with ESP8266 Wi-Fi module - MQTT Protocol - IoT service platform - IoT weather monitoring - IoT Physics Applications - IoT based air pollution meter.

Books for Study

1. Atmega328/P Data sheet.
2. Brain Evans, "Beginning Arduino Programing", Apress, 2011.
3. Peter Waher, "Learning Internet of Things", Packt Publishing, 2015.

Unit	Book	Chapters	Sections
I	1	1, 2, 4, 5, 11 & 12.1	1, 2, 4, 5, 11 & 12
	2	1	All
II	2	2, 3, 4, & 5	2, 3, 4, & 5
III	2	6, 7 & 10	6, 7 & 10
IV	2	Projects	Programs
V	3	1, 2, 5, & 7	1, 2, 5, & 7

Book for Reference

1. Simon Monk, "Programming Arduino, Getting Started with Sketches", Second Edition, McGraw-Hill Education, 2016.

WEB RESOURCES*

1. https://www.arduino.cc/
2. https://www.arduino.cc/en/Tutorial/HomePage
3. https://opensource.com/resources/what-arduino
4. https://nurdspace.nl/ESP8266

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
IV	**21PPH4ES04A**	**DSE - 4: MICROCONTROLLER BASED PHYSICS INSTRUMENTATIONS**	**4**	**4**

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	3	3	2	2	2	3	3	3	3	2	2.6
CO-2	3	3	3	2	2	3	3	3	3	2	2.7
CO-3	3	3	2	3	2	3	3	3	3	2	2.7
CO-4	3	3	3	3	2	3	3	3	2	2	2.7
CO-5	3	3	3	2	2	3	3	3	3	2	2.7
Mean Overall Score											**2.68 (High)**

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4ES04B	DSE - 4: PHYSICS OF SENSORS AND TRANSDUCERS	4	4

CO No.	CO- Statements	Cognitive Levels (K- Levels)
	On the successful completion of the course, student will be able to	
CO-1	describe and discuss different signals	K1 & K2
CO-2	list, explain and use different sensors and transducers	K1, K2 & K3
CO-3	compare the sensor principles, classify the sensors and transducers and design a transducer to sense the physical quantity.	K2, K3 & K6
CO-4	identify and recommend suitable sensors and transducers to an instrument.	K4 & K5
CO-5	examine the signals, assess the problems and synthesize a new sensors and transducers.	K4, K5 & K6

Unit-I: Data Acquisition and Sensors **(12 Hours)**

Sensors, Signals, and Systems - Sensor Classification - Mathematical models - Calibration - Computation of parameters - mobile communication sensors - Span - Full-Scale Output - Calibration Error - Hysteresis - Nonlinearity - Saturation - Repeatability – Dead band - Resolution - Special Properties - Dynamic Characteristics – Uncertainty.

Unit-II: Physical Principles of Sensing **(12 Hours)**

Capacitance - Magnetism - Induction - Resistance - Piezoelectric Effect - Pyroelectric Effect - Hall Effect - Thermoelectric Effects - Temperature and Thermal Properties of Materials - Heat Transfer.

Unit-III: Physics of Detectors **(12 Hours)**

Ultrasonic Detectors - Microwave Motion Detectors - Linear Optical Sensors - Optoelectronic Motion Detectors - Optical Presence Sensors - Pressure-Gradient Sensors - Gesture Sensing - Tactile Sensors.

Unit-IV: Transducers I (Principle and Design) **(12 Hours)**

Metal detector - Magnetostrictive detector - proximity detector with polarized light - ablation transducer - cryogenic liquid level transducer - Tachometer - laser gyroscope - Inclinometer - Seismic transducer - piezoelectric accelerometer - pressure sensitive film - vacuum pressure gauge - ultrasonic flow transducer.

Unit-V: Transducers II (Principle and Design) **(12 Hours)**

Condenser microphone - optical microphone - optical hygrometer - oscillating hygrometer - soil moisture - image detector - UV detector - thermal radiation detector - Ionization detector - ceramic PTC transducer - chemical transducer - biological transducer.

Book for Study

1. Jacob Fraden, "Handbook of Modern Sensors - Physics, Designs, and Applications", Fifth Edition, Springer, 2016.

Unit	Book	Chapters	Sections
I	1	1, 2, 3	1.1, 1.2, 2.1-2.3, 3.1-3.3, 3.5-3.12, 3.16, 3.21
II	1	4	4.2-4.9, 4.11, 4.12.
III	1	7	7.1, 7.2, 7.5, 7.8-7.13
IV	1	8, 9, 10	8.4.5, 8.4.8, 8.5.2, 8.6.1, 9.1.2, 9.2.3, 9.3.2, 9.3.3, 9.3.6, 10.3, 11.10, 12.4
V	1	13, 14, 15, 16, 17, 18	13.3, 13.5, 14.6-14.8, 15.6-15.8, 16.2, 17.4.5, 18.1-18.4, 18.9

Book for Reference

1. Michael Stanley and Jongmin Lee, "Sensor Analysis", Morgan & Laypool publishers, 2018.

Web Resources*

1. https://www.nap.edu/read/4782/chapter/4
2. https://www-physics.lbl.gov/~spieler/TSI-2007/PDF/Sensor_Physics_I.pdf
3. https://www.elprocus.com/tilt-sensor-types-working-principle-and-its-applications/

(* subject to availability - not to be used for exam purpose)

Relationship matrix for Course outcomes, Programme outcomes/Programme Specific Outcomes

Semester	Course Code	Title of the Course	Hours	Credit
IV	**21PPH4ES04B**	**DSE - 4: PHYSICS OF SENSORS AND TRANSDUCERS**	**4**	**4**

Course Outcomes (COs)↓	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO-1	2	2	3	3	2	2	2	2	3	2	2.3
CO-2	3	2	2	2	3	2	3	3	3	2	2.5
CO-3	3	2	2	2	2	2	3	3	3	2	2.4
CO-4	3	2	3	2	2	3	3	2	2	3	2.5
CO-5	3	2	2	2	2	3	3	3	2	2	2.4
Mean Overall Score											**2.42 (High)**

Semester	Course Code	Title of the Course	Hours	Credit
IV	21PPH4CE01	COMPREHENSIVE EXAM	-	2

Unit-I: Classical and Statistical Mechanics

Generalized coordinates system, Lagrangian and Hamiltonian formulation and equation of motion, Central force motions, Two body collisions - Scattering in laboratory and center of mass frames, Rigid body dynamics - non linear frame and pseudo forces, Special theory of relativity - Lorentz transformation, relativistic Kinematics and mass energy Equivalence.

Fundamentals of statistical mechanics, classical statistical mechanics - micro and macro states, thermodynamic quantities, Maxwell's relations, Boltzmann's entropy relation, quantum statistical mechanics - ideal Bose and Fermi gas - Bose-Einstein condensation, Transport properties - Boltzmann transport equations - random walk - Brownian movement.

Unit-II: Mathematical Physics and Electromagnetic Theory

Mathematical tools of vector and matrix spaces - vector algebra and vector calculus, linear algebra, matrices, eigen values and eigen vectors, partial differential equations - Laplace, wave and heat equations in two and three dimensions, Complex analysis - Cauchy's theorem -derivatives of analytic Complex function - Laurent series, Fourier series - Fourier and Laplace transforms, Special function – series solution of Hermite and Legendre polynomial.

Gauss law and its applications - Laplace and Poisson equations - boundary value problems - Biot-Savart law - Ampere's theorem - Maxwell's equations in free space and linear isotropic media - Boundary conditions on fields at interface - Scalar and vector potential, Electromagnetic waves in free space, dielectrics and conductors, wave guides - Radiation from moving charges and retarded potential.

Unit-III: Quantum Mechanics

Basic postulates and quantum system - Schrodinger equation and wave packets - Properties of 1D motions, one and three dimensional problems - Tunneling through barrier - Eigen value problems - Harmonic oscillator and Hydrogen atom problem, Angular momentum - spin angular momentum - orbital angular momentum - Iso spin, Approximation methods - Time independent Perturbation Theory - JWKB approximation.

Unit-IV: Condensed Matter Physics

Semiconductor crystals - Origin of energy gap - carrier concentration - mobility – conductivity - Fermi surface - construction of Fermi surface - nearly free electron model – Pseudo potential Thermodynamics of the superconducting transition - London equation - BCS theory of superconductivity - Type II superconductors - DC and AC Josephson effect - High temperature superconductors, Magnetic properties of solids - Dia, para and ferro magnetism, magnetic resonance, dielectric function of gas.

Unit-V: Spectroscopy and Nuclear Physics

Electronic, rotational, vibrational and Raman spectra of diatomic molecules - selection rule, Spin and applied field - NMR spectroscopy - Electron spin resonance spectroscopy - Mossbauer Spectroscopy.

Basic nuclear properties: size, shape and charge distribution - binding energy - Nuclear models - Theories of alpha and beta decay, types of nuclear reactions, elementary particles and their quantum numbers - Quark model, Cosmic rays - discovery and applications, diagnostic nuclear medicine.

Books for Reference

1. Herbert Goldstein, Charles P. Poole, John L. Safko, Classical Mechanics, 3rd Edition, Pearson Education, 2002.
2. Quantum Mechanics: Concepts and Applications, Nouredine Zettile, 2/e, John Wiley & Sons, UK, 2009.