VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES
DEPARTMENT OF PHYSICS

M.Sc Physics
(MSP)

Curriculum & Syllabus
(2021-2022 Admitted Students)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

To be an internationally renowned science school in research and innovation by imparting futuristic education relevant to the society.

MISSION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

- To nurture students from India and abroad by providing quality education and training to become scientists, technologists, entrepreneurs and global leaders with ethical values for a sustainable future.

- To enrich knowledge through innovative research in niche areas.

- To ignite passion for science and provide solutions for national and global challenges.

M.Sc. Physics

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be practitioners and leaders in their chosen field.
2. Graduates will function in their profession with social awareness and responsibility.
3. Graduates will interact with their peers in other disciplines in their work place and society and contribute to the economic growth of the country.
4. Graduates will be successful in pursuing higher studies in their chosen field.
5. Graduates will pursue career paths in teaching or research.

M.Sc. Physics

PROGRAMME OUTCOMES (POs)

PO_01: Having a clear understanding of the subject related concepts and of contemporary issues.

PO_02: Having problem solving ability to address social issues.

PO_03: Having a clear understanding of professional and ethical responsibility.

PO_04: Having cross cultural competency exhibited by working in teams.

PO_05: Having a good working knowledge of communicating in English.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M.Sc. Physics programme, graduates will be able to

- PSO1: Hone the basic concepts of core areas of Physics especially in mathematical Physics, electromagnetism, classical mechanics, statistical mechanics and quantum mechanics for unraveling the diverse phenomena observed in nature.

- PSO2: Perform the general Physics and research oriented experiments with appropriate analysis for proper interpretation of results; to undertake individual project and present the research findings.

- PSO3: Independently carry out research / investigation to solve practical problems and write / present a substantial technical report/document

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	**29**
Programme core (PC)	**23**
Programme elective (PE)	**22**
University elective (UE)	**06**
Bridge course (BC)	**-**
Total credits	**80**

DETAILED CURRICULUM

University Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	MAT5007	Applied Statistical Methods	2	0	2	0	3
2.	PHY6099	Master's Thesis	0	0	0	0	14
3.	RES5001	Research Methodology	2	0	0	0	2
4.	SET5001	Science, Engineering and Technology Project – I	0	0	0	0	2
5.	SET5002	Science, Engineering and Technology Project – II	0	0	0	0	2
6.	SET5003	Science, Engineering and Technology Project – III	0	0	0	0	2
7.	ENG5003	English for Science and Technology	0	0	4	0	2
8.	STS4001	Soft Skills	3	0	0	0	1
9.	STS4002	Soft Skills	3	0	0	0	1

DETAILED CURRICULUM

Programme Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	PHY5001	Mathematical Physics	3	2	0	0	4
2.	PHY5002	Classical Mechanics	3	2	0	0	4
3.	PHY5003	General Physics Lab-I	0	0	4	0	2
4.	PHY5004	Electromagnetic Theory	4	0	0	0	4
5.	PHY5005	Quantum Mechanics	4	0	0	0	4
6.	PHY5006	Statistical Mechanics	3	0	0	0	3
7.	PHY5007	General Physics Lab-II	0	0	4	0	2

DETAILED CURRICULUM

Programme Elective

S. No.	Course Code	Course Title	L	T	P	J	C
1.	PHY6001	Introduction to Solid State Physics	3	0	0	4	4
2.	PHY6002	Nuclear and Particle Physics	3	0	0	4	4
3.	PHY6003	Atomic and Molecular Physics	3	0	0	4	4
4.	PHY6004	Basic Electronics	3	0	0	4	4
5.	PHY6005	Advanced Solid State Theory	3	0	0	0	3
6.	PHY6006	Nanomaterials and its applications	3	0	0	0	3
7.	PHY6007	Optoelectronics	3	0	2	0	4
8.	PHY6008	Laser and Fiber Optics	3	0	0	0	3
9.	PHY6009	Bio Physics	3	0	0	0	3
10.	PHY6010	Microwave Physics and Device Technology	3	0	0	0	3
11.	PHY6012	Solid State Magnetism	3	0	0	0	3

University Elective Baskets

Sl. No	Code	Title	L	T	P	J	C
1	PHY6006	Nanomaterials and its applications	3	0	0	0	3
2	PHY6008	Laser and Fiber Optics	3	0	0	0	3

University Core

Course Code	Course title	L	T	P	J	C
MAT5007	Applied Statistical Methods (UC)	2	0	2	0	3
Pre-requisite	None	Syllabus version				
		v.1.1				

Course Objectives:

1. To provide students with a framework that will help them to choose the appropriate descriptive statistics in various data analysis situations.
2. Recognize and appreciate the connections between theory and applications;
3. To apply estimation and testing methods to make inference for decision making using various statistical techniques.

Expected Course Outcome: Students will be able

1. Independently calculate basic statistical parameters. (measures of central tendency, measures of dispersion)
2. Provide a clear sense of how to investigate the strength and direction of a relationship between two or more variables by collecting measurements and using appropriate statistical analysis.
3. Apply basics of discrete and continuous random variables
4. Understand the logical frame work of testing of hypothesis and based on the acquired knowledge to interpret the meaning of the calculated statistical indicators.
5. Choose a statistical method for solving practical problems.
6. Demonstrate R programming for statistical data

Module:1	Introduction to Statistics:	7 hours

Introduction to Statistics and data analysis-Measures of central tendency, Measures of dispersion, Skewness and Kurtosis.

Module:2	Correlation and regression:	5 hours

Correlation and Regression–Rank Correlation-Partial and Multiple Correlation Regression, Multiple Regression.

Module:3	Random Variables	5 hours

Introduction to discrete random variables – Binomial – Poisson – Geometric, continuous random
variables-Normal, Student's T, expectation of random variables, mean and variance.

Module:4	Testing of hypothesis I:	5 hours

Introduction-Types of errors, Critical region, procedure of testing hypothesis- tests of hypotheses-Z- test for Single Proportion, Difference of Proportion, Single mean and difference of means.

Module:5	**Testing of hypothesis II:**	**6 hours**
Small Sample Tests - Student t-test, F-test, Chi-Square test for independence of Attributes, Analysis of Variance-Principles of experimental design, Completely randomized design, Randomized block design, Latin Square design- Problems.		
Module:6	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery George C. Runger, 6th edition, John Wiley & Sons, (2016)
2	Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences, J. Susan Milton and Jesse Arnold, Mc.Grawhill education, (2017).

Mode of Evaluation

Digital Assignments, Quiz, Continuous Assessment Test, Final Assessment Test

Reference Books

1.	Statistics for Engineers and scientists, Navidi ,W., McGraw-Hill Education (2017)
2	Fundamentals of Statistics, S.C. Gupta 7th edition, Himalaya Publishing House Pvt. Ltd (2016)

List of Challenging Experiments (Indicative)

1.	Introduction: Understanding Data types; importing/exporting data.	**2 hours**
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	**2 hours**
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting coefficient of determination	**2 hours**
4.	Applying multiple linear regression model to real dataset; comput-ing and interpreting the multiple coefficient of determination	**2 hours**
5.	Testing of hypothesis for One sample mean and proportion from real-time problems.	**2 hours**
6	Testing of hypothesis for Two sample mean and proportion from real-time problems.	**2 hours**
7	Applying the t test for independent and dependent samples	**2 hours**
8	Applying Chi-square test Contingency test to real dataset	**2 hours**
9	Performing ANOVA for One-way, Two-way classification for real dataset	**2 hours**
10	Performing ANOVA in Design of Experiments- Completely randomized design, Randomized Block design, Latin square Design.	**2 hours**
11	Performing two-way ANOVA in Randomized block design	**2 hours**
12	Performing Three-way ANOVA in Latin square Design.	**2 hours**
	Total Laboratory Hours	**24 hours**

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
ENG5003	English for Science and Technology (for MCA & M.Sc., Programmes)	0	0	4	0	2
Pre-requisite	Nil	Syllabus version				
		v. 1.1				

Course Objectives:

1. To enable students communicate effectively in social, academic and professional contexts thereby enhancing their interpersonal, managerial, problem-solving, and presentation skills.
2. To facilitate students develop their listening competency and critically evaluate and review documentaries, talks and speeches.
3. To Assist students read and comprehend News Articles and Scientific Texts; effectively interpret tables and graphs; write and proof-read official correspondences.

Expected Course Outcome: Students will be able to

1. Make effective presentations and display their interpersonal skills in academic and professional contexts.
2. Emerge as good listeners and critically evaluate oral communication.
3. Excel in reading, comprehending and interpreting technical reports, texts and data.
4. Able to write effectively in English and also display their proof-reading abilities.
5. Face real interviews and handle personal and professional conflicts effectively.

Module:1	**Career Goals**	**4hours**
Short term and long term career goals Activity: SWOT Analysis/ Comprehending speeches		
Module:2	**Interpersonal Skills**	**4 hours**
Interpersonal Communication in/with Groups (Corporate Etiquette: Journey from Campus to corporate) Activity: Role Plays/Mime/Skit		
Module:3	**Listening Skills**	**4 hours**
Listening to Documentary Activity: Critically evaluate/Review a documentary/TED Talk		
Module:4	**Reading Skills**	**4hours**
Skimming, Scanning, Intensive & Extensive reading Activity: Reading News Papers/Magazines/Scientific Texts		
Module:5	**Report Writing**	**4hours**
Language and mechanics of writing report Activity: Writing a Report/Mini Project		
Module:6	**Study Skills**	**4hours**
Summarizing the report Activity: Abstract, Executive Summary, Digital Synopsis		
Module:7	**Interpreting skills**	**4hours**

Interpret data in tables and graphs Activity: Transcoding		
Module:8	**Editing Skills**	**4hours**
Proof eading Sequencing Activity: Editing any given text		
Module:9	**Presentation Skills**	**4 hours**
Oral Presentation using digital tools Activity: Oral presentation on the given topic using appropriate non-verbal cues		
Module:10	**Group Discussion**	**4 hours**
Intragroup interaction (avoid, accommodate, compete, compromise, collaborate) Activity: Group discussion on a given topic		
Module:11	**Professional Skills**	**4 hours**
Résumé Writing Activity: Prepare an Electronic Résumé		
Module:12	**Skill-Gap Analysis**	**4 hours**
Tailor your skills to suit the Job needs Activity: Write a SoP for higher Studies/Purpose Statement for job		
Module:13	**Interview Skills**	**4 hours**
Placement/Job Interview Activity: Mock Interview		
Module:14	**Managerial Skills**	**4 hours**
Official Meeting to organize events Activity: Writing Agenda, Minutes of Meeting (video conferencing) and Organizing an event		
Module:15	**Problem Solving Skills**	**4 hours**
Conflict Management & Decision Making Activity: Case analysis of a challenging Scenario		
	Total Lecture hours:	**60 hours**

Text Book(s)	
1.	Kuhnke, E. Communication Essentials For Dummies. (2015). First Edition. John Wiley & Sons.
2.	Hewings, M. Advanced Grammar in Use Book with Answers and CD-ROM: A Self-Study Reference and Practice Book for Advanced Learners of English. (2013). Third Edition. Cambridge University Press. UK.
Reference Books	
1.	Churches, R. Effective Classroom Communication Pocketbook. Management Pocketbooks. (2015). First Edition. USA.
2.	Wallwork, A. English for Writing Research Papers. (2016). Second Edition. Springer.
3.	Wood, J. T. Communication in Our Lives. (2016). Cengage Learning. Boston. USA.

4.	Anderson, C. TED Talks: The Official TED Guide to Public Speaking. (2016). First Edition.Boston. Houghton Mifflin. New. York.
5.	Zinsser, William. On writing well. HarperCollins Publishers. 2016. Thirtieth Edition. New York.
6.	Tebeaux, Elizabeth, and Sam Dragga. The essentials of Technical Communication. 2015. First Edition Oxford University Press. USA.

Mode of Evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

List of Challenging Experiments (Indicative)		
1.	Setting short term and long term goals	**2 hours**
2.	Mime/Skit/ Activities through VIT Community Radio	**6 hours**
3.	Critically evaluate / review a documentary/ Activities through VIT Community Radio	**4 hours**
4.	Mini Project	**10 hours**
5.	Digital Synopsis	**4 hours**
6.	Case analysis of a challenging Scenario	**4 hours**
7.	Intensive & Extensive reading of Scientific Texts	**4 hours**
8.	Editing any given text	**8 hours**
9.	Group discussion on a given topic / Activities through VIT Community Radio	**8 hours**
10.	Prepare a video résumé along with your video introduction and then create a website (in Google Sites/Webly/Wix) showcasing skills and achievements.	**10 hours**
	Total Laboratory Hours	**60 hours**

Mode of evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	24.08.2017

Course code	Course title	L	T	P	J	C
FRE5001	Francais Fonctionnel	2	0	0	0	2
Pre-requisite		Syllabus version				
Nil		v.1				

Course Objectives:

The course gives students the necessary background to:

1. demonstrate competence in reading, writing, and speaking basic French, including knowledge of vocabulary (related to profession, emotions, food, workplace, sports/hobbies, classroom and family).
2. achieve proficiency in French culture oriented view point.

Expected Course Outcome: Students will be able to

1. Remember the daily life communicative situations via personal pronouns, emphatic pronouns, salutations, negations, interrogations etc.
2. Create communicative skill effectively in French language via regular / irregular verbs.
3. Demonstrate comprehension of the spoken / written language in translating simple sentences.
4. Understand and demonstrate the comprehension of some particular new range of unseen written materials.
5. Demonstrate a clear understanding of the French culture through the language studied.

Module:1	Saluer, Se présenter, Etablir des contacts	**3 hours**

Les Salutations, Les nombres (1-100), Les jours de la semaine, Les mois de l'année, Les Pronoms Sujets, Les Pronoms Toniques, La conjugaison des verbes réguliers, La conjugaison des verbes irréguliers- avoir / être / aller / venir / faire etc.

Module:2	**Présenter quelqu'un, Chercher un(e) correspondant(e), Demander des nouvelles d'une personne.**	**3 hours**

La conjugaison des verbes Pronominaux, La Négation, L'interrogation avec *'Est-ce que ou sans Est-ce que'*.

Module:3	**Situer un objet ou un lieu, Poser des questions**	**4 hours**

L'article (défini/ indéfini), Les prépositions (à/en/au/aux/sur/dans/avec etc.), L'article contracté, Les heures en français, La Nationalité du Pays, L'adjectif (La Couleur, l'adjectif possessif, l'adjectif démonstratif/ l'adjectif interrogatif (quel/quelles/quelle/quelles), L'accord des adjectifs avec le nom, L'interrogation avec Comment/ Combien / Où etc.,

Module:4	**Faire des achats, Comprendre un texte court, Demander et indiquer le chemin.**	**6 hours**

La traduction simple :(français-anglais / anglais –français)

Module:5	**Trouver les questions, Répondre aux questions générales en français.**	**5 hours**

L'article Partitif, Mettez les phrases aux pluriels, Faites une phrase avec les mots donnés, Exprimez les phrases données au Masculin ou Féminin, Associez les phrases.

Module:6	**Comment ecrire un passage**	**3 hours**
Décrivez : La Famille /La Maison, /L'université /Les Loisirs/ La Vie quotidienne etc.		
Module:7	**Comment ecrire un dialogue**	**4 hours**
Dialogue: a) Réserver un billet de train b) Entre deux amis qui se rencontrent au café c) Parmi les membres de la famille d) Entre le client et le médecin		
Module:8	**Invited Talk: Native speakers**	**2 hours**

	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Echo-1, Méthode de français, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
2	Echo-1, Cahier d'exercices, J. Girardet, J. Pécheur, Publisher CLE International, Paris 2010.
Reference Books	
1.	CONNEXIONS 1, Méthode de français, Régine Mérieux, Yves Loiseau,Les Éditions Didier, 2004.
2	CONNEXIONS 1, Le cahier d'exercices, Régine Mérieux, Yves Loiseau, Les Éditions Didier, 2004.
3	ALTER EGO 1, Méthode de français, Annie Berthet, Catherine Hugo, Véronique M. Kizirian, Béatrix Sampsonis, Monique Waendendries , Hachette livre 2006.

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	26-2-2016		
Approved by Academic Council	No 41	Date	17-6-2016

Course code	Course title	L	T	P	J	C
GER5001	Deutsch für Anfänger	2	0	0	0	2
Pre-requisite	NIL	Syllabus version				
		v.1				

Course Objectives:

The course gives students the necessary background to:

1. enable students to read and communicate in German in their day to day life
2. become industry-ready
3. make them understand the usage of grammar in the German Language.

Expected Course Outcome: Students will be able to

6. Create the basics of German language in their day to day life.
7. Understand the conjugation of different forms of regular/irregular verbs.
8. Understand the rule to identify the gender of the Nouns and apply articles appropriately.
9. Apply the German language skill in writing corresponding letters, E-Mails etc.
10. Create the talent of translating passages from English-German and vice versa and to frame simple dialogues based on given situations.

Module:1	**3 hours**

Einleitung, Begrüssungsformen, Landeskunde, Alphabet, Personalpronomen, Verb Konjugation, Zahlen (1- 100), W-fragen, Aussagesätze, Nomen – Singular und Plural

Lernziel:

Elementares Verständnis von Deutsch, Genus- Artikelwörter

Module:2	**3 hours**

Konjugation der Verben (regelmässig /unregelmässig) die Monate, die Wochentage, Hobbys, Berufe, Jahreszeiten, Artikel, Zahlen (Hundert bis eine Million), Ja-/Nein- Frage, Imperativ mit Sie

Lernziel :

Sätze schreiben, über Hobbys erzählen, über Berufe sprechen usw.

Module:3	**4 hours**

Possessivpronomen, Negation, Kasus- AkkusatitvundDativ (bestimmter, unbestimmterArtikel), trennnbare verben, Modalverben, Adjektive, Uhrzeit, Präpositionen, Mahlzeiten, Lebensmittel, Getränke

Lernziel :

Sätze mit Modalverben, Verwendung von Artikel, über Länder und Sprachen sprechen, über eine Wohnung beschreiben.

Module:4	**6 hours**

Übersetzungen : (Deutsch – Englisch / Englisch – Deutsch)

Lernziel :

Grammatik – Wortschatz – Übung

Module:5	**5 hours**

Leseverständnis,Mindmap machen,Korrespondenz- Briefe, Postkarten, E-Mail **Lernziel :** Wortschatzbildung und aktiver Sprach gebrauch		
Module:6		**3 hours**
Aufsätze : Meine Universität, Das Essen, mein Freund oder meine Freundin, meine Familie, ein Fest in Deutschland usw		
Module:7		**4 hours**
Dialoge: e) Gespräche mit Familienmitgliedern, Am Bahnhof, f) Gespräche beim Einkaufen ; in einem Supermarkt ; in einer Buchhandlung ; g) in einem Hotel - an der Rezeption ;ein Termin beim Arzt. Treffen im Cafe		
Module:8		**2 hours**
Guest Lectures/Native Speakers / Feinheiten der deutschen Sprache, Basisinformation über die deutschsprachigen Länder		
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	**Studio d A1 Deutsch als Fremdsprache, Hermann Funk, Christina Kuhn, Silke Demme : 2012**
Reference Books	
1	Netzwerk Deutsch als Fremdsprache A1, Stefanie Dengler, Paul Rusch, Helen Schmtiz, Tanja Sieber, 2013
2	Lagune ,Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, 2012.
3	Deutsche SprachlehrefürAUsländer, Heinz Griesbach, Dora Schulz, 2011
4	ThemenAktuell 1, HartmurtAufderstrasse, Heiko Bock, MechthildGerdes, Jutta Müller und Helmut Müller, 2010
	www.goethe.de wirtschaftsdeutsch.de hueber.de, klett- sprachen.de www.deutschtraning.org

Mode of Evaluation: CAT / Assignment / Quiz / FAT			
Recommended by Board of Studies	04-03-2016		
Approved by Academic Council	No. 41	Date	17-06-2016

Course code	Course title	L	T	P	J	C
STS4001	Essentials of Business Etiquettes	3	0	0	0	1
Pre-requisite		Syllabus version				
		v2				

Course Objectives:

1. To develop the students' logical thinking skills
2. To learn the strategies of solving quantitative ability problems
3. To enrich the verbal ability of the students
4. To enhance critical thinking and innovative skills

Expected Course Outcome:

- Enabling students to use relevant aptitude and appropriate language to express themselves
- To communicate the message to the target audience clearly

Module:1	**Business Etiquette: Social and Cultural Etiquette and Writing Company Blogs and Internal Communications and Planning and Writing press release and meeting notes**	**9 hours**

Value, Manners, Customs, Language, Tradition, Building a blog, Developing brand message, FAQs', Assessing Competition, Open and objective Communication, Two way dialogue, Understanding the audience, Identifying, Gathering Information,. Analysis, Determining, Selecting plan, Progress check, Types of planning, Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph., Body – Make it relevant to your audience,

Module:2	**Study skills – Time management skills**	**3 hours**

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

Module:3	**Presentation skills – Preparing presentation and Organizing materials and Maintaining and preparing visual aids and Dealing with questions**	**7 hours**

10 Tips to prepare PowerPoint presentation, Outlining the content, Passing the Elevator Test, Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation, Importance and types of visual aids, Animation to captivate your audience, Design of posters, Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	**Quantitative Ability -L1 – Number properties and Averages and Progressions and Percentages and Ratios**	**11 hours**
Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, Averages, Weighted Average, Arithmetic Progression, Geometric Progression, Harmonic Progression, Increase & Decrease or successive increase, Types of ratios and proportions		
Module:5	**Reasoning Ability-L1 – Analytical Reasoning**	**8 hours**
Data Arrangement(Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzle test, Selection Decision table		
Module:6	**Verbal Ability-L1 – Vocabulary Building**	**7 hours**
Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler(2001) Crucial Conversations: Tools for Talking When Stakes are High. Bangalore. McGraw-Hill Contemporary
2.	Dale Carnegie,(1936) How to Win Friends and Influence People. New York. Gallery Books
3.	Scott Peck. M(1978) Road Less Travelled. New York City. M. Scott Peck.
4.	FACE(2016) Aptipedia Aptitude Encyclopedia. Delhi. Wiley publications
5.	ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com
5.	www.eguru.ooo

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
STS4002	Preparing for Industry	3	0	0	0	1
Pre-requisite		Syllabus version				
						v2

Course Objectives:

5. To develop the students' logical thinking skills
6. To learn the strategies of solving quantitative ability problems
7. To enrich the verbal ability of the students
8. To enhance critical thinking and innovative skills

Expected Course Outcome:

- Enabling students to simplify, evaluate, analyze and use functions and expressions to simulate real situations to be industry ready.

Module:1	Interview skills – Types of interview and Techniques to face remote interviews and Mock Interview	3 hours

Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview, Video interview¸ Recorded feedback, Phone interview preparation, Tips to customize preparation for personal interview, Practice rounds

Module:2	Resume skills – Resume Template and Use of power verbs and Types of resume and Customizing resume	2 hours

Structure of a standard resume, Content, color, font, Introduction to Power verbs and Write up, Quiz on types of resume, Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module:3	Emotional Intelligence - L1 – Transactional Analysis and Brain storming and Psychometric Analysis and Rebus Puzzles/Problem Solving	12 hours

Introduction, Contracting, ego states, Life positions, Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming, Skill Test, Personality Test, More than one answer, Unique ways

Module:4	Quantitative Ability-L3 – Permutation-Combinations and Probability and Geometry and mensuration and Trigonometry and Logarithms and Functions and Quadratic Equations and Set Theory	14 hours

Counting, Grouping, Linear Arrangement, Circular Arrangements, Conditional Probability, Independent and Dependent Events, Properties of Polygon, 2D & 3D Figures, Area & Volumes, Heights and distances, Simple trigonometric functions, Introduction to logarithms, Basic rules of logarithms, Introduction to functions, Basic rules of functions, Understanding Quadratic Equations, Rules & probabilities of Quadratic

Equations, Basic concepts of Venn Diagram		
Module:5	**Reasoning ability-L3 – Logical reasoning and Data Analysis and Interpretation**	**7 hours**
Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic, Data Sufficiency, Data interpretation-Advanced, Interpretation tables, pie charts & bar chats		
Module:6	**Verbal Ability-L3 – Comprehension and Logic**	**7 hours**
Reading comprehension, Para Jumbles, Critical Reasoning (a) Premise and Conclusion, (b) Assumption & Inference, (c) Strengthening & Weakening an Argument		
	Total Lecture hours:	**45 hours**

Reference Books

1.	Michael Farra and JIST Editors(2011) Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Saint Paul, Minnesota. Jist Works
2.	Daniel Flage Ph.D(2003) The Art of Questioning: An Introduction to Critical Thinking. London. Pearson
3.	David Allen(2002) Getting Things done : The Art of Stress -Free productivity. New York City. Penguin Books.
4.	FACE(2016) Aptipedia Aptitude Encyclopedia.Delhi. Wiley publications
5.	ETHNUS(2013) Aptimithra. Bangalore. McGraw-Hill Education Pvt. Ltd.

Websites:

1.	www.chalkstreet.com
2.	www.skillsyouneed.com
3.	www.mindtools.com
4.	www.thebalance.com
5.	www.eguru.ooo

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
SET 5001	Science, Engineering and Technology Project– I	0	0	0	0	2
Pre-requisite		Syllabus Version				
Anti-requisite		v1.10				

Course Objectives:

- To provide opportunity to involve in research related to science / engineering
- To inculcate research culture
- To enhance the rational and innovative thinking capabilities

Expected Course Outcome: Student will be able to

1. Identify a research problem and carry out literature survey
2. Analyse the research gap and formulate the problem
3. Interpret the data and synthesize research findings
4. Report research findings in written and verbal forms

Modalities / Requirements

1. Individual or group projects can be taken up
2. Involve in literature survey in the chosen field
3. Use Science/Engineering principles to solve identified issues
4. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
5. Submission of scientific report in a specified format (after plagiarism check)

Student Assessment : Periodical reviews, oral/poster presentation

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Course title	L	T	P	J	C
SET 5002	Science, Engineering and Technology Project– II	0	0	0	0	2
Pre-requisite		Syllabus Version				
Anti-requisite		v1.10				

Course Objectives:

- To provide opportunity to involve in research related to science / engineering
- To inculcate research culture
- To enhance the rational and innovative thinking capabilities

Expected Course Outcome: Student will be able to

1. Identify a research problem and carry out literature survey
2. Analyse the research gap and formulate the problem
3. Interpret the data and synthesize research findings
4. Report research findings in written and verbal forms

Modalities / Requirements

6. Individual or group projects can be taken up
7. Involve in literature survey in the chosen field
8. Use Science/Engineering principles to solve identified issues
9. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
10. Submission of scientific report in a specified format (after plagiarism check)

Student Assessment : Periodical reviews, oral/poster presentation

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Course title	L	T	P	J	C
SET 5003	Science, Engineering and Technology Project– III	0	0	0	0	2
Pre-requisite		Syllabus Version				
Anti-requisite		v1.10				

Course Objectives:

- To provide opportunity to involve in research related to science / engineering
- To inculcate research culture
- To enhance the rational and innovative thinking capabilities

Expected Course Outcome: Student will be able to

1. Identify a research problem and carry out literature survey
2. Analyse the research gap and formulate the problem
3. Interpret the data and synthesize research findings
4. Report research findings in written and verbal forms

Modalities / Requirements

11. Individual or group projects can be taken up
12. Involve in literature survey in the chosen field
13. Use Science/Engineering principles to solve identified issues
14. Adopt relevant and well-defined / innovative methodologies to fulfill the specified objective
15. Submission of scientific report in a specified format (after plagiarism check)

Student Assessment : Periodical reviews, oral/poster presentation

Recommended by Board of Studies	17-08-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course title	L	T	P	J	C
RES5001	Research Methodology	2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		v. 1.0				

Course Objectives:

1. Impart skills to develop a research topic and design
2. Define a purpose statement, a research question or hypothesis, and a research objective
3. Analyze the data and arrive at a valid conclusion
4. Compile and present research findings

Expected Course Outcome: student will be able to

1. Explain the basic aspects of research and its ethics
2. Outline research problems, their types and objectives
3. Formulate good research designs and carry out statistically relevant sampling
4. Collect, collate, analyze and interpret data systematically
5. Experiment with animals ethically
6. Make use of literature and other search engines judiciously for research purposes

Module:1	Introduction and Foundation of Research	2 hours

Meaning, Objectives, Motivation, Utility for research. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method –Understanding the language of research.

Module:2	Problem identification and formulation	4 hours

Scientific Research: Problem, Definition, Objectives, Types, Purposes and components of Research problem

Module:3	Research Design	4 hours

Concept and Importance in Research : Features of a good research design, Exploratory Research Design and Descriptive Research Designs

Module:4	Sampling	6 hours

Sampling methods, Merits and Demerits. Observation methods, Sampling Errors (Type I and Type II). Determining size of the sample. Experimental Design: Concept of Independent & Dependent variables.

Module:5	Data analysis and Reporting	6 hours

Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression; Research Reports: Structure, Components, Types and Layout of
Research report and articles, Writing and interpreting research results, Figures and Graphs

Module:6	Animal handling	2 hours

Guidelines-animal ethical committee, animal models, various routes of drug administrations, LD_{50}, ED_{50}

Module:7	Use of encyclopedias and tools in research	4 hours

Research Guides, Handbook, Academic Databases for Biological Science Discipline. Methods to search required information effectively.			
Module:8	**Contemporary issues:**		**2 hours**
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Catherine Dawson, Introduction to research methods : a practical guide for anyone undertaking a research project, Oxford : How To Books, Reprint 2010
2.	Julius S. Bendat, Allan G. Piersol, Random Data: Analysis and Measurement Procedures, 4th Edition, ISBN: 978-1-118-21082-6, 640 pages, September 2011
3.	Research in Medical and Biological Sciences, 1st Edition, From Planning and Preparation to Grant Application and Publication, Editos: Petter Laake Haakon Benestad Bjorn Olsen, ISBN: 9780128001547, Academic Press, March 2015
Reference Books	
1.	John Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Fourth Edition (March 14, 2013)
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	03-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course Code	Course title	L	T	P	J	C
PHY6099	Master's Thesis	0	0	0	0	14
Pre-requisite	As per the academic regulations	Syllabus version				
		v 1.0				

Course Objectives:

To provide sufficient hands-on learning experience related to the area of specialization with a focus
on research orientation

Expected Course Outcome: Students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Develop a suitable solution methodology for the problem
4. Conduct experiments / Design & Analysis / solution iterations and document the results
5. Perform error analysis / benchmarking / costing
6. Synthesise the results and arrive at scientific conclusions / products / solution
7. Document the results in the form of technical report / presentation

1. Can be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Should be individual work.
4. Carried out inside or outside the university, in any relevant industry or research institution.
5. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	04.03.2016		
Approved by Academic Council	40thAC	Date	18.03.2016

Course code	Course title	L	T	P	J	C
PHY5001	Mathematical Physics	3	2	0	0	4
Pre-requisite	Students should have the preliminary knowledge of basic mathematical physics learned in undergraduate level	Syllabus version				
		v. 1.1				

Course Objectives:

1. To correlate its applications in various branches of Physics.
2. To understand and assimilate higher level topics by themselves.

Course Outcome: Students will be able to

1. Recall the bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, representation of states and operators as matrices, similarity transformation and diagonalization.
2. Apply series solution method to solve second order ordinary homogeneous differential equation with variable coefficients.
3. Explain the origin of Legendre polynomial, Bessel functions and Hermite polynomial and use their properties in relevant problems.
4. Analyze different coordinate systems and perform line integral, surface integral and volume integrals.
5. Evaluate separation of variable technique to solve Laplace equation in different coordinate systems.
6. Demonstrate contour integrals in relevant problems in Physics.
7. Explain the underlying concept in Tensors and the associated algebra
8. Understand basic, preliminary concepts related to group of elements.

Module:1	Linear Vector Space and Matrix	9 hours

Linear Vector Space, Linear independence, Dimension of Vector Space, Basis vectors, Matrix representation of vectors (bra and ket notation), Inner product, Orthonormal basis, Gram-Schmidt orthogonalization procedure, Linear vector operators and their matrix representation. Special matrices, Similarity transformation, Eigen value problem, Diagonalization of a matrix, Eigen vectors of commutating matrices, Cayley-Hamilton theorem, conditions of diagonalizability, Functions of a diagonalizable matrix, Evaluation of functions using Cayley-Hamilton theorem.

Module:2	Ordinary Differential Equation	4 hours

Definitions: Linearity, Order, Homogeneous and Inhomogeneous; Linear independence of functions, Wronskian, Inhomogeneous differential equations - particular integral using variation of parameters, Series Solution of second order ordinary DE, Method of Frobenius, Inhomogeneous boundary value problems using Green's function method.

Module:3	Special Functions	5 hours

By solving the respective differential equations, introduction of Bessel functions, Legendre, Laguerre and Hermite polynomials and their properties.

Module:4	Vector Calculus	5 hours

Line, surface and volume integrals, Cylindrical and Spherical Polar coordinate system. Laplacian operator in spherical and cylindrical coordinate system, Line, volume and surface integrals in spherical and cylindrical coordinate systems.

Module:5	**Partial Differential Equation**	**4 hours**
Method of separation of variables for wave equations in Cartesian and curvilinear coordinates, applications in electrostatics, Laplace and Poisson equations: heat conduction, diffusion, fluids.		
Module:6	**Complex Variables**	**9 hours**
Functions, Differentiation, Cauchy-Riemann conditions, Analytic and harmonic functions, Contour integrals, Cauchy-Goursat theorem, Cauchy integral formula, Series: Taylor Series, Laurent's theorem, Singularities, Residue theorem, applications of residue theorem, Conformal mapping and application.		
Module:7	**Tensors and Introduction to Group Theory**	**7 hours**
Tensors in index notation, inner and outer products, Kronecker and Levi Civita tensors, tensor rank, symmetric and asymmetric, covariant and contravariant, tensor transformation and contraction, quotient law, metric tensors and their determinants, pseudo tensors, simple applications: stress tensor and electromagnetic field tensor. Groups, cyclic groups, subgroups, cosets, permutation group, multiplication table, conjugate element and class structure, factor groups and invariant subgroups, isomorphism and homomorphism.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
Total Lecture hours:		**45 hours**
Tutorial Example problems from each module will be worked out by the student with help of the teacher which will also help them to prepare for CSIR and GATE examinations. Students' doubts will be addressed. Problem set is to be given as home work in each tutorial**.**		**15 hours**

Text Book(s)

1. G. B. Arfken, H. J. Weber and F. E. Harris, Mathematical Methods for Physicists, 2012, Seventh Edition, Elsevier Academic Press, UK and USA.
2. M. L. Boas, Mathematical Methods in Physical Sciences, 2006, 3rd Edition, John Wiley & Sons, USA.

Reference Books

1. A.W. Joshi, Matrices and Tensors in Physics, Paperback, 2017, 4th Edition, New Age International Publisher, India.
2. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 2009, Eighth Edition, McGraw- Hill, USA.
3. Michael Tinkham, Group Theory and Quantum Mechanics, 2003, Dover Publications, New York, USA.
4. Daniel A. Fleisch, A Student's Guide to Vectors and Tensors, 2011, Cambridge University Press.
5. V. Balakrishnan, Mathematial Physics with Applications, Problems & Solutions, 2018, Ane Books Pvt. Ltd.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar

Recommended by Board of Studies	25-06-2020		
Approved by Academic Council	No. 59	Date	24.09.2020

Programme Core

Course Code	Course title	L	T	P	J	C
PHY5002	Classical Mechanics	3	2	0	0	4
Pre-requisite	Students must have learnt Newtonian Mechanics at UG level	Syllabus version				
		v. 1.1				

Course Objectives:

1. To learn the Lagrangian and Hamiltonian formalisms of simple classical systems
2. To learn the methods of solving central force problems and rigid body dynamics

Expected Course Outcome: Students will be able to

1. To understand basic formalism of Lagrangian dynamics
2. To understand basic formalism of Hamiltonian dynamics
3. To apply Lagrangian formalism for solving Kepler's problem
4. To understand rigid body dynamics and small oscillations using Lagrangian approach
5. To discuss conservation laws in the Hamiltonian dynamics
6. To understand canonical transformations
7. To explain the foundations of relativistic physics
8. To apply Lagrangian and Hamiltonian for solving simple classical dynamics problems

Module:1	Basics of Lagrangian	6 hours

Generalized coordinates -principle of virtual work - D'Alembert's principle - Lagrangian formulation and simple applications - Variational principle and Lagrange equation

Module:2	Hamilton's principle	6 hours

Hamilton's principle - Lagrange equation from Hamilton's principle; Symmetry and conservation laws: conservation of linear momentum, energy and angular momentum.

Module:3	Central Force Problem	7 hours

Reduction of two body problem in central force - Equations of motion - effective potential energy - nature of orbits - Virial theorem - Kepler's problem; Scattering in a central force field - centre of mass and laboratory frame.

Module:4	Rigid Body System - Oscillating System	7 hours

Elements of rigid-body dynamics – Euler angles – symmetric top and applications-- Small oscillations – normal mode analysis – normal modes of a linear tri-atomic molecule – forced oscillations.

Module:5	Hamiltonian Formulation I	5 hours

Legendre transformation – Hamiltonian equations of motion – cyclic coordinates – phase space and Liouville's theorem; Symmetries and conservation laws in Hamiltonian picture.

Module:6	Hamiltonian Formulation II	5 hours

Canonical transformations- Poisson brackets- Hamilton-Jacobi theory - action-angle variables. Time dependent perturbation – examples of time dependent perturbation.

Module:7	Special Theory of Relativity	7 hours

Inertial frames – principle and postulate of relativity – Lorentz transformations - Matrix in Minkowski space-time – Lorentz transformation in real four dimensional space-time - four-vector notation – energy-momentum –four-vector for a particle - Covariant four dimensional formulation.		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**
Tutorial	**Tutorial topics**	**15 hours**
	GATE, CSIR problems related to the subject will be solved in the tutorial sessions. Assignment problems/ problem sets will be discussed during the tutorial sessions	

Text Book(s)	
1.	Classical Mechanics by H. Goldstein, C. Poole and J. Safko, 3rd edition, Pearson Education, Delhi, 2002.
2.	Classical Mechanics: Systems of particles and Hamiltonian Dynamics by W. Greiner, Springer (India), New Delhi, 2004.
Reference Books	
1.	Mechanics by Landau and Lifshitz, 2nd edition, Pergamon Press, New York, 1976
2.	Introduction to Classical Mechanics - With Problems and Solutions by David Morin, Cambridge University Press, New York, 2007
3.	Introduction to Special Relativity by R Resnick, Wiley student Edition, New Delhi, 2010
4.	Classical Mechanics by N.C. Rana and P.S. Joag, 1st edition, Mcgraw Hill Education, New Delhi, 2001
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar	

Recommended by Board of Studies	25.06.2020		
Approved by Academic Council	No. 59	Date	24.09.2020

Course code	Course title	L	T	P	J	C
PHY5003	General Physics Lab-I	0	0	4	0	2
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. To make the students to understand experimental physics
2. To apply the theoretical knowledge for developing new devices

Expected Course Outcome: Students will be able to

1. Comprehend the concepts through simple experiments.
2. Design and develop the instruments for advanced studies.
3. Evaluate theoretical calculations using experimental observations.

Module:1	**Four Probe Method**	**6 hours**

Band gap determination of a semiconductor: Temperature dependent resistivity by four probe method

Module:2	**Dielectric Measurement**	**6 hours**

Determination of Curie's temperature of the given ferroelectric material

Module:3	**Quincke's method**	**4 hours**

Magnetic susceptibility using Quincke's method

Module:4	**Electron Diffraction**	**4 hours**

Determination of interplaner spacing of graphite-Electron diffraction

Module:5	**Mayer's Oscillation**	**2 hours**

Coefficient of Viscosity of liquid: Mayer's oscillation

Module:6	**Diffraction Grating**	**6 hours**

Determination of wavelength of mercury lamp spectral lines using plane diffraction grating

List of Challenging Experiments (Indicative)

1.	Hall Effect	**8 hours**
2.	Photovoltaics	**6 hours**
	Total Laboratory Hours	**42 hours**

Mode of evaluation: Lab performance, Viva-voce and FAT

Recommended by Board of Studies	11-08-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
PHY5004	Electromagnetic Theory	4	0	0	0	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. To understand how materials are affected by electric and magnetic fields.
2. To understand the relation between the fields under time varying situations and also the Maxwell equations.
3. To understand principles of propagation of uniform plane waves.

Expected Course Outcome: Students will be able to

1. Apply the knowledge of vector calculus and different coordinate systems to problems of electromagnetic theory.
2. Recall the concepts of electrostatics for different charge distribution systems.
3. Comprehend the basics of magnetostatics and their applications to understand the concepts of magnetism in magnetic materials.
4. Demonstrate the knowledge of electricity and magnetism to derive Maxwell's equations and be able to apply them to real electromagnetic systems.
5. Derive the electromagnetic wave equations from Maxwell's equations and calculate the energy carried by electromagnetic waves.
6. Analyze the propagation of electromagnetic waves and the phenomena of reflection, refraction, transmission of these waves in different mediums.
7. Realise the concepts of waveguides/transmission lines and modes of electromagnetic waves.
8. Develop understanding of dynamics of charges in electromagnetic fields and generation of electromagnetic radiations from moving charge systems such as dipole.

Module:1	Electrostatics	10 hours

Electric field–divergence and curl –electric potential –conductors–Laplace and Poisson equation–uniqueness theorem – separation of variables: Cartesian, spherical and Polar coordinate systems–field of
an electric dipole –polarization

Module:2	Electrostatic fields in Matter	6 hours

Gauss's law in dielectrics- Applications of Gauss Law –linear dielectrics – energy density – boundary value
problems.

Module:3	Magnetostatics	9 hours

Lorentz force–magnetic induction–electric current–equation of continuity –Biot-Savart law – magnetic
potential –magnetization –Ampere's law in magnetized material.

Module:4	Magnetostatics fields in Matter	7 hours

Faraday's law – Magnetic field due to solenoid and toroid–energy density – Properties of different magnetic materials-linear and nonlinear media

Module:5	**Electrodynamics**	**7 hours**
Maxwell's equations–boundary conditions–scalar and vector potentials–gauge invariance–Lorentz transformation- electromagnetic energy – Poynting's theorem.		
Module:6	**EM Wave Equation**	**8 hours**
Electromagnetic wave equation in free space – solution of 3D wave equation –propagation of EM waves in non – conducting media – waves in conducting media		
Module: 7	**Wave Guides**	**10 hours**
Reflection and refraction at the boundary of non-conducting media –Fresnel's coefficients – Brewster's angle and critical angle – reflection from a conducting plane. Transmission lines and wave guides; Dynamics of charged particles in static and uniform electromagnetic fields; Radiation from moving charges, dipoles and retarded potentials.		
Module:8	**Contemporary Issues**	**3 hours**
Industry Expert Lecture		
	Total Lecture hours:	**60 hours**

Text Book(s)

1.	Introduction to Electrodynamics, D. J. Griffith, 4th edition, Addison-Wesley Professional, Boston, 2012.
2.	Foundations of Electromagnetic Theory, J.R. Reitz., F.J. Milford and R. W. Christy, 2010, 4th edition, Pearson.

Reference Books

1.	Classical Electrodynamics, J.D. Jackson, 3rd edition, Wiley-India, Delhi, 2011
2.	Classical Electrodynamics, W. Greiner, 3rd edition, Springer, New York, 2010

Mode of Evaluation: **Assignments / Quiz(es) / CAT-I /CAT-II/ FAT**

Recommended by Board of Studies	11-08-2017		
Approved by Academic Council	No. 47	Date	15-10-2017

Course code:	Course title	L	T	P	J	C
PHY5005	Quantum Mechanics	4	0	0	0	4
Pre-requisite	NONE	Syllabus version				
	Total Number of Hours: 60	1.1				

Course Objectives:

1. Show an understanding of quantum mechanics in threedimensions;
2. Describe the structure of the hydrogen atom and show an understanding of quantisation of angular momentum
3. Apply techniques such as ladder operators for selected problems in quantum mechanics;
4. Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations

Expected Course Outcome: Students will be able to

1. Comprehend the basic concepts in quantum Mechanics of real world.
2. Recall the physical operations
3. Analyze the language of quantum mechanics in 1-dimensional and 3-dimensional problems
4. Apply the concept of angular momentum
5. Solve the effect of perturbations to the energy values to hydrogen-like problems
6. Explain the interactions between the system under consideration and external forces
7. Apply the concept of relativity in quantum Mechanics, Understand the complete picture of existence of matter and antimatter
8. Demonstrate contemporary issues and application

Module:1	Formalism : Schrödinger Formalism	6 hours

Physical interpretation of Uncertainty principles, Schrödinger's wave equation – physical interpretation and conditions on wave function – Eigenvalues and Eigen functions – Continuity equation and probability current density-Expectation values and Ehrenfest's theorem, Quantum Confinement Problems (1D, extension to 3D)

Module:2	Formalism : Operator and Path Integrals	10 hours

Linear operators-Hermitian operators and their properties – Commutation relations - Uncertainty relation – Dirac representations - Bra and Ket vectors - Hilbert space – Schrödinger, Heisenberg and Dirac pictures. Path integrals in quantum Mechanics, Double slit experiment using path integrals, Propagator, Schrödinger Equation from Path Integral. Free Particle and Normalization

Module:3	Quantum mechanical problems	10 hours

Harmonic oscillator – Operator method – Schrödinger equation for spherically symmetric potentials – Angular momentum operator – Condition on solutions and eigenvalues – spherical harmonics – Rigid rotor – Radial equation of Central potential – Hydrogen atom – Degenerate states.

Module:4	Angular Momentum Theory	8 hours

Angular momentum-Commutation relations- Eigenvalues of angular momentum J – Matrix representation of J – Addition of angular momentum – Clebsh-Gordan coefficients – Identical particles with spin – Pauli exclusion principle.

Module:5	Perturbation Theory	8 hours

Time independent (First order) perturbation theory for non-degenerate states – Removal of degeneracy – Zeeman effect and Stark effect, Stern- Gerlach Experiment – Variation method – WKB approximation.		
Module:6	**Scattering Theory**	**8 hours**
Theory of scattering- Scattering cross section- Optical theorem- Scattering by attractive square well potential- Scattering amplitude-Born approximation.		
Module:7	**Relativistic Quantum Mechanics**	**8 hours**
Klein-Gordon equation for a free particle and in an electromagnetic field – Charge and current densities – Plane wave solution – Dirac equation - Conserved current - -Free particle solution - Interpretation of Negative energy states		
Module:8	**Contemporary issues:**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**60 hours**

Text Book(s)

1. D.J. Griffiths, Introduction to Quantum Mechanics, 2014, 2nd Edition, Pearson Education.
2. EUGEN MERZBACHER, Quantum Mechanics, 2011, 3rd Edition, Wiley Publication

Reference Books

1. L.D. Landau and E.M. Lifshitz, Quantum Mechanics (Non-relativistic Theory), 2011, 3rd edition, Elsevier.
2. R. Shankar, Principles of Quantum Mechanics, Springer; 2nd ed. 1994. Corr. 14th printing 2014 edition
3. Hecht, K.T. , Quantum Mechanics, Series : Graduate Texts in Contemporary Physics, Springer publishing, 2012
4. Richard L. Liboff , Introductory Quantum Mechanics, Addison Wesley.
5. J. J. Sakurai, Modern Quantum Mechanics, Cambridge University Press, 2017 Edition
6. Richard Feynman and Albert R Hibbs, Quantum Mechanics and Path Integrals, DOVER publications, 2010 Emended Edition.
7. Albert Messiah, Quantum Mechanics(Two Volumes Bound As One), DOVER publications 2017 Edition

Mode of Evaluation: CAT / Assignment / Quiz / FAT

Recommended by Board of Studies	25-06-2020		
Approved by Academic Council	No. 59	Date	24-09-2020

Course code	Course title	L	T	P	J	C
PHY5006	Statistical Mechanics	3	0	0	0	3
Pre-requisite	Introduction to thermodynamics, Undergraduate level basics of classical mechanics and quantum mechanics	Syllabus version				
		v. 1.0				

Course Objectives:

To understand the concepts of statistical mechanics and its applications

Expected Course Outcome: Students will be able to

1. Analyze the concepts of microstate and macrostate of a model system
2. Recall the concept of ensembles and their comparison
3. Apply the concept of partition function to obtain macroscopic properties of thermodynamic systems
4. Define and compare the Fermi-Dirac and Bose-Einstein statistics
5. Explain the formation of White Dwarf Stars and the magnetic susceptibility of free electrons by applying Fermi-Dirac Statistics
6. Learn the Blackbody Radiation and Bose-Einstein condensation by applying Bose-Einstein Statistics

Module:1	Introduction to Thermodynamics and Statistical Mechanics	5 hours

Thermodynamic potentials, Maxwell's relations, Chemical potential, Entropy and probability, Micro and macro states, Phase space, Liouville's theorem

Module:2	Ensembles	6 hours

Microcanonical ensemble, Ideal gas, Gibb's paradox, Canonical ensemble, Ideal gas in canonical ensemble, Grand canonical ensemble, Ideal gas in grand canonical ensemble, Comparison of various ensembles

Module:3	Partition function	6 hours

Canonical and grand canonical partition function, Molecular partition function, Translational partition function, Rotational partition function, Vibrational partition function, Applications

Module:4	Classical and Quantum Statistics	6 hours

Maxwell-Boltzmann, Bose-Einstein & Fermi-Dirac statistics, Equipartition theorem

Module:5	Fermi gas	6 hours

High and low temperature limits, Electrons in metals, Magnetic susceptibility of free electrons

Module:6	Bose gas	7 hours

Black body radiation, Planck's radiation law, Phonons, Dulong and Petit's law, Einstein and Debye's theories of heat capacities, Bose-Einstein condensation

Module:7	Phase transition & Liquid Helium	7 hours

First and second order phase transitions, Ising model, Superfluidity, Diffusion equation, Introduction to non-equilibrium processes. Two fluid model of liquid Helium II, Super fluid phase of ^{3}He, Random walk and Brownian motion

Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours: 45 hours

Text Book(s)

1.	Statistical Mechanics and properties of Matter by E.S.R. Gopal — Student Edition, Ellis Horwood, 1974
2.	Fundamentals of Statistical and Thermal Physics, F. Reif—4th Edition, McGraw Hill, 1965
3.	Elementary Statistical Physics, C. Kittel, Dover Publications, 2004
4.	Statistical Mechanics, B. K. Agarwal, Melvin Eisner, 2nd Edition, New Age International (P) Ltd., 2007

Reference Books

1.	Statistical mechanics–3rd edition by R. K. Pathria, Paul D. Beale (2011)
2.	Statistical mechanics (2 ed., John Wiley) by K. Huang.
3.	Statistical Physics: Equilibrium and Non-equilibrium Aspects, J. K. Bhattacharjee, Allied Publishers (2001)
4.	Introduction to Statistical Physics, Silvio R. A. Salinas, Springer (2006)

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar

Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course code	Course title	L	T	P	J	C
PHY5007	General Physics Lab-II	0	0	4	0	2
Pre-requisite	General Physics Lab- I	Syllabus version				
		v. 1.1				

Course Objectives:

1. To make the students to understand experimental physics
2. To apply the theoretical knowledge for developing new devices

Expected Course Outcome: Students will be able to

1. Comprehend the concepts through simple experiments.
2. Design and develop the instruments for advanced studies.
3. Evaluate theoretical calculations using experimental observations.

Module:1	**Cornu's Interferometer**	**3hours**
Cornu's method- Young's modulus by elliptical/hyperbolic fringes		
Module:2	**e/m Measurement**	**3hours**
Determination of e/m by magnetron method / Thomson method		
Module:3	**Michelson Interferometer**	**4 hours**
Michelson interferometer-wavelength measurement		
Module:4	**Geiger Muller Counter**	**4hours**
G.M. Counter-Characteristics, Inverse square law & Absorption co-efficient		
Module:5	**Magnetic Measurements**	**6 hours**
B-H loop – Energy loss of a magnetic material – Anchor ring using B.G.		
Module:6	**Franck-Hertz experiment**	**6hours**
Franck-Hertz experiment for neon and mercury		

List of Challenging Experiments (Indicative)		
1.	Zeeman Effect	**8 hours**
2.	Arc Melting Furnace- Using Arc Melting Furnace Preparing the polycrystalline metal ingots and studying their various properties	**8 hours**
	Total laboratory hours	**42 hours**

Mode of evaluation: Lab performance, Viva-voce and FAT

Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Programme Elective

Course code:	Course title	L	T	P	J	C
		3	0	0	4	4
PHY 6001	Introduction to Solid State Physics	Syllabus Version				
Course prerequisites	None	v.1.0				

Course Objectives:

1. To provide an introduction to some basic concepts in solid state Physics.
2. To understand crystal structure; lattice vibrations, electron interactions, Fermi surface and models of electron dynamics.
3. To understand electron transport in metals semiconductors and super conductors.

Expected Course Outcome: Students will be able to

1. Comprehend basic model of electron dynamics in metals
2. Analyze higher and advanced models of electron dynamics in metals
3. Learn basic concepts of crystal structure and lattice arrangements
4. Recall lattice dynamics electron and lattice interactions
5. Explain basic electron mobility in a crystal structure
6. Apply semi classical picture of electrons in a crystal structure and its outcomes
7. Analyze electron dynamics in a semiconductors
8. Demonstrate electron dynamics in superconductors

Module:1	Drude Model of Metals	5 hours

DC & AC Electrical Conductivity, Hall Effect and Magneto resistance, Thermal Conductivity, Thermal Electric Effect

Module:2	Sommerfeld Theory of Metals	5 hours

Fermi Statistics and Fermi Surface, Electronic Heat Capacity - The Linear T-dependence, Consequences to the Transport Properties of Metals, Inadequacy of the Free Electron Model

Module:3	Crystalline Solids	5 hours

Some Basic Concepts of Crystal Structure: Basis and Lattice, Bragg Diffraction and Reciprocal Lattice Vectors, Kinematic Theory of Scattering, Brillouin Zone, Structure Factor, Atomic Form Factor.

Module:4	Lattice Dynamics	9 hours

Classical Theory of the Harmonic Crystal - The Harmonic Approximation, Specific Heat of A Classical Crystal: The Dulong and Petit Law, Normal Modes of a 1-D, 3D Monatomic Lattice, Normal Modes of a 1-D Lattice With a Basis, Quantum Theory of the Harmonic Crystal - Normal Modes and Phonons, High-Temperature Specific Heat, Low-Temperature Specific Heat, Intermediate Temperature Specific Heat: The Models of Debye and Einstein, Density of Normal Modes.

Module:5	Electrons in a Periodic Potential	5 hours

Bloch's Theorem, Some Consequential New Concepts, Crystal Momentum, Energy Bands, Mean Velocity, Fermi Surface, Density of States and van Hove Singularity, Electrons in a Weak Periodic Potential - A Simple Example, Fermi Surface in the Reduced Zone Scheme

Module:6	**Semiclassical Model of Electron Dynamics**	**5 hours**
Description of the Semiclassical Model, Basis for the Equation of Motion, Holes, Semiclassical Motion in Uniform Electric and Magnetic Field, Effective Mass, Quantization of Electron Orbits in a Magnetic Field, De Haas-van Alphen Effect		
Module:7	**Electrons in Semiconductor Crystals and Superconductivity**	**9 hours**
Energy Band Gap, Intrinsic Carriers, Impurity Conductivity: Donors and Acceptors, P-N Junction, Occurrence of Superconductivity, Meissner effect, Heat Capacity and Energy Gap, London Equation, Coherence Length, Flux Quantization in a Superconducting Ring, Type II Superconductors, Josephson Superconductor Tunnelling, DC Josephson Effect, AC Josephson Effect, BCS Theory		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
Total Lecture Hours: 45		
Text Books:		
1. C.Kittel, Introduction to Solid State Physics, John Wiley & Sons. 8th Edition 2004. 2. W. Ashcroft, N. David Mermin, Solid State Physics-Neil, Cornell University, Dan Wei., Holt, Rinehart and Winston. 3rd Edition 2016. 3. J.P. Srivastava, Elements of Solid State Physics, Prentice-Hall of India. 3rd Edition 2011.		
Reference Books:		
1. A. J. Dekker, Solid State Physics, Prentice Hall of India, 1 st Edition 2008. 2.M. Ali Omar, Elementary solid state Physics, Pearson Education, 3rd 2002. 3. M. A. Wahab, Solid State Physics, Narosa Publishing House. India 3rd Edition 2015.		
Mode of Evaluation: CAT / FAT/Assignment / Quiz / Project Seminar		

Recommended by Board of Studies		11-08-2017	
Approved by Academic Council	No. 46	Date	24-08-2017

Course code	Course title	L	T	P	J	C
PHY 6002	Nuclear and Particle Physics	3	0	0	4	4
Pre-requisite	Classical and Quantum Mechanics	Syllabus version				
		v. 01.1				

Course Objectives:

1. To know the basic properties of nucleus and visualize the characteristics
2. To Understand the fundamentals of shell model and the necessity of nuclear models
3. To know the standard particle model and nuclear synthesis of elements in stars

Expected Course Outcome: Students will be able to

1. Explain the basic properties and parameters of nucleus such as stability, size, shape, spin and electric-magnetic moments.
2. Comprehend the nature of nuclear forces.
3. Analyze the nuclear structure through different models.
4. Apply the different nuclear model to calculate the radioactivity decay process.
5. Learn the abundance of H, He, C, O, N and Fe in interstellar.
6. Recall the particle physics phenomena.
7. Demonstrate the mechanism of particle accelerators and detector technologies.

Module:1	Basic Nuclear Properties	6 hours

Nuclear size, shape, density, nuclear masses, segre chart, classification of nuclei, separation energy, binding energy, spin, parity of nuclear states, electric moments, magnetic dipole moment, quadrupole moment.

Module:2	Nuclear Forces	6 hours

Nuclear stability, nature of nuclear force, meson theory of nuclear force, reaction cross-sections, Q-value equation.

Module:3	Nuclear Models	7 hours

Single particle shell model – Evidences that led to shell model, its validity and limitations, Parabolic and square well.

Module:4	Nuclear Radiations	6 hours

Radioactivity-Gamow's theory, nuclear reaction in stars, Continuous β ray spectrum, Pauli's Neutrino hypothesis, detection of neutrino, Nuclear isomerism.

Module:5	Nucleosynthesis in Interstellar	6 hours

Helium burning, nuclear synthesis of elements in stars, Hydrogen chain, carbon chain, emission and escape of neutrinos from the core of stars, Chandrasekhar limit, evolution of neutron rich matter and supernova explosion.

Module:6	**Introduction to Particle Physics**	**6 hours**
Fundamental interactions, classification of elementary particles, Quantum numbers of different particles, Conservation laws, Production of pions and their mass determination, Quark Gluon model.		
Module:7	**Detectors and Accelerators**	**6 hours**
Interaction of charged particles and electromagnetic radiation with matter. Basic principles of particle detectors, Geiger-Muller counter, scintillation detectors. Particle accelerators – LINAC, cyclotron, synchrotron, Pelletron.		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours: 45 hours

Text Book(s)	
1.	S.B.Patel, Nuclear Physics, An Introduction, 2nd New edition edition, 2011, Anshan Ltd.
2.	Kennath S Krane, Introductory Nuclear Physics, 2008, 1st edition, wiley publications.
3.	David Griffths, Introduction to particle physics, 2008, 2nd Revised edition ,Willey VCH, N. Delhi
4.	B.R. Martin and G. Shaw, Particle Physics, 3rd edition, 2008, John Wiley & Sons, Manchester Physics
Reference Books	
1.	Harwit, M. Astrophysical Concepts, 2006,4th edition, Springer.
2.	Irving Kaplan, Nuclear Physics, 2002, Narosa Publications, New Delhi.
3.	W.R.Leo, Techniques for Nuclear and particle Physics Experiments, 2009, 2nedition, Springer India pvt ltd.
4.	Hans Ohanian ,Gravitation and space time, 2013, 3rd Edition, , Cambridge University Press
5.	Donald A Perkins, Particle Astro Physics (Oxford Master Series in Physics), 2008, 2ndedition, OUP Oxford. Oxford
Mode of Evaluation: CAT / Digital Assignment / Quiz / FAT / Project	
J Component Projects	
1.	Corrections to Binding energy
2.	Finding out unknown nuclide mass
3.	Mesons in cosmic rays- an analysis
4.	Possibility for cold fusion- an attempt
5.	Parity violation
	Total Non-Contact Hours: 60 hours
Mode of evaluation: Seminar	

Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code:	Course title	L	T	P	J	C
PHY6003	Atomic and Molecular Physics	3	0	0	4	4
Pre-requisite	None	Syllabus version				
		v1.0				

Course Objectives:

1. To gain knowledge about the basic concepts and methodology in atomic and molecular physics.
2. To understand in detail the structure of atoms and molecules by studying various spectroscopic methods.
3. To study the spectroscopic techniques for analyzing different atomic and molecular spectra.

Expected Course Outcome: Students will be able to

1. Analyze different atomic structure and will be able to understand fine- structure and hyperfine- structure spectra.
2. Recall different coupling schemes and their interactions with magnetic and electric fields.
3. Explain rotational and IR spectroscopy and apply the techniques of microwave and infrared spectroscopy to analyze the structure of atoms and molecules.
4. Apply the principle of Raman spectroscopy and its applications in various disciplines of science & technology.
5. Explain different magnetic and electron spin resonance spectroscopic techniques and its applications.
6. Demonstrate the contemporary issues on atomic and molecular physics.
7. Evaluate problems related to different atomic& molecular systems by carrying out the project work.

Module:1	Atomic Spectroscopy	5 hours

Atomic Spectroscopy: Quantum states of electrons in atoms- Spectroscopic terms and selection rules- spin orbit interaction- fine structure –Landau g factor –Equivalent and nonequivalent electrons.

Module:2	Different coupling schemes	5 hours

Zeemen effect and Paschen Back effecting oneelectron system-LS and JJ coupling schemes- Hunds rule- Derivation of interaction energy-Examples of LS and JJ coupling- L landeintervel rule- Stark effect hyperfine structure- width of spectral lines.

Module:3	Molecular spectroscopy	6 hours

Molecular spectroscopy : Introduction to rotation of molecules – rotational spectra of diatomic molecules –rigid and non rigid rotator – frequency of spectral line – effect of isotopic substitution – rotational spectra of polyatomic molecules – linear, symmetric and asymmetric top molecules – problems

Module:4	IR spectroscopy	6 hours

Introduction to IR – vibrating diatomic molecules (harmonic and anharmonic) – diatomic vibrating rotator (rigid and non rigid) – linear and symmetric topmolecules – modes of vibrations of atomic in polyatomic molecules – problems

Module:5	Raman Spectroscopy	6 hours
Raman Effect – Quantum and Classical theory of Raman Effect – Probability of energy transition – vibration and rotational Raman spectra – problems		

Module:6	Electronic Spectroscopy	6 hours
Electronic spectra of diatomic molecules – intensity of spectral lines – Franck – Condon principle – dissociation energy and dissociation products –rotation fine structure of electronic vibration transitions – the Fortrat diagrams – predissociation –problems.		

Module:7	Magnetic Resonance Spectroscopy	9 hours
Introduction to NMR – Quantum mechanical description of NMR - spin-spin and spin – lattice relaxation – coupling constant – chemical shift – causes of chemical shift – origin of ESR and resonance condition – Quantum mechanical theory of ESR – problems.Principle, Experimental technique and applications of Microwave, FTIR, Raman, UV, ESR and NMR spectroscopy.		

Module:8	Contemporary issues:	2 hours
Lecture by Industry Experts		

Total Lecture hours:45 hours

Text Book(s)

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash – McGraw Hill Education, 4th Edition (1994)
2. Elements of Spectroscopy by S.L. Gupta, V. Kumar and R.C. Sharma – PragatiPrakashan, 27th Edition (2015)
3. Spectroscopy by Sham K. Anand and Gurdeep R. Chatwal – Himalaya publishing House, 5th Edition (2013)

Reference Books

1. Spectrometric identification of organic compounds by Robert M. Silverstein, Francis X. Webster and David J. Kiemle – Johnwiley& Sons Inc., 7th Edition (2005)
2. Molecular Spectroscopy by Jack D. Graybeal – McGraw Hill Inc., 2nd Edition (1993)
3. Organic Spectroscopy (English language book society student editions) by William Kemp – Palgrave Macmillan, 3rd Edition (1991)

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

J Component Projects (Indicative)

1.	Spectroscopic terms and selection rules
2.	Zeemen effect and Paschen Back effecting
3.	Analysis of Microwave spectrum
4.	Analysis of FTIR spectrum
5.	Analysis of UV spectrum
6.	Analysis of Raman spectrum
7.	Analysis of ESR spectrum
8.	Analysis of NMR spectrum

Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course Code:	Course title	L	T	P	J	C
PHY6004	Basic Electronics	3	0	0	4	4
Pre-requisite	None	Syllabus version				
		v. 1.1				

Course Objectives:

1. To impart the knowledge of Circuit Analysis
2. To understand the construction and working function of semiconductor devices
3. To apply their knowledge to build new devices

Expected Course Outcome: Students will be able to

1. Analyze the circuit and appreciate the basic physics behind the advanced devices
2. Comprehend the structure and working of different transistors
3. Apply the knowledge of transistor to predict the characteristics of op-amps
4. Design the filters by the knowledge of op-amps
5. Evaluate the Op amp predictions by constructing different oscillators
6. Design composite digital devices for various applications
7. Demonstrate the design and working of Microprocessors

Module:1	Circuit Theorems and Special Diodes	7hours

Kirchoff's laws for current and voltage – Thevenin's and Norton's theorems, superposition and reciprocity theorems with examples – p-n junction diodes – Zener diode – tunnel diode – Schottky barrier diode – varactor diode-photodiode – solar cell – photodiodes and transistors – light emitting diode – semiconductor laser – UJT – opto-couplers.

Module:2	Special semiconductor devices	6 hours

JFET- Structure and working – I -V Characteristics under different conditions – biasing circuits – CS amplifier design – ac analysis – MOSFET: Depletion and Enhancement type MOSFFT – UJT characteristics – relaxation oscillator – SCR characteristics – application in power control DIAC, TRIAC.

Module:3	Basics of operational amplifier	6 hours

Operational amplifier characteristics – inverting and noninverting amplifier – instrumentation amplifier – voltage follower –integrating and differential circuits – log & antilog amplifiers – op amp as comparator – Voltage to current and current to voltage conversions

Module:4	Filter Circuits	4 hours

active filters: low pass, high pass, band pass & band rejection filters-Solving simultaneous and differential equations.

Module:5	Oscillators	5hours

Oscillator principle – oscillator types – frequency stability, RC oscillators – phase shift oscillator – Wein bridge oscillator – LC tunable oscillators – limitations – multivibrators – monostable and astable – 555 IC timer – sine wave and triangular wave generation – crystal oscillators and their applications.

Module:6	Digital Circuits Logic gates	6 hours

De Morgan's law, binary adder, comparators, decoders, multiplexers. Flip-flops: RS flip-flop, JK flipflop, JK master-slave flip-flops, T flip-flop, D flip-flop. Shift registers – synchronous and asynchronous counters – registers – A/D and D/A conversion.		
Module:7	**Microprocessors**	**9 hours**
Introduction to microprocessors, Organization and Architecture of Intel 8086. Signal diagram, explanation of various functional modules of 8086.Flag Register and explanation of various flags with suitable examples, Interrupts, Stack. Instruction set: Instruction formats, addressing modes, and instruction groups of 8086, Data transfer, Arithmetic, logical, branch, I/O and machine control group. Interfacing and programming examples: Interfacing stepper motor, traffic lights to 8086. Assembly Language Programs for sorting data, arranging data in Ascending or Descending, BCD addition.		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours: 45 hours

Text Book(s)	
1.	R. L. Boylsted and L. Nashelsky, Electronic Device and Circuits, 2015, 11th edition, Pearson Education India.
2.	Albert Malvino, David J Bates, Electronics Principles, 2017,7th edition, Tata McGraw-Hill, New Delhi
3.	Barry b. Brey, The Intel Microprocessors, 8th edition, 2012, Pearson Education India.
Reference Books	
1.	J. Milman and C.C. Halkias, Electronic Devices and Circuits, 4the edition, 2015, McGraw-Hill, New Delhi.
Mode of Evaluation: CAT / Assignment / Quiz /Project/ FAT	
J Component Projects (Indicative)	
1.	Characteristics of Various diodes and transistors
2.	Applications of MOSFET, SCR
3.	Constructions and analysis of differential and integrator circuits using OP AMP
4.	Solving simultaneous equations using OP AMP
5.	Generation of wave patterns
6.	Study of the attenuation characteristics of Phase shift and Wein bridge networks
7.	Design of Asynchronous and synchronous counters
Total Laboratory Hours	60 Non Contact hours
Mode of evaluation: Seminar	

Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course Code	Course title	L	T	P	J	C
PHY6005	Advanced Solid State Theory	3	0	0	0	3
Pre-requisite	Introduction to Solid State Physics, Quantum Mechanics, Mathematical Physics, Statistical Mechanics	Syllabus version				
		v.1.0				

Course Objectives:

1. The course is to give a broad phenomenological overview and background to cutting-edge topics of modern condensed matter physics.
2. Students will learn the advanced topics in solid state theory to apply in materials science research.
3. The goal is to address many-body effects in solid state systems.

Expected Course Outcome: Students will be able to

1. Understand the electronic states govern the material properties microscopically.
2. Learn the free-electron metallic states as the simplest itinerant electron system.
3. Comprehend the electron states of solid crystals become Bloch states.
4. Apply many-body effects among electrons reduce the Coulomb-repulsion energy.
5. Understand the basics of first-principles electron theory to describe electronic states non-empirically.
6. Demonstrate the above mentioned ideas from industrial perspective.

Module:1	Beyond one-electron approximation	8 hours

Introduction to many-electron problem, Hartree equations, Hatree-Fock equations: Ground state energies, ionization energies and transition energies, Density functional theory and Kohn-Sham equations

Module:2	Band theory of crystals	8 hours

Basic assumptions, Tight-binding method (LCAO): description of simple lattices, illustrative applications of tight-binding scheme, Orthogonal plane wave method (OPW), Pseudopotential method, Augmented plane wave method (APW)

Module:3	Elementary excitations	10 hours

Interacting electron gas (Plasmons), Electron-hole interaction in insulators and semiconductors (Excitons): ground state of the insulator in Bloch and Wannier representation, exciton representation, Wannierexcitons, Frenkelexcitons, Ion-ion interactions (Phonons): classical equations of motion, Normal coordinates, specific heat, phonon dispersion relations, phonon density of states, Spin-spin interaction (magnons)

Module:4	Electron-Phonon interaction: Transport phenomena	4 hours

Interaction of electrons with acoustics phonons, Electron-phonon interaction in polar solids (polarons), Boltzmann transport equation: relaxation time approximation and variational method, transport equations, Transport in Metals and Semiconductors

Module:5	**Electron-Photon interaction: Optical properties**	**4 hours**
Complex dielectric constant, Drude theory for optical properties of free carriers in metals, Direct and Indirect transitions in semiconductors, Two-photon absorption, Exciton absorption		
Module:6	**Phonon-Phonon interaction: Thermal Properties**	**4 hours**
Introduction, frequency shift and lifetime of phonons, Anharmonic contributions to the Free energy, Thermal conductivity of the lattice		
Module:7	**Localized states and Disorder**	**5 hours**
Point imperfections: crystal field theory, defect statistics, disorder equilibria, Optical transitions at imperfections, Bound excitons, Kondo effect		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours: 45 hours

Text Book(s)

1. Introduction to Solid State Theory, Otfried Madelung, Springer (2008).
2. Solid State Physics, Giuseppe Grosso and Giuseppe Pastori Parravicini, Elsevier (2012)
3. Quantum Theory of Solids, Charles Kittel, Wiley (1987)
4. Solid State Theory, Walter A. Harrison, Dover Publications (2012).

Reference Books

1. Advanced Solid State Theory, Thomas Pruschke, Morgan and Claypool (2014).
2. Advanced Solid State Physics, Philip Phillips, Cambridge University Press (2012).
3. Solid State Physics: Introduction to the Theory, James Patterson and Bernard Bailey, Springer (2010).
4. Many-Body Quantum Theory in Condensed Matter, Henrik Bruus and Karsten Flensberg, Oxford University Press (2005)

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar			
Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course code	Course title	L	T	P	J	C
PHY 6006	Nanomaterials and its Applications	3	0	0	0	3
Pre-requisite	None	Syllabus version				
		v. 1.0				

Course Objectives:

To enable the students to understand the concepts of nanomaterials and improve their knowledge in synthesis methods and characterization for further advanced research studies**.**

Expected Course Outcome: Students will be able to

1. Describe the basic science behind the properties of materials at the nanometer scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials
2. Explain different types of nanomaterials including carbon and metal based materials
3. Synthesize nanomaterials both from top-down and bottom-up routes and how to develop an engineering related devices
4. Identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature.
5. Evaluate state-of-the-art characterization methods for nanomaterials, and determine nanomaterial safety and handling methods required during characterization.
6. Apply interdisciplinary systems of engineering approaches to the field of bio and nanotechnology systems.

Module:1	Introduction to Nanomaterials	4 hours

Overview of Nanotechnology, Quantum effect, Nanotechnology in nature. Properties: Physical (Optical, mechanical, dielelectric, photocatalytic, magnetic properties), Chemical and biological properties of nanomaterials, Effects on structure, ionization potential, melting point, and heat capacity, Electronic structure at nanoscale, Magnetism at Nanoscale

Module:2	Types of Nanomaterials	4 hours

Carbon based materials (nanotubes and fullerene), metal based materials (quantum dots, nanogold, metal oxide), Nanocomposites, nanoporous materials and Dendrimers

Module:3	Nanomaterials Synthesis	6 hours

Physical approaches:- CVD, PVD, Molecular beam epitaxy, Vapor (solution) liquid-solid growth (VLS or SLS), mechanical milling, Inert gas condensation technique, spray pyrolysis, lithography technique.

Module:4	Chemical Approaches	5 hours

Self-assembly, self-assembled monolayers (SAMs), Langmuir-Blodgett (LB) films, organic block copolymers, emulsion polymerization, template based synthesis, and confined nucleation and/or growth.

Module:5	Biomimetric Approaches	7 hours

Polymer matrix isolation, and surface-templated nucleation and/or crystallization. Electrochemical

Approaches: Anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition		
Module:6	**Characterization Techniques**	**7 hours**
(Structural, Morphological and Thermal studies): X-ray diffraction (XRD): (Powder and single crystal diffraction), Thermal analysis (DTA-TGA), Spectroscopic studies(FTIR and NMR), Microscopic studies(SEM,TEM and AFM)		
Module:7	**Nanomaterials Applications**	**10 hours**
Characterization Techniques: (Electrical, Magnetic and Optical studies):- Electrical studies (Dielectric studies and Four probe method), Magnetic studies (VSM and SQUID) and Mechanical studies (Nano indentation), UV-vis spectroscopy (liquid and solid state) **Nanomaterials Applications:** Energy storage and generation, Molecular Electronics and Nanoelectronics,, Nanosensors, Catalysts, Biological Applications, Carbon Nanotube, Nanophotonics, Green nanotechnology.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours: 45 hours

Text Book(s)

	Text Books:
1.	Charles P. Poole and Frank J. Owens, "Introduction to Nanotechnology", John Wiley and Sons, New Delhi, 2003
2.	Cao Guozhong, "Nanostructures and nanomaterials: Synthesis, properties and applications", Imperial college press, 2007
3.	Carl.C.Koch, "Nanostructured materials, processing, properties and applications, NFL publications, 2007
4.	C.N.R.Rao, P.J.Thomas and U.KulkarniNanomaterials: Synthesis, properties and applications, Springer Verlag (2007)
5.	Guozhong Cao, Ying Wang, Nanostructures and Nanomaterials, 2nd Edison, Imperial College Press in 2004,USA
	Zhen Guo, Li Tan, Fundamentals and Applications of Nanomaterials, Artech house, 2009

Reference Books

1.	T. Pradeep, Nano: The Essentials Understanding Nanoscience and Nanotechnology, New Delhi, 2007, reprinted, McGraw Hill Education, New Delhi 2010
2.	R.Vajtai, Handbook of nanomaterials, Springer publications,Verlag Berlin Heidelberg, 2013
3.	Dieter Vollath,Nanomaterials: An Introduction to Synthesis, Properties and Applications, Wiley, 2nd Edition,2013
4.	B.Bhusha, D.Luo, S.R.Schricker, W. Sigmund, S. Zauscher, Handbook of Nanomaterials Properties, Springer publications, 2014

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar

Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course code:	Course title	L	T	P	J	C
PHY6007	Optoelectronics	3	0	2	0	4
Pre-requisite	Basic Solid State Physics	Syllabus version				
		v. 1.0				

Course Objectives:

1. Upon learning this subject, the students will have been exposed to the fundamental principles behind the operation of various light sources as well as detectors.
2. They would have also learned about how light is modulated and subsequently launched into an optical fiber.
3. The students would have come to know about the problems currently faced with fiber optic communications system and their mitigations.
4. They would have also learned about the important phenomena that arise in nonlinear optical regime.

Expected Course Outcome: Students will be able to

1. Explain the working mechanism of various types of LEDs
2. Comprehend the basics of coherent light source (LD)
3. Recall the working principles of various types of photo detectors
4. Design the various types of modulators
5. Apply the knowledge of various types of sources and detectors for designing a typical optical fiber communication system.
6. Analyze the various types of fiber sensors
7. Learn the fundamentals of nonlinear optics and then to introduce the basics of solitons
8. Apply the linear and nonlinear optics for designing a soliton based fiber optic communication system

Module:1	Incoherent Source	4 hours

Semiconductor – basics - direct and indirect bandgap semiconductors – light emitting diode (LED) - internal and external quantum efficiency – LED characteristics – types of LEDs (Self-study) – problems.

Module:2	Coherent Source	4 hours

Lasers – basics –laser diode (LD) – internal and external quantum efficiency – laser modes (Self-study) – problems.

Module:3	Detectors	8 hours

Photodiode – quantum efficiency – responsivity – long-wavelength cut-off – p-i-n photodiode – avalanche photodiode (APD) – heterojunction photodiodes – separate absorption and multiplication (SAM) APD – superlattice APD (Self-study) – phototransistors (Self-study) – problems.

Module:4	Modulators	8 hours

Introduction – optical polarization – birefringence – retardation plates (Self-study) – electro-optic modulator (EOM) - Pockels effect - Kerr effect – longitudinal and transverse EOMs - acousto-optic modulator (AOM) – Raman -Nath modulator – Bragg modulator – magneto optic modulator (MOM) (Self-study) – problems.

Module:5	Fiber Optic Communication Systems	5 hours

Optical fibers – basics – digital systems and analog systems – system architecture: point to point links – distribution networks – local area networks.

Module:6	Fiber Sensors	6 hours

Fiber optic sensors – intensity modulated sensors – phase modulated sensors – Fiber optic Mach- Zehnder interferometric sensor–Fiber based plasmonic sensors.

Module:7	**Nonlinear Optics and Soliton based Fiber Optic Communications System**	**8 hours**

Introduction – harmonic generation – relationship between refractive index and light intensity in a nonlinear regime – second harmonic generation (SHG) – factors influencing SHG- optical parametric oscillator (Self-study).

Nonlinear effects in optical fibers – Kerr effect – self-phase modulation – modeling pulse propagation in optical fibers – nonlinear Schrödinger equation (Self-study) – soliton communication system.

Module:8	**Contemporary issues:**	**2 hours**

Lecture by Industry Experts

Total Lecture hours: 45 hours

Text Book(s)

1.	R. P. Khare ,Fiber optics and optoelectronics, 2004, First Edition, Oxford University Press.
2.	Jasprit Singh, Optoelectronics- An Introduction to Materials and Devices, 1998, McGraw-Hill International Edition.
3.	S. O. Kasap, Optoelectronics and Photonics-Principles and Practices, 2001, Prentice-Hall, Inc., New Jersey.
4.	G. P. Agrawal, Nonlinear Fiber Optics, 2013, 5th edition, Academic Press.

Reference Books

1.	J. Wilson and J.F.B. Hawkes, Optoelectronics – An Introduction, 2003, 3rd Edition, Indian reprint, Prentice-Hall of India.
2.	Djafar K. Mynbaev and Lowell L. Scheiner, Fiber-optic communications technology, 2011, Addison Wesley Longman(Singapore) Pte Ltd, Indian reprint.
3.	Pallab Bhattacharya, Semiconductor Optoelectronic Devices, 2004, Prentice-Hall of India Pvt. Ltd, Second Edition.
4.	L. F. Mollenauer and J. P. Gordon, Solitons in Optical Fibers: Fundamentals and Applications, 2006, Academic Press.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Experiments

1.	Diffraction through a single and double slit	2 hours
2.	Determination of refractive index of a solid and liquid	2 hours
3.	Measurement of Laser beam parameters	2 hours
4.	Construction of Michelson interferometer	2 hours
5.	Measurement of fiber coupling loss and bending loss	2 hours
6.	Determination of fiber attenuation by cut-back method	2 hours
7.	Determination of numerical aperture and mode field diameter	2 hours
8.	Characteristics of a Photo-diode and an LDR	2 hours
9.	Characteristics of an LED	2 hours
	Total Laboratory Hours	18 hours

Mode of assessment: CAT / FAT

Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course code:	Course title	L	T	P	J	C
PHY6008	Lasers and Fiber Optics	3	0	0	0	3
Pre-requisite	Spectroscopy	Syllabus version				
		v. 1.0				

Course Objectives:

1. To understand the basic concepts of lasers and their characteristics and to apply these concepts in real-world environment.
2. To expose the students to the optical fiber communication systems and to explain the importance and advantages of optical fiber communications, basic problems and possible mitigations.

Expected Course Outcome: Students will be able to

1. Explain the basic concepts of lasers
2. Learn the various properties of laser light
3. Analyze the various types of laser systems
4. Comprehend the importance of optical resonators in lasers and to study the laser modes
5. Analyze the various physical mechanisms for realizing pulses lasers
6. Recall the basic structure of an optical fiber and the pulse propagation in optical fibers
7. Explain the various types of dispersions in optical fibers and their mitigations by deploying various types of optical fibers
8. Design various types of laser systems and optical fiber communication systems

Module:1	Fundamentals of Lasers	5 hours

Interaction of light and matter– Einstein's theory –two, three and four level systems– building lasers–threshold condition.

Module:2	Properties of Laser Light	5 hours

Coherence: spatialandtemporal–line width– spectral width –connection to uncertainty principle – directionality– intensity– laser rate equations (Self-study)

Module:3	Laser Systems	7 hours

Solidstatelasers–Nd:YAG–colourcenterlaser –liquidlaser –dyelaser –gaslasers– He:Nelaser(Self-study)–CO_2laser– excimer laser–semiconductorlaser–quantum well laser –free electron laser(Self-study).

Module:4	Optical Resonators and Modes	7 hours

Need for resonators–types of resonators– Fabry-Perot resonator– resonatormodes– longitudinalmodes–quality factor – cavity finesse –transversemodes – Gaussian beam (Self-study).

Module:5	Pulsed Lasers	7 hours

Importance of pulsedlasers –Q-switching – Methods –Electro-optic shutter –Acousto- optic shutter(Self- study) – Modelocking – Two lasingmodes–*N* Lasingmodes – Pulse width– Pulse Repetition Time –Pulse Energy – Mode locking– Active mode locking – Passive mode locking (Self-study).

Module:6	Introduction to Fiber Optics	5 hours

Optical fibers – basic structure – light propagation in a step index fiber – conditions – linear effects – attenuation – measuring attenuation – dispersion – inter and intra – fiber modes – V-parameter – mode field diameter.

Module:7	**Mitigations to Linear Effects Novel Fibers**	**7 hours**
Mitigations to attenuation – repeaters – optical amplifier – semiconductor optical amplifier – Erbium doped fiber amplifier – fiber Raman amplifier – mitigations to dispersion – dispersion shifted fiber – non- zero dispersion shifted fiber – dispersion flattened fiber – dispersion compensating fiber. Fiber Bragg grating – Dispersion compensation –Photonic crystal fiber – Photonic Devices		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours:45 hours

Text Book(s)	
1.	WilliamT.Silfvast , LaserFundamentals, 2009,CambridgeUniversityPress.
2.	DjafarK.MynbaevandLowellL.Scheiner, Fiber-opticcommunications technology, 2011,AddisonWesleyLongman(Singapore)PteLtd, Indianreprint.
3.	JeffHecht,Understanding Lasers, 2008, 3rd Edition,JohnWiley.
4.	AjoyGhatak and K.Thyagarajan, Introduction to Fiber Optics, 2006, Cambridge University Press.
Reference Books	
1.	Richard S.Quimby, Photonics andLasers,2006, Wiley Interscience.
2.	Gerd Keiser, Optical Fiber Communications, 2015, McGraw Hill.
3.	F. Graham Smith, Terry A. King and Dan Wilkins, Optics andPhotonics:AnIntroduction,2007, Second Edition,JohnWiley.
4.	OrazioSvelto, Principles ofLasers, 2010,FifthEdition,Springer.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course code	Course title	L	T	P	J	C
PHY6012	Solid State Magnetism	3	0	0	0	3
Pre-requisite	Introduction to Solid State Physics	Syllabus version				
		v. 1.00				

Course Objectives:

1. To know the basic science of magnetism and visualize the applications.
2. To understand the theory of magnetization dynamics and the necessity magnetic anisotropy.
3. To know MCE at the first order & second order phase transitions for refrigeration applications.

Expected Course Outcome: Students will be able to

1. Explain the fundamentals of magnetism by molecular field theory and band theory.
2. Apply solid state physics to appreciate domain wall mechanism.
3. Analyze the magnetization dynamics through various characterization techniques.
4. Interpret the physical origin of magnetic anisotropy and its effects.
5. Evaluate the magnetostriction for various single and polycrystalline materials.
6. Recall the mechanism of Magnetocalorics and Magnetoelectronics

Module:1	Theory of Magnetism	6 hours

Introduction- Maxwell equations - magnetic moments of electron & atoms – theory of diamagnetism – classical & quantum theory of para magnetism- molecular field theory – exchange interactions – band theory – ferromagnetic alloys- theories of ferromagnetism – anti-ferro magnetic alloys – Rare earths.

Module:2	Domain wall mechanism	6 hours

Introduction – Domain wall structure- domain wall observation methods (Bitter, TEM, SEM with polarization Analysis) – magnetostatic energy & domain structure – micro magnetics- domain wall motion & hindrances – single-domain vs multi-domain behavior- coercivity of fine particles- magnetic reversal by spin rotation & wall motion- preparation and structure of thin films- domain walls & domain in films.

Module:3	Magnetization Dynamics	7 hours

magnetization in low fields & high fields – shapes of hysteresis loops- vibrating sample magneto meter (VSM) – superconducting quantum interference device (SQUID) - eddy current- domain wall velocity- time effects- magnetic damping- magnetic resonance (NMR ,EPR and FMR).

Module:4	Magnetic Anisotropy	6 hours

Physical origin of crystal anisotropy- Anisotropy measurements – shape and mixed anisotropies- magnetic annealing- magnetic irradiation- exchange anisotropy.

Module:5	Magnetostriction	6 hours

Magnetostriction of single and polycrystals – physical origin of magnetostriction- effect of stress on magnetic properties &magnetostriction- application of magnetostriction.

Module:6	Magnetocalorics	6 hours

Theory of magnetocaloric effect (MCE)- MCE at first order & second order phase transitions- Anisotropic and magnetoelastic contribution to the MCE- MCE and elastocaloric effect- adiabatic demagnetization- direct and indirect measurement methods for magneto caloric properties.

Module:7	**Magnetoelectronics**	**6 hours**
Principles of magnetic recording- introduction to magneto electronics and magneto impedance - spin for novel functionalities- key issues in magneto electronics for applications – GMR.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
		Total Lecture hours: 45 hours

Text Book(s)	
1.	Jiles David, Introduction to magnetism and magnetic materials,3rd edition, 2015, London: Chapman & Hall.
2.	B. D. Cullity, C.D. Graham, Introduction to Magnetic Materials, 2008, willey IEEE Press ,Newyork.
3.	K.H. J. Buschow, Handbook of Magnetic Materials, 1 edition, 2014, North Holland Publisher.
4.	A M Tishin, Y I Spinchkin, The Magneto caloric Effect and its Applications, 1 edition, 2013 CRC Press.
Reference Books	
1.	Allan H Morrish, The Physical Principle of Magnetism, 2001, willey- IEEE press.
2.	R. C. O' Handley, Modern Magnetic Materials: Principles and Applications, 1999,willey, Newyork.
3.	Mark Johnson, Magneto electronics, 2004, 1 edition, Academic Press.
4.	D. H. Martin, Magnetism is Solids, 1967, The MIT press Ltd
5.	Chikazumi, S , Physics of Ferromagnetism, 2nd edition, 1997, Clarendon Press

Mode of Evaluation: CAT / Digital Assignment / Quiz / FAT / Project

Recommended by Board of Studies	04-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019