B.Sc. PHYSICS HONORS
(AS PER NEP – 2020)

SYLLABUS

(For the batches joining in 2024–2025 and afterwards)

DEPARTMENT OF PHYSICS

The Gandhigram Rural Institute–Deemed to be University

Gandhigram – 624 302

Dindigul District –Tamil Nadu, India

CONTENT PAGE

BOARD OF STUDIES MEMBERS

Dr.S.Ariponnammal Professor and Head, Department of Physics, GRI (DTBU) Gandhigram. – Chairperson	Dr.k.Marimuthu Associate Professor , Department of Physics, GRI (DTBU) Gandhigram. – Member
Dr.G.Muralidhran Professor , Department of Physics, GRI (DTBU) Gandhigram. – Member	Dr.P.Nithiananthi Assistant Professor , Department of Physics, GRI (DTBU) Gandhigram. – Member
Dr.P.Vickraman Professor , Department of Physics, GRI (DTBU) Gandhigram. – Member	Dr.C.Rajamohan Assistant Professor , Department of Physics, GRI (DTBU) Gandhigram. – Member
Dr.M.Sivakumar Professor , Department of Physics, Alagappa University Karaikudi – Member	Dr.N.Ponpandian Professor and Head, Department of Nanoscience and Technology Bharathiar University Coimbatore. – Member

DEPARTMENT OF PHYSICS
THE GANDHIGRAM RURAL INSTITUTE (DEEMED TO BE UNIVERSITY)
MINUTES OF THE BoS MEETING

Place : I M.Sc Classroom **Date: 25.06.2024 Time:11.00 am**

Members Present:

1. Dr.S.Ariponnammal - Chairman
2. Dr.G.Muralidharan - Member
3. Dr.P.Vickraman - Member
4. Dr.K.Marimuthu - Member
5. Dr.P.Nithiananthi - Member
6. Dr.C.Raja Mohan - Member
7. Dr. M.Sivakumar – External Subject Expert
8. Dr.N.Ponpandian – External Subject Expert

The Board of Studies meeting has been held on 25th June 2024 at 11.00 am in the Department of Physics. All the Department BoS members and two external members were present. The BoS members have gone through the syllabi of B.Sc.,(As per NEP ie., four year programme,) M.Sc. and Ph.D. programmes and revisited in terms of (i) Content of the syllabus in unit wise. (ii). Quality of the content with reference to CSIR-NET and other national level and other competitive examinations, (iii) Strengthening of the syllabus content (iv) No. of credits course wise and the corresponding lecture hour were deliberated and approved in the board of studies. The chairman of the BoS is authorized to make minor changes as per the suggestions of the BoS members. The appropriate changes, new incorporations are added in the syllabi and the details are given in the annexure.

25/6/2024
Dr.S.Ariponnammal

Dr.G.Muralidharan

Dr.P.Vickraman

25/6
Dr.K.Marimuthu

25/6/24
Dr.P.Nithiananthi

Dr.C.Raja Mohan

25/06/2024
Dr. M.Sivakumar

25/6/24
Dr.N.Ponpandian

Percentage of Revision in B.Sc Physics Honors

Scheme of the Programme

FIRST SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 1	24PHUC1101	Mechanics and Properties of Matter	3	Revised	20%
	24PHUC1102	Practical – I	1	Revised	20%
Multidisciplinary - I	24PHUI1101	Electronics for Computer Technology	3	New - 1	100%
	24PHUI1102	Renewable Energy and Thermal Systems	3	New - 2	100%
		TOTAL	**21**		

SECOND SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 2	24PHUC1203	Optics	3	Revised	50%
	24PHUC1204	Practical II	1	Revised	20%
Multidisciplinary- II	24PHUI1202	Concept of Physics in Sports	3	New - 3	100%
		TOTAL	**23**		

THIRD SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major – 3	24PHUC2105	Heat and Thermodynamics	3	Revised	30%
	24PHUC2106	Practical - III	1	Revised	20%
Major – 4	24PHUC2107	Renewable Energy Sources	4	Revised	60%
Multidisciplinary - III	24PHUI2101	Electronics Communication Media	3	New – 4	100%
	24PHUI2102	Physics in Day – today Life	3	New - 5	100%
	24PHUI2103	Biomedical Instruments	3	New - 6	100%
		TOTAL	**23**		

FOURTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 5	24PHUC2208	Electric Circuits and Magnetic Properties	4	New	100%
Major – 6	24PHUC2209	Basic Electronics	3	Revised	30%
Major – 7	24PHUC2210	Vector analysis and Differential equations	3	Revised	20%
	24PHUC2211	Practical -IV	2	Revised	20%
Ability Enhancement Course (AEC)	24PHUA2201	Electrical Measurements	3	New – 7	100%
	24PHUA2202	Weather forecasting	3	New – 8	100%
	24PHUA2203	Introduction to Astrophysics	3	New - 9	100%
		TOTAL	**23**		

FIFTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 8	24PHUC3112	Atomic Physics and Lasers	4	Revised	20%
Major - 9	24PHUC3113	Nuclear Physics	3	Revised	30%
Major - 10	24PHUC3114	Classical Mechanics and Relativity	3	Revised	30%
	24PHUC3115	Practical - V	2	Revised	20%
Minor - 5	24PHUB3101	Physics of Sound and Acoustics	4	New - 10	100%
		TOTAL	**18**		

SIXTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 11	24PHUC3216	Electromagnetics	4	Revised	20%
Major – 12	24PHUC3217	Fundamentals of Spectroscopy	4	Revised	40%
Major – 13	24PHUC3218	Fundamental Concepts Of Quantum Mechanics	4	Revised	20%
Major – 14	24PHUC3219	Solid State Physics	3	Revised	20%
	24PHUC3220	Practical - Vl	1	Revised	20%
Minor - 6	24PHUB3202	Waves and Oscillations	4	New – 11	100%
Project / Major 15	24PHUC3221	Instruments and servicing	4	New - 12	100%
		Project			
		TOTAL	**24**		

B.Sc., Physics (Honors) 4th year

* (Eligibility - Minimum 75% and above without arrears up to 6th semesters)

SEVENTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 16	24PHUC4122	Classical Mechanics and Dynamics	4	New – 13	100%
Major - 17	24PHUC4123	Statistical Mechanics	4	New – 14	100%
Major – 18	24PHUC4124	Electronic devices and Operational amplifier	3	New – 15	100%
	24PHUC4125	Practical - VII	2	New – 16	100%
Minor – 7	24PHUB4103	Nanophysics	4	New – 17	100%
Minor - 8	24PHUB4104	Physics of crystals	4	New - 18	100%
		TOTAL	**21**		

EIGHT SEMESTER

Category	Course Code	Course Title	No. of Credits	Remarks	Percentage of Revision
Major - 19	24PHUC4226	Mathematical Physics: Tensors, Complex analysis and Integral Transforms	4	New – 19	100%
Major - 20	24PHUC4227	Quantum Mechanics: Time Independent Problems	4	New – 20	100%
Major - 21	24PHUC4228	Project	12	New – 21	100%
		TOTAL	**20**		

Total number of new courses: 21

B.SC., PHYSICS HONORS (AS PER NEP – 2020)

OBE ELEMENTS

Programme Educational Objectives (PEO)

PEO1: To make the students proficient in the subject of Physics from the basics to advanced level.
PEO2: To use the knowledge gained to devise experiments and to get a better understanding of the physical world.
PEO3: To use the knowledge of Physics for going towards higher education or career plan.
PEO4: To use the knowledge of Physics for the self development and create sustainable environment.
PEO5: To apply innovative ideas for the development of low cost instruments to cater the social needs.
PEO6: To enable the students to practice physics at home and at the work place.

Program Outcome (PO)

On completion of the B.Sc. Physics Programme, the graduate will:

PO1: Become knowledgeable in the subject of Physics.
PO2: Be capable of applying the knowledge gained to suit the requirements of the Employer / Institution / Enterprise / Society.
PO3: Apply the skills in the area of Applied Physics.
PO4: Use the acquired knowledge to bring – in visible changes in the quality of life.
PO5: Adopt and adapt the Physics principles to solve societal and national problems.
PO6: Manage energy crisis through new and renewable energy sources.
PO7: Blend with the society with a high degree of professional ethics, community living and Nation Building initiatives

PROGRAMME SPECIFIC OUTCOME (PSO)

On completion of the B.Sc., Physics Programme, the graduates will be capable of:

PSO1: Identifying the principles behind the phenomena exhibited by nature.
PSO2: Solving the problems in the field of applied Physics with the understanding of the knowledge gained.
PSO3: Establishing mathematical relations for the phenomena and solve them.
PSO4: Fabricating and servicing simple gadgets
PSO5: Designing experiments and analyzing the outcome of the same.
PSO6: Adopt and adapt the Physics principles to solve societal and national problems.
PSO7: Disseminating knowledge to stakeholders
PSO8: Competing with their peer group towards their personal progress in the scientific arena.
PSO9: Developing scientific temper.

B.Sc. PHYSICS HONORS (AS PER NEP – 2020)
(For the batches joining in 2024-2025 and afterwards)

Name of the Programme	B.Sc. Physics								
Year of Introduction	1976				Year of Revision				2024
Semester- wise Courses and Credit distribution	I	II	III	IV	V	VI	VII	VIII	Total
No. of Courses	8	9	8	9	7	9	6	3	59
No. of Credits	21	23	23	23	18	24	21	20	173

Progressive Certificate, Diploma, Bachelor's Degree or Bachelor's Degree with Honors provided at the end of each year of exit of the four-years Undergraduate Programme.

S. No	EXIT OPTIONS	CREDITS REQUIRED
1.	**Certificate** upon the successful completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme.	**44**
2.	**Diploma** upon the successful completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme.	**88**
3.	**Basic Bachelor's Degree** at the successful completion of the Third Year (Six Semesters) of the multidisciplinary Four-year Undergraduate Programme	**132**
4.	**Bachelor's Degree with Honors** in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary four-year Undergraduate Programme	**172**

Scheme of the Programme

FIRST SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 1	24PHUC1101	Mechanics and Properties of Matter	3	3	3	40	60	100
	24PHUC1102	Practical – I	1	3	3	60	40	100
Minor - 1	24MAUB1101	Allied Mathematics - I	4	4	3	40	60	100
Multidisciplinary - I	24PHUI1101	Electronics for Computer Technology	3	3	3	40	60	100
	24PHUI1102	Renewable Energy and Thermal Systems	3	3	3	40	60	100
Ability Enhancement Course (AEC)	24ENUA1101	English I	3	3	3	40	60	100
Skill Enhancement Course	24TAUS1101/ 24MLUS1101/ 24HIUS1101	Indian Language – l (Tamil/Malayalam/Hindi)	3	3	3	40	60	100

Value Added Course VAC – 1	24PEUV1101	Yoga/Sports	2	2	-	50	-	50
Value Added Course VAC – 2	24FAUV1101	Heritage and cultural history of India	2	2	-	50	-	50
		TOTAL	**21**	**23**				

SECOND SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 2	24PHUC1203	Optics	3	3	3	40	60	100
	24PHUC1204	Practical II	1	3	3	60	40	100
Minor – 2	24MAUB1202	Allied Mathematics -II	4	4	3	40	60	100
Multidisciplinary-II	24CSUI1202	Computational Skills	3	3	3	40	60	100
	24PHUI1202	Concept of Physics in Sports	3	3	3	40	60	100
Ability Enhancement Course (AEC)	24ENUA1202	English II	3	3	3	40	60	100
Skill Enhancement Course	24TAUS1202/ 24HIUS1202/ 24MLUS1202	Indian Language – Il (Tamil / Hindi/Malayalam)	3	3	3	40	60	100
Value Added Course VAC- 3	24FSUV1203	Environmental Science / Education	2	2	-	50	-	50
Value Added Course VAC - 4	24GTUV1204	Gandhian Thought	2	2	-	50	-	50
Functional Course	24TAUF1201/ 24MLUF1201/ 24HIUF1201	Tamil / Malayalam / Hindi	2	2	-	50	-	50
		TOTAL	**23**	**25**				

THIRD SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major – 3	24PHUC2105	Heat and Thermodynamics	3	3	3	40	60	100
	24PHUC2106	Practical - III	1	3	3	60	40	100
Major – 4	24PHUC2107	Renewable Energy Sources	4	4	3	40	60	100
Minor - 3	24CHUB2101	Allied Chemistry - I	3	3	3	40	60	100
	24CHUB2102	Allied Chemistry Practical - I	1	3	3	60	40	100
Multidisciplinary - III	24PHUI2101	Electronics Communication Media	3	3	3	40	60	100
	24PHUI2102	Physics in Day – today Life	3	3	3	40	60	100

	24PHUI2103	Biomedical Instruments	3	3	3	40	60	100
Ability Enhancement Course (AEC)	24ENUA2103	English - III	3	3	3	40	60	100
Skill Enhancement Course	24TAUS2103/ 24MLUS2103/ 24HIUS2103	Indian Language – Ill (Tamil/ Malayalam/ Hindi)	3	3	3	40	60	100
	24EXUE2101	Village Placement Programme	2	2	-	50	-	50
		TOTAL	**23**	**27**				

FOURTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 5	24PHUC2208	Electric Circuits and Magnetic Materials	4	4	3	40	60	100
Major – 6	24PHUC2209	Basic Electronics	3	3	3	40	60	100
Major – 7	24PHUC2210	Vector analysis and Differential equations	3	3	3	40	60	100
	24PHUC2211	Practical -IV	2	6	3	60	40	100
Minor - 4	24CHUB2203	Allied Chemistry - II	3	3	3	40	60	100
	24CHUB2204	Allied Chemistry Practical - II	1	3	3	60	40	100
Ability Enhancement Course (AEC)	24PHUA2201	Electrical Measurements	3	3	3	40	60	100
	24PHUA2202	Weather forecasting	3	3	3	40	60	100
	24PHUA2203	Introduction to Astrophysics	3	3	3	40	60	100
Community engagement	24PHUE2201	Community engagement	2	2	-	50	-	50
Internship	24PHUI2201	Internship (Summer Vacation)	2		-	50	-	50
		TOTAL	**23**	**27**				

FIFTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 8	24PHUC3112	Atomic Physics and Lasers	4	4	3	40	60	100
Major - 9	24PHUC3113	Nuclear Physics	3	3	3	40	60	100
Major - 10	24PHUC3114	Classical Mechanics and Relativity	3	3	3	40	60	100
	24PHUC3115	Practical - V	2	6	3	60	40	100

Minor - 5	24PHUB3101	Physics of Sound and Acoustics	4	4	3	40	60	100
Field study / Community Engagement	24PHUE3102	Field study / Community Engagement	2	2	-	50	-	50
		TOTAL	**18**	**22**				

SIXTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 11	24PHUC3216	Electromagnetics	4	4	3	40	60	100
Major – 12	24PHUC3217	Fundamentals of Spectroscopy	4	4	3	40	60	100
Major – 13	24PHUC3218	Fundamental Concepts Of Quantum Mechanics	4	4	3	40	60	100
Major – 14	24PHUC3219	Solid State Physics	3	3	3	40	60	100
	24PHUC3220	Practical - Vl	1	3	3	60	40	100
Minor - 6	24PHUB3202	Waves and Oscillations	4	4	3	40	60	100
Project / Major 15	24PHUC3221	Instruments and servicing	4	4	3	40	60	100
		Project			-	40	40+20*	100
		TOTAL	**24**	**26**				

B.Sc., Physics (Honors) 4th year

* (Eligibility - Minimum 75% and above without arrears up to 6th semesters)

SEVENTH SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 16	24PHUC4122	Classical Mechanics and Dynamics	4	4	3	40	60	100
Major - 17	24PHUC4123	Statistical Mechanics	4	4	3	40	60	100
Major – 18	24PHUC4124	Electronic devices and Operational amplifier	3	3	3	40	60	100
	24PHUC4125	Practical - VII	2	6	3	60	40	100
Minor – 7	24PHUB4103	Nanophysics	4	4	3	40	60	100
Minor - 8	24PHUB4104	Physics of crystals	4	4	3	40	60	100
		TOTAL	**21**	**25**				

EIGHT SEMESTER

Category	Course Code	Course Title	No. of Credits	Lt. Hrs per week	Exam Duration (Hrs.)	Marks		
						CFA	ESE	Total
Major - 19	24PHUC4226	Mathematical Physics: Tensors, Complex analysis and Integral Transforms	4	4	3	40	60	100
Major - 20	24PHUC4227	Quantum Mechanics: Time Independent Problems	4	4	3	40	60	100
Major - 21	24PHUC4228	Project	12	12	-	40	40+20*	100
		TOTAL	**20**	**20**				

*40 marks for External Examiner and 20 marks for Viva-voce.

Courses offered to the other Departments:

24PHUB1101/ 24PHUB2101	Allied Physics – I (Allied Physics for B.Sc., Mathematics, Geology and ChemistryMajor)
24PHUB1202/ 24PHUB2202	Allied Physics – II (Allied Physics for B.Sc., Mathematics, Geology and ChemistryMajor)

LIST OF MULTIDISCIPLINARY COURSES

Course Code	Course Title	Credit
	First Semester	
24PHUI1101	Electronics for Computer Technology	3
24PHUI1102	Renewable Energy and Thermal Systems	3
	Second Semester	
24PHUI1202	Concept of Physics in Sports	3
	Third Semester	
24PHUI2101	Electronics Communication Media	3
24PHUI2102	Physics in Day – Today Life	3
24PHUI2103	Biomedical Instruments	3

Semester	I	Course Code	**24PHUC1101**
Course Title	**MECHANICS AND PROPERTIES OF MATTER**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed by the Course	▪ K-1: Remember ▪ K-2: Understand ▪ K-3: Apply ▪ K-4: Analyze ▪ K-5: Evaluate ▪ K-6: Create		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To impart knowledge about linear and rotational motion of bodies and gravitational forces among bodies. 2. To make them understand the principles and methods of finding the bulk properties of structural materials.		

UNIT	Content	No. of Hours
I	**Collision:** Impulse and Linear momentum – series of collisions – elastic collisions and inelastic collisions in one dimension – collision in two dimension – reactions and decay processes – Angular quantities as vectors – rotation with constant angular acceleration – linear and angular – variables – Kinetic energy of rotation – torque – Newton's second law – Newton's second law for rotation – work – Power and the work – Kinetic energy theorem – angular momentum and its conservation.	10
II	**Gravitation** : Newton's laws of gravitation and principle of superposition – gravitation near the earth's surface – gravitation inside the earth – gravitational potential energy – planets.	10
III	**Mechanical property of solid materials:** Bending of beams – modulie of elasticity – Young's Modulus – Bulk Modulus and Rigidity Modulus - bending moments – Cantilever– loaded at the free end when the beam weight is ineffective – depression of a beam supported at the ends – loaded cylindrical wire – torsional pendulum – columns – pillars and struts.	9

IV	**Flow of Liquids and surface tension:** Streamlines and equation of continuity – Bernoulli's equation – proof and applications – Velocity of efflux of liquid – Toricelli's theorem, Vena contractor – Venturimeter and pitot tube – Properties of Surface tension – Surface Tension by drop weight method and Capillary rise method – Applications.	10
V	**Viscosity**: Coefficient of viscosity – critical velocity – Reynolds number and its significance – Poiseuille's equation – experimental determination of viscosity – Poiseuille's method – Stokes method – Ostwald's viscometer – Diffusion and osmosis – basic ideas.	9
Course Outcomes	**On completion of the course, students should be able to do** CO1: Specify the principles and types of collision between the bodies. CO2: State the Newton's second law and conservation of Angularmomentum. CO3: Estimate the gravitational force near and inside the earth surface and the energy of satellites CO4: Design experiments to find the Young's modulus and rigidity modulus of building materials. CO5: Discuss the principle of flow of liquids and itsapplications in daily life.	
Reference	Text Books: 1. Fundamentals of Physics – VII Edn. David Halliday, Robert Resnick and Krane –Asian Books, New Delhi (1994) Unit I: Relevant section of Chapter 10, 11 and 12. Unit II: Relevant section of ibid Chapter 15. 2. Elements of properties of matter, – D.S. Mathur, Chapter 10, 11 and 12 and chapter 21. Reprinted in 1984, S. Chand & Co., New Delhi. Relevant section of XII & XIII and related problems. 3. Concept of physics H.C.Verma, Bharati Bhawan publishersand distributors (2015).	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	–	1
CO2	3	3	3	–	2
CO3	3	2	3	–	–
CO4	3	3	3	2	3
CO5	3	3	3	2	3

Mean = 57/25 = 2.28

Semester	I	Course Code	**24PHUC1102**
Course Title	**PRACTICAL – I**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	New Course	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed by the Course	▪ K-1: Remember ▪ K-2: Understand ▪ K-3: Apply ▪ K-4: Analyze ▪ K-5: Evaluate		
Course Objectives (Maximum: 5)	**The Course aims to** a. To familiarize and make the students acquire knowledge and skills through basic Measuring instruments and measurement techniques. b. Comprehensive coverage of requisite practicals for one session (Minimum 10)		

UNIT	Content	No. of Hours
I	Basic Measurement Techniques, Errors of observation, Data Representation and Analysis 1. Vernier calipers and Vernier Microscope 2. Single Optic level and Screw gauge 3. Measurement of length / a dimension using Crude estimation Un graduated scale Graduated meter scale Vernier caliper Vernier microscope Screw gauge Single optic lever Choice of instrument for measurement. Random Errors in observation 4. Due to personal judgment – Period of oscillation of a simple pendulum. 5. Due to fluctuation in the experimental conditions– resistance measurement at cold water temperature, at a slightly higher and at slightly lower temperature method of reducing random errors.	3

	6. Systematic Errors in observation due to 7. Personal judgment – Parallax Error 8. Due to the instrument – Zero Error inmeters, screw gauge etc. 9. Due to backlash Error in Vernier microscope. 10. Due to experimental conditions – measurement of resistance at cold water temperatureand higher temperature. 11. Method of reducing Systematic. Estimation of errors of observation. In a single measurement 12. In several measurement of the samequantity 13. Estimation of standard deviation 14. Effect of the number of readingson standard deviation. 15. Generation of linear and nonlinear data and graphicalrepresentation ➢ Extension of a spring ➢ Water flowing through a burette or cooling of a hotbody. 16. Least square fit, arriving at empirical relations froman examination of the graph. 17. Study of Motion of a compound pendulum. ➢ Dependence of the period of oscillation on moment of Inertia, amplitude of oscillation, damping (viscous, frictional and electromagnetic) ➢ Determination of the acceleration due to gravity 18. Surface tension – Interfacial tension. 19. Coefficient of viscosity.	

Semester	I	Course Code	24PHUI1101
Course Title	**Electronics for Computer Technology**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revisioneffected **(Minimum 20%)**	-
Category	**Multidisciplinary - I**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course objectives (Maximum: 5)	**The Course aims to** 1. Be capable of understanding and working principles of electronics in a computer.		

UNIT	Content	No. of Hours
I	Elements of Computer: CPU – CU – ALU – Memory – IO Generation of computers – 1st, 2nd, 3rd – Block diagram of CPU.	8
II	Design Methodology: System design – representation – Process – Gate level – Register level.	10
III	Memory Basics: Basic Memory addressing – ROM – PROM – EPROM – RAM.	10
IV	Memory Organizations: Multilevel memory – Address Translation – Memory Allocation – Cache Memory.	10
V	Virtual Memory – Memory management Requirements – Memory Management Unit (MMU) – Secondary Storage Devices.	10

References	**Text Books** Unit 1- Computer Architecture and Organization- Third Edition, 1998 John P. Hayes,Page 1 – 55. Unit 2 - Computer Architecture and Organization - Third Edition,1998 John P. Hayes, Page 64 – 113 Unit 3 - Computer Organization – Fifth Edition, 2002.Page No. 309 - 311 by Carl Hamacher, Zvonko Vranesic, Safwat Zaky. Unit 4 - Computer Architecture and Organization - Third Edition,1998 John P. Hayes, Page 426 – 452

	Unit 5 - Computer Organization – Fifth Edition, 2002.Page No. 330 - 360 by Carl Hamacher, Zvonko Vranesic, Safwat Zaky.
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** have knowledge about CPU and generation of computers . **CO 2:** able to understand the design methodology **CO 3:** have knowledge about ROM,PROM,EPROM.. **CO 4:** be capable of understand Multilevel memory Organizations. **CO 5:** be able to know the Memory Management system.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	1	1
CO2	3	2	3	2	2
CO3	3	3	3	3	1
CO4	3	–	1	3	–
CO5	3	1	2	2	–

Mean = 51/ 25 = 2.04

Semester	I	Course Code	**24PHUI1102**
Course Title	**RENEWABLE ENERGY AND THERMAL SYSTEMS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	**New**	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Multidisciplinary – I**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. It gives basic functionalities of different types of energy systems in everyday life. 2. It gives a method of designing different types of systems for home and national wide applications.		

UNIT	Content	No. of Hours
I	**Solar Radiation and its Measurement**: Solar constant – Solar Radiation at the Earth's surface – Solar Radiation Geometry – Measurements and Data – Estimation of average Solar Radiation and Solar radiation on tilted surfaces.	9
II	**Solar Energy Collectors:** Physics principles of the conversion of solar radiation into heat – Flat Plate Collector (FPC) – Performance analysis of FPC – concentrating collector (CC) – advantages and disadvantages of CC over FPC. Application of Solar Energy – Solar water heating – space heating – space cooling – agricultural and industrial process – Solar distillation – solar cooker – Solar Photovoltaics .	10

III	**Wind energy** – Basic principles of wind energy conversion – Nature of the wind – the power in the wind – forces on the blades and thrust on turbines – wind energy conversion (WEC) – basic components of wind energy conversion – classification of types of WEC systems – advantages and disadvantages of WECs.	9
IV	**Biomass** – Introduction – biomass conversion technologies – biogas generation – factors affecting bio digestion on generation of gas – classification and types of biogas plants – advantages and disadvantages of floating drum plant and fixed dome type plant.	10
V	**Geothermal and OTEC** – Introduction – nature of geothermal fields – geothermal sources – hydrothermal (convective resources) – advantages and disadvantages of geothermal energy over other energy forms – applications of geothermal energy. OTEC – Introduction – Basic ideas of OTEC – methods of OTECpower generation.	10
References	**Text Books** 1. Non– Conventional energy sources – G.D. Rai, Khanna Publishers - Sixth edition (2017)	
	Reference Books **1.** Solar energy principles of thermal collection and storage – S.P. Sukhatme,TMC – 1984 **2.** Renewable energy sources and conversion technology – N.K. Bansal, M.Kleemann and M. Melinn **3.** Solar Energy Hand Book – John F. Kreider and F. Kreith, McGraw HillBook Company, (1981)	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Define the solar constant and estimate the solar radiation on earth's surfaces. **CO 2:** Describe the Solar Energy Collectors and its Physics principles. **CO 3:** Explain the wind energy conversion technologies and its classifications. **CO 4:** Illustrate the methods of biomass conversion technologies and its classifications.. **CO 5:** Illustrate the methods of generating energy form Geothermal sources and OTCE powergeneration systems.	

E-Resources	https://youtube.com/playlist?list=PL3QMEfkolRFbGhXveCE7RFDBgY0_gRxkh&si=gLkJLHm_jqF2-UKX https://www.scribd.com/document/491553447/Non-conventional-Energy-Sources-by-G-D-Rai https://youtube.com/playlist?list=PLXVLLNeys8Zdki_eqsG1URq5w863clE49&si=hMZyM8n2BJi-h6nX

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	2	1
CO 2	3	3	2	3	3
CO 3	3	3	2	3	3
CO 4	3	2	2	3	3
CO 5	3	2	1	2	3

Mean =63 /25= 2.52

Semester	II	Course Code	**24PHUC1203**
Course Title	**OPTICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	50%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed by the Course	➢ K– 1: (Remember) ➢ K– 2: (Understand) ➢ K– 3: (Apply) ➢ K– 4: (Analyze) ➢ K– 5: (Evaluate) ➢ K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To acquire knowledge on few basic physics optical phenomena and their corresponding theoretical aspects.		

UNIT	Content	No. of Hours
I	**INTERFERERENCE:** Theory - Michelson Interferometer (MI) Circular fringes, and Localized fringes in MI. Applications of Michelson Interferometer – Multiple beam interference – the Fabry – Perot Interferometer, Interference filters and channeled spectra – Lummer–Gehrcke plate.	12
II	**FRESNEL DIFFRACTION** : Classification: Zone plate; Theory of zone plate, Multiple foci of a zone plate, Comparison of a zone plate and convex lens, Intensity at a point due to a cylindrical wave front – Fresnel diffraction of a cylindrical wavefront at a straight edge; at a narrow obstacle; at a rectangular aperture - Cornu's spiral.	10

III	**FRAUNHOFER DIFFRACTION** : Fraunhofer diffraction at a single slit; mathematical investigation of its intensity distribution; Fraunhofer Diffraction at two slits; Diffraction grating, theory of plane transmission grating, Secondary maxima and minima; Concave reflection grating ; Focal curve and elementary theory of concave reflection grating.	10
IV	**RESOLVING POWER OF OPTICAL INSTRUMENTS:** Resolving power, Rayleigh's criterion of resolution, Resolving power and magnifying power of a telescope and a microscope; Electron microscope; Phase contrast microscope, Resolving power of a prism, Dispersive power and resolving power of a grating.	6
V	**POLARIZATION :** Birefringence, Nicol prism – its construction and theory – Elliptically and circularly polarized light; Theory ; Quarter and half-wave plates; Production of elliptically and circularly polarized light and their comparison; Fresnel's rhomb; Babinet's compensator - Rotatory polarization; Fresnel's explanation; Calculation of the angle of rotation; Specific rotation; Laurent's polarimeter, Half Shade device; Lippich polarimeter,	10
Course Outcomes	**On completion of the course, students should be able to do** CO1: Acquire the knowledge of principle of interference CO2: Apply the principle of interference to applications MichelsonInterferometer Fabry – Perot Interferometer – Interference filters – Lummer–Gehrcke plate – Jamins' Interferometer and Raylegh's refractometer. CO3: Discuss theory of zone plate and Compare zone plate withconvex lens. CO4: Discuss intensity distribution in Fresnel diffraction due to straight edge – narrow obstacle – rectangular aperture – circular aperture andCornu's spiral. CO5: Explain the principle of polarization and apply the principle to optical applications.	

Reference	**BOOKS FOR STUDY**: 1. Optics By Brijilal and Subramaniyam. 2001, S.Chand and Co. 2. Fundamentals of Optics – Khanna & Gulati, R. Chand & Co., 14th Edn., New Delhi. Chaper 13, PP 282-312 Chapter 14, PP 313-315, 321-342. Chapter 15, PP 353-382, 387-390 Chapter 16, 400-430 Chapter 18, PP 456-475, Chapter 19, PP 476-487. 2. Optics – Ajoy Ghatak, 2nd Edition, Tata McGraw Hill Pub. Cpy.Ltd., New Delhi, 1992. **BOOK FOR REFERENCES:** 1. Optics – F.W. Sears, 3rd Edition – Addison-Wesley Publishing Company, INC, Reading, Massachuselts, 1975. 2. Fundamentals of Optics – F.A. Jenkins and White. 3. Fundamentals of Physics – VIIth Edn. David Holliday, Robert Resnick and Jearl Walker – Asian Books, New Delhi (1994).

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	1	–	–
CO2	3	3	2	2	3
CO3	3	3	1	–	–
CO4	3	3	3	–	–
CO5	3	3	3	2	3

Mean = 50/ 25 = 2

Semester	II	Course Code	**24PHUC1204**
Course Title	**PRACTICAL – II**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed by the Course	➢ **K– 1: (Remember)** ➢ **K– 2: (Understand)** ➢ **K– 3: (Apply)** ➢ **K– 4: (Analyze)** ➢ K– 5: (Evaluate) ➢ **K– 6: (Create)**		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To expose the measuring skills on the fine apparatus to measure to magnitudes of properties on mechanical and optical areas. 2. Comprehensive coverage of requisite practicals for one session (Minimum 10)		

UNIT	Content	No. of Hours
I	➢ Study of depression and deflection of a cantilever. ➢ Variation of deflection / depression with distance from fixed end ➢ Young's modulus – Non uniform bending ➢ Young's modulus – Uniform bending ➢ Young's modulus – Koenig's method ➢ Familiarisation with spectrometer – Refractive Index of solid and liquid. ➢ Dispersive power of the material of a prism ➢ i– d curve ➢ i– i' curve and Stoke's formula ➢ Radius of curvature – Newton's rings ➢ Thickness of a wire – Air wedge ➢ Wavelength of light – Biprism	3

Semester	II	Course Code	**24PHUI1202**
Course Title	**CONCEPT OF PHYSICS IN SPORTS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revision effected (Minimum 20%)	-
Category	**Multidisciplinary – II**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To Identify the distribution of mass in human body 2. To describe the velocity, speed and acceleration during running.		

UNIT	Content	No. of Hours
I	**HUMAN PHYSIOLOGY:** Distribution of mass in Human body – forces in muscles and bones – elastic properties – work – energy and power of the body – sizes – strength and food requirements – calculation of calorific content needed for each sports person.	9
II	**JUMPING AND RUNNING:** Basic ideas about distance – velocity and speed – acceleration – acceleration due to gravity – angular distance – speed and angular acceleration – Analysis of Track Techniques – Starting – running – hurdling – stride length – frequency – sprint length – frequency and sprint – start. Analysis of Field Techniques – Standing broad jump – running broad jump – pole vault – techniques involved – guiding principles – (video demonstration of track and field events and the techniques).	9

III	**LINEAR KINETIC CONCEPTS**: Inertia –mass – force – momentum –Newton's laws of motion – friction – impulse – impact – oblique impact – elasticity – impact on fixed surface – moving bodies. Analysis of Cricket / Base Ball – Impact – moment of inertia – spin – size of the ball– size of the bat – batting – stride – swing – bunting. Analysis Of Tennis Techniques – Grip – striking – serve – direction of flight of ball – guiding principles	10
IV	**PROJECTILES IN SPORTS**: Projectiles – horizontal and vertical motion – range of projectile – trajectory – Analysis of throwing events – techniques involved in speed of release – angle of release and reverse in shot– put – discus – javelin and hammer throw – analysis of broad jump – basket ball shooting and foot ball kicking (video demonstration of projectiles in sports) – guiding principles – analysis of basket ball techniques – Dribblingand passing.	10
V	**ADVENTURE SPORTS:** Eccentric force – moment – equilibrium – centre of gravity – weight – rotator and circular motion – Analysis of Gymnastics activities– Analysis of rope climb – tight rope walking – skipping – car race – boat race – cycle race – guiding principles. Swimming And Diving – Basic ideas of flotation – buoyant force – centre of buoyancy – specific gravity – relative motion – fluid resistance – conservation of momentum – Analysis of swimming techniques – starting – racing – turn different strokes – diving techniques.	10
References	**Text Books** 1. The Biomechanics of Sports Techniques, Third edition, Hay.G.James – Relevant portion of chapters 3 to 10 & 12, 13 to 17. 2. Scientific Principles of Coaching, Second Edition – Relevant portion of chapters 5, 7 to 14, 16 to 21. 3. General Physics with Bioscience Essays, Marion and Nornyak, Second Edition– Chapters 1.2, 2.5, 2.8, 3.4, 4.2, 5.3, 7.3.	
Course Outcomes	**On completion of the course, students should be able to do** CO 1: Identify the distribution of mass in human body CO 2: Calculate the food requirements and calorific content needed for a sports person CO 3: Describe the velocity, speed and acceleration during running. CO 4: Analyze the track techniques such as starting, running, hurdling, stride length, frequency and sprint length. CO 5: Analyze the techniques of Gymnastics activities.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	4	1	2	2	1
CO 2	2	1	2	3	1
CO 3	3	3	2	1	3
CO 4	3	3	1	1	–
CO 5	3	3	3	2	2

Mean = 52/25 = 2.08

Semester	III	Course Code	**24PHUC2105**
Course Title	**HEAT AND THERMODYNAMICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	30%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed by the Course	➢ **K– 1: (Understand)** ➢ **K– 2: (Apply)** ➢ **K– 3: (Analyze)**		
Course Objectives (Maximum: 5)	**The Course aims to** 1. The fundamental concepts on Thermal Physics is being exposed under variousangles		

UNIT	Content	No. of Hours
I	**Heat flow:** Conduction – Thermal conductivity – rectilinear flow of heat along a bar – convection - Newton's law of cooling – specific heat of liquid – Black body radiation – Stefens - boltzman law – Wein's law – Rayleigh gens law – plank's law. **Kinetic theory of gases:** Deduction of gas laws on the basis of kinetic theory – Maxwell's law of velocity distribution – Maxwell – Boltzmann law of velocity distribution– Vibratory motion of molecules – Internal energy of a gas – Law of equipartition – partition of energy – Mean free path– Transport phenomena– viscosity – diffusion.	9
II	**Equation of state for real gases**: Vander Waals equation – Critical constants in terms of Vander Waals constants – Reduced equation of states – Law of corresponding states – Joules experiments on inter molecular attraction – Discovery of intermolecular attraction – Porous plug experiment – Linde's process for liquefaction of air– liquefaction of hydrogen – liquefaction of Helium.	10
III	**First & Second law of thermodynamics:** Introduction – Zeroth law of thermodynamics – Work done in a (i) Non–cyclic process – (ii) Cyclic process (iii) Isothermal process (iv) Adiabatic process (v) Isobaric process (vi) Isochoric process – Concept of point and path functions – Internal energy –First law of thermodynamics – Relation connecting P,V and T in an adiabatic process – Application of first law of thermodynamics to the specific heat – Second law of thermodynamics – Clausius and Kelvin – Planck statement of the second law – Heat engine Carnot theorem – Refrigerator .	11

IV	**Thermodynamic scale of temperature:** Applications of Second law of thermodynamics – Clausius – Clapeyron equation – Other thermodynamic work cycles – Rankine cycle – Otto cycle –Diesel cycle – Expressions for their efficiency – Heat engines in actual practice – Steam engine –Otto engine– Diesel engine – Zero point energy.	8
V	**Entropy:** Introduction – Definition of entropy – Entropy and adiabatics – Change of entropy in any reversible and irreversible cycle –Expression connecting two laws of thermodynamics – Entropy of a perfect gas – Entropy changes in simple reversible processes – T– S diagram – Thermodynamic functions – Internal energy – Enthalpy – Helmholtz function – Gibbs function – Maxwell's thermodynamic relations – TdS equations .	10
Course Outcomes	**On completion of the course, students should be able to do** **CO 1**: Understand the basic kinetic theory of gases and deduce gaslaws **CO 2**: Understand the real gas analysis and arrive at Van der Waal's equation **CO 3**: Know the I and II Law of thermodynamics and its applications **CO 4**: Identify the functioning of the Heat engines and Refrigerator **CO 5**: Be aware of basic ideas of entropy and thermodynamic functions	
Reference	**Text Books:** Heat and Thermodynamics by D.S. Mathur, Sultan Chand & Sons Educational publishers, New Delhi, Fifth Edition Unit I : Chapter 6: 207, 3 Unit II: Chapter 7: 268– 278; 282– 287; Chapter11: 429– 433 Unit III: Chapter 8: 305– 315, 316– 323 Unit IV: Chapter 8: 323–328, 334–357 Unit V : Chapter 9: 358–366 & 374–387; Chapter 10: 387–398 & 401–403.	
Reference	**BOOKS FOR REFERENCE:** 1. Heat and Thermodynamics: M.W. Zemansky and R.H. Dittman – International edition. 2. A treatise on heat – Saha and Srivastava, Vth Edition. 3. Thermodynamics , Kinetic theory and Statistical thermodynamics III Edition – Sears and Salinger, Indianstudent's edition, Narosa Publications, New Delhi. 4. Fundamentals of Physics – VIIth Edn., – David Holliday,Robert Resnick and Krane 5. Heat and thermodynamics by D.S. Mathur, Sultan Chand,1978.	

	Related online courses – MOOC courses: https://www.edx.org/course/basics– transport– phenomena– delftx– tp101x– 2https://www.edx.org/course/thermodynamics– tbombayx– me209– 1x– 1

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	3	3	–	–
CO 2	1	2	3	1	1
CO 3	3	2	2	2	2
CO 4	3	3	3	3	2
CO 5	–	2	3	3	2

Mean = 52/ 25 = 2.08

semester	**III**	Course Code	**24PHUC2106**
Course Title	**PRACTICAL – III**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed by the Course	➢ **K– 1: (Understand)** ➢ **K– 2: (Apply)** ➢ **K– 3: (Analyze)**		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To expose the measurement on electricity and advanced measurementon optics areas has been exposed. 2. Comprehensive coverage of requisite practicals for one session (Minimum 10)		

UNIT	Content	No. of Hours
I	1. Study of Fraunhofer diffraction at single and double slits. 2. Wavelength of light – Diffraction grating 3. Cauchy's dispersion formula – Cauchy's constants 4. a. Verification of Brewster's law b. Study of rotatory power of materials – Laurent's half shade polarimeter. 5. Familarisation with the use of Voltmeter, Ammeter – Multimeter Voltage divider and current divider arrangements – series and parallel connections. 6. Verification of Kirchoff's laws and Thevenin's theorem. 7. Measurement of resistance and temperature Coefficient of resistance – Carey Foster's bridge 8. Potentiometer – measurement of low voltage – EMF of Thermocouple – calibration of low range voltmeter 9. Potentiometer – measurement of medium and high voltages calibration of medium and high range voltmeters 10. Potentiometer – measurement of current – calibration of ammeter.	3

Semester	**III**	Course Code	**24PHUC2107**
Course Title	**RENEWABLE ENERGY SOURCES**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	60%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. It gives basic functionalities of different types of energy systems in everyday life. 2. It gives a method of designing different types of systems for home and national wide applications.		

UNIT	Content	No. of Hours
I	**Solar Radiation and its Measurement** – Solar constant – Solar Radiation at the Earth's surface – Solar Radiation Geometry – Measurements and Data – Estimation of average Solar Radiation and Solar radiation on tilted surfaces.	8
II	**Solar Thermal utilization** – Physics principles of the conversion of solar radiation into heat – Flat Plate Collector (FPC) – Performance analysis of FPC – concentrating collector (CC) – advantages and disadvantagesof CC over FPC – selective coatings. Application of Solar Energy – Solar water heating solar– agricultural and industrial process– Solar distillation – solar pumping – solar furnace – solar cooker.	14

III	**Photovoltaics:** Fundamentals of PV conversion – Semiconductor – Photon Energy – Electron hole concentration and Fermi level – P-N junction – Solar cell materials – Efficiency of solar cells	14
IV	**Silicon solar cell**- silicon wafer to silicon solar cell fabrication- module design –polycrystalline and amorphous cells – Fabrication - structure, installation, control and storage in energy systems - applications.	14
V	**Wind energy:** Basic principles and components of wind energy conversion - classification of types of WEC systems – advantages and disadvantages of WECs. **Geothermal:** Nature of geothermal fields – geothermal sources –advantages and disadvantages– applications of geothermal energy. **OTEC:** Introduction – Basic ideas of OTEC – methods of OTEC power generation – Open cycle and closed cycle system.	14
References	**Text Books** 1. Non– Conventional energy sources – G.D. Rai, Khanna Publishers - Sixth edition (2017) 2. Solar Energy Fundamentals and Applications – H P Garg and J Prakash – Tata McGraw Hill publishers – Fourteenth Edition 2011.	
	Reference Books **1.** Solar energy principles of thermal collection and storage – S.P. Sukhatme,TMC – 1984 **2.** Renewable energy sources and conversion technology – N.K. Bansal, M.Kleemann and M. Melinn **3.** Solar Energy Hand Book – John F. Kreider and F. Kreith, McGraw HillBook Company, (1981)	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Define the solar constant and estimate the solar radiation on earth's surfaces. **CO 2:** Describe the different types of solar collector systems **CO 3:** Explain the photovoltaic design, , and its applications **CO 4:** Explain the fabrication, installation and its outreaching applications. **CO 5:** Illustrate the wind energy conversion technologies , methods of generating energy form Geothermalsources and OTCE power generation systems.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	2	1
CO 2	3	3	2	3	3
CO 3	3	3	2	3	3
CO 4	3	2	2	3	3
CO 5	3	2	1	2	3

Mean = 63/25= 2.52

Semester	III	Course Code	**24PHUI2101**
Course Title	**Electronics Communication Media**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revisioneffected **(Minimum 20%)**	-
Category	**Multidisciplinary - III**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• **K– 1: (Remember)** • **K– 2: (Understand)** • **K– 3: (Apply)** • **K– 4: (Analyze)** • **K– 5: (Evaluate)** • **K– 6: (Create)**		
Course objectives (Maximum: 5)	**The Course aims to** 1. Academic and practical knowledge on functioning of communication media and its skill on cables, connectors etc..		

UNIT	Content	No. of Hours
I	**Electromagnetic spectra** – Frequency, Wavelength – Types of spectra – Properties – Applications – Poynting vector.	8
II	**Radio waves** – Ground wave propagation – Sky wave propagation – Space wave propagation – Role of atmosphere on propagation.	10
III	**Fiber optic communication:** Types of fibers – Single – mode, multi – mode & grade – index fibers – Advantages of fiber optic communications.	10
IV	**Cables** – Co-axial cable – Shielded/ unshielded twisted pairs – Types of UTP – Applications.	10
V	**Connectors** – RS232C – 25 PIN – 9 PIN – Cables – Straight through Adapter – Cross over – UART – Ir DA – USB.	10

References	**Text Books** Unit 1 - Practical Fiber Optics by David Bailey, Edwin Wright, Newnes, I Edition (2003) Chapter 2.5 – 2.6, Unit 2 -, Practical Fiber Optics by David Bailey, Edwin Wright, Newnes, I Edition (2003) Chapter 4 Unit 3 - Practical Fiber Optics by David Bailey, Edwin Wright, Newnes, I Edition (2003) Chapter 3, Unit 4 - Practical Fiber Optics by David Bailey, Edwin Wright, Newnes, I Edition (2003) Chapter 2.7 – 2.10, Unit 5 - Hardware Bible – Winn L. Rosch, Techmedia, 1997
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** have a complete knowledge about Electromagnetic spectra **CO 2:** be able to know various wave propagation **CO 3:** have knowledge about fiber optic communication **CO 4:** be capable of understanding types of cables **CO 5:** be able to differentiate between connectors' adaptor and USB.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	1	1
CO2	3	2	3	2	2
CO3	3	3	3	3	1
CO4	3	–	2	3	–
CO5	3	1	2	2	–

Mean = 52/ 25 = 2.08

Semester	**III**	Course Code	**24PHUI2102**
Course Title	**PHYSICS IN DAY-TODAY LIFE**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	NEW	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Multidisciplinary –III**		
Scope of the Course (may be more than one)	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship • Value– Added Courses imparting transferable and life skills • Field Placement / Field Project		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate)		
Course Objectives (Maximum:5)	**The Course aims to** • To introduce the physics behind the household equipment. • To impart a knowledge on the working principle and maintenance of household equipment. • To develop the skills like criticalunderstanding , thinking and analysing real-world phenomena using physics concepts • To provide fundamental understanding of vision and the way physics helps to overcome difficulties		

UNIT	Content	No. of Hours
I	**Electricity:** Basics of electricity- Ohms law, power consumption, Joule heating-saving electricity-ways to minimize power consumption – verification of goodness of your household energy meter- Fuse – miniature circuit breaker – earth leakage detector.	10
II	**Car, Refrigerator and Microwave oven:** Concept of temperature& electromagnetic waves - Conversion of Work into Heat vice versa-Heat Engines- Carnot's Cycle, Carnot engine & efficiency- Refrigerator: need for refrigeration - old new concepts like freon free refrigeration and forced convection refrigerators - microwave ovens – magnetron, need for rotating table ina microwave oven -water heater and geyser.	10

III	**Mechanical devise in the house:** washing machines: front loading and top loading types – drier – dish washer –coconut scrapper – wet grinder – mixier grinder – juicer – exhaust fan with and without oil filter	9
IV	**Physics in Human Body:** The eyes as an optical instrument - standard vision – defect in vision and their refractive correction – lasers in eye surgery - Sound waves and hearing, Sound intensity, Decibel scale	9
V	**Physics in kitchen:** Pressure, Volume, Temperature - Working of a pressure cooker - Newtons law of cooling- cooking with different Stove – wood – gas. Preparation of Degree coffee- Smell of food.	10
References	**Text Books** 1. Fundamentals of Physics by D. Halliday, R. Resnick, J. Walker, John Wiley &Sons , 12th edition (2021) 2. Concepts of Physics Volume I and II – HC Verma , Bharati Bhavan Publishers (2020)	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:**willbeabletopredict,the electricity bill according to usage pattern. **CO2:**select proper equipmentfor households **CO3:**analyze the specifications of mechanical devices and select the right kind of appliance **CO4:** select the right kind of treatment in an eye hospital **CO5:**design a proper kitchen.	
E- Resources	1. https://blog.schoolspecialty.com/physics-in-everyday-life-examples-for-the-classroom/ 2. https://www.sciencexplorers.com/examples-of-physics-from-everyday-life/ 3. https://www.geeksforgeeks.org/applications-of-physics-in-daily-life/	

Mapping of Cos with PSOs:

PSO / CO	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	3	3	2	3	3
CO 2	3	3	2	1	3
CO 3	3	3	2	1	3
CO 4	3	3	2	1	3
CO 5	3	3	2	1	3

Mean = 59/**25= 2.36**

Semester	**III**	Course Code	**24PHUI2103**
Course Title	**BIOMEDICAL INSTRUMENTS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	NEW	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Multidisciplinary –III**		
Scope of the Course (may be more than one)	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship • Field Placement / Field Project		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate)		
Course Objectives (Maximum:5)	**The Course aims to** • To introduce Introduction to biomedical instrumentation • To study Measurement of important Non- Electronic Parameters and Sources of Bioelectric Parameters. • To have a basic knowledge Instrumentation • To study about the Safety and Prevention		

UNIT	Content	No. of Hours
I	**Introduction to biomedical instrumentation :**Development of Biomedical Instrumentation – Biometrics – Physiological Systems of the Body – Problems Encountered in measuring a living System – Interfering and Modifying Inputs – Transducer - Transducers for Biomedical Applications, Piezoelectric Sensors – Ultrasonic Measurements - Temperature Measurements– Fiber-Optic Temperature Sensors -Optical Measurements	10
II	**Non- Electronic Parameters Measurement:** The heart and Cardiovascular System - the Heart - Blood Pressure - Characteristics of Blood Flow – Heart Sounds and Measurements – Electrocardiography (ECG Amplifiers - Recorder Principles and -Types, Electrodes and Leads) – Measurement of Blood Pressure – Measurement of Blood Flow and Cardiac Output.	10

III	**Sources of Bioelectric Parameters:**Resting and Action Potentials - The Bioelectric Potentials, (ECG, EEG, EMG, ERG, EOG and EGG) - Electrode Theory – Biopotential Electrodes (Micro, Skin Surface and Needle electrodes) - Biochemical Transducers.	9
IV	**Instrumentation:** Psychophysiological Measurements - Instruments for Test Motor Responses – Instrumentation for Sensory Measurements – Instrumentation for the Experimental Analysis of Behaviour – Biofeedback Instrumentation – Instrumentation for Diagnostic X-Rays – Instrumentation for the Medical Use of Radioisotopes.	10
V	**Electrical Safety:** Physiological Effects of Electrical Current – Shock Hazards from Electrical Equipment – Testing the electric System - Methods of Accident Prevention.	9
References	**Text Books for Reference:** 1. Biomedical Instrumentation and Measurements – Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer 2. Medical Instrumentation Application and Design – John G. Webster.	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** Ability to identify the Physiological Systems of the Body and describe the basic sensors and Principles of system **CO2:** Ability to illustrate the measurement of Non- Electronic Parameters in human body system. **CO3:** Ability to study the measurements of Sources of Bioelectric Parameters **CO4:** Ability to understand the instrumentation for sensory measurements and study of behaviour **CO5:** Ability to identifythe Safety and Prevention	

Mapping of Cos with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	1	2	3
CO 2	3	2	–	2	3
CO 3	3	2	1	2	3
CO 4	3	2	–	2	3
CO 5	3	2	2	2	3

Mean = 54/25 = 2.16

Semester	IV	Course Code	24PHUC2208
Course Title	ELECTRIC CIRCUITS AND MAGNETIC PROPERTIES		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revisioneffected **(Minimum 20%)**	-
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives(Maximum: 5)	**The Course aims to** 1. Provide knowledge of electrical network theoremand electrical component properties. 2. Give inputs regarding various combinations of R, Land C so that these circuits will be understood. 3. Understand the magnetic properties of materials.		

UNIT	Content	No. of Hours
I	**NETWORK THEOREM:** Thevenin's theorem – Norton's theorem – Superposition theorems - Maximum power transfer theorem – solving networks using theorems- current through the galvanometer in an unbalanced Wheatstone's bridge – sensitivity of Wheatstone's bridge – Carey Foster's bridge – Calibration of Carey Foster's bridge – Kelvin's double bridge. Ballistic Galvanometer – its theory and damping correction.	12
II	**TRANSIENT PHENOMENA:** Growth and decay of current in an LR circuit-time constant – charging and discharging of a capacitor through a resistor – CR and LCR circuits measurement of High resistance by leakage – mutual inductance between a pair of coils – self inductance by Rayleigh's bridge.	14

III	**AC CIRCUIT THEORY :** AC quantities as vectors – LR, CR, LCR series and parallel circuits – resonance, sharpness of resonance – Q factor of a coil, power in AC circuits – AC bridges – Maxwell's bridge – Schering bridge – De Sauty's bridge – Anderson's bridge.	10
IV	**THERMOELECTRICITY:** Seeback effect – Peltier – Thompson effect – their origin and applications – Application of thermodynamics to thermoelectric effects – Thermoelectric power – measurement of thermo emf using potentiometer – Thermoelectric diagrams.	14
V	**MAGNETIC PROPERTIES :** Intensity of Magnetisation – Susceptibility, permeability and their relations hysterisis curve and its applications – basic concepts of Ferro, dia and paramagnetism – force on a dia and para magnetic substances in a homogeneous field – Guoy's method of determining susceptibility.	14
References	**Text Books** 1. For Network Theorems: relevant sections of Direct and Alternating current circuits – B. Grab, McGraw Hill Book Co., Newyork Updated Edition (International edition 1986) 2. Fundamentals of Physics – IV Edn., David Holliday, Robert Resnick and Jearl Walker – Asian Books, New Delhi (2010) Relevant Sections. 3. Electricity and magnetism – K.K. Tiwari, S. Chand and Co., Updated Edition 4. Electricity and Magnetism – Sehgal – Chopra – Sehgal, Third Edition (1980), Sultan Chand & Sons.	
	Reference Books 1. Electrical Engineering fundamentals – Vincent Del Toro, PHI, New Delhi 1989. **2.** Electricity and Magnetism – C.J. Smith, Third Edition, Radha Publishing House, Calcutta.	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To understand the basic theorem involved in a circuit and to analyze different circuits. **CO 2:** To study the transient phenomenon in LR, RC and LCR circuits. **CO 3:** To analyze the AC various AC bridge circiuts **CO 4:** To have knowledge on thermoelectricity and its applications. **CO 5:** To learn and distinguish the magnetic materials based on their magnetic properties.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	3	2	1
CO 2	3	3	2	3	3
CO 3	3	3	2	3	3
CO 4	3	2	2	3	3
CO 5	3	2	1	2	3

Mean = 63/25= 2.52

Semester	IV	Course Code	24PHUC2209
Course Title	BASIC ELECTRONICS		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	30%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Provide knowledge of electronic devices and the way they work 2. Make the student understand the analysis of amplifiers circuits. 3. Impart knowledge on feedback amplifiers and their classification 4. Impart knowledge on power amplifiers and multivibrators. 5. Introduce special semiconductor devices.		

UNIT	Content	No. of Hours
I	**TRANSISTOR DEVICES**: Transistor structure – action of a transistor – relation between currents in a transistor – sign conventions – transistor as an amplifier – three configurations – CE, CB and CC – transistor characteristics in CE configuration – relation between alpha and beta – comparison between the three configurations – reasons for the choice of CE configuration – basic CE amplifier.	10
II	**SINGLESTAGE AND MULTISTAGE AMPLIFIERS:** single stage transistor amplifier – graphical method – calculation of gain – hybrid parameters – simplified model – amplifier analysis – Calculation of gain – input and output impedances.Gain of a multistage amplifier – decibel – coupling of two stages – RC coupling transformer coupling– frequency response of an RC coupled amplifier – bandwidth of an amplifier	10
III	**FEEDBACK AMPLIFIER** – Concept of feedback – types of feedback voltage gain with feedback – advantages of negative feedback – Oscillators – positive feedback amplifier as an oscillator – Hartley oscillator and Colpit's oscillator – Phase shift oscillator (no detailed derivation).	8

IV	**POWER AMPLIFIER:** Classification of power amplifier – Class A, Class B, Class C – Push pull amplifier – emitter follower. **MULTI VIBRATOR:** Astable, monostable, and bistable vibrator using transistors.	12
V	**SPECIAL SEMICONDUCTOR DEVICES:** clipping and clamping circuits- integrating circuits – UJT - UJT relaxation oscillator, SCR characteristics – SCR as switch and rectifier**.**	8
Course Outcomes	**On completion of the course, students should be able to do** **CO 1**:Willbecapableofanalyzingtransistoramplifiers **CO 2**:Can design multistage transistor amplifiers **CO 3**:Willbecapableofdesigning and implementing opamp based circuits **CO4**:will be able to design digital circuits for specific applications **CO5**:Willbeable to fault find and rectify digital and analog circuits	
Reference	**Text Books:** 1. BhargavaNN,KulshreshtaDCandGuptaSC,Basicelectronicsandlinearcircuits,TataMcGrawHill(1984), UnitI: Chapter5,page126– 161,168– 173,Chapter8,page261– 278 UnitII:Chapter9,302– 320,Chapter12,page390– 402andChapter13, page413– 424. 2. JacobMillman,Microelectronics:DigitalandAnalogCircuitsandSystems,McGrawHill,Singapore(1979). UnitIII:Chapter16,page 569–573,577– 582 3. DonalPLeach.AlbertPaulMalvinoandGautamSaha,Digitalprinciplesandapplications,SeventhEdition,McGrawHill,NewDelhi(1986). UnitIV: Chapter2,page48–56,Chapter3,page74– 101,Chapter6, Page 226–228. UnitV:Chapter8,page 270– 286,288– 289,Chapter10,page341– 346, 349–356,360– 367.	
	BOOKS FOR REFERENCE: 1. Digital Electronics, II Edition, W.H. Gothmann PHI, New Delhi (1991) 2. Digital Fundamentals, 3rd Edition, L.Floyd, Universal Book Stall, New Delhi (1998) 3. Digital Integrated Electronics, Herbert Taub and Donald Schilling, McGraw Hill,International Book Company, 11th Edition (1985). 4. Electronics devices and circuits by jacob millman and christos halkias black edition paperback – 8 october 2017	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	2	3
CO2	3	2	–	2	3
CO3	3	2	1	2	3
CO4	3	2	–	2	3
CO5	3	2	2	2	3

Mean = 54/ 25 = 2.16

Semester	**IV**	Course Code	**24PHUC2210**
Course Title	**Vector analysis and Differential equations**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Provide the physical understanding of mathematical insight about allphysical items. 2. Value the liquid dynamics and charge properties of matter through themathematical formulation. 3. The applications of special functions in electro dynamics andelectromagnetic		

UNIT	Content	No. of Hours
I	Differentiation of vectors – Scalar and vector point functions – gradient, divergence and curl of vector fields – vector integration – line integrals – surface integrals –volume integrals – divergence theorem – Stokes theorem and related problems.	10
II	Types of matrices – rank of a matrix – inverse of a matrix – eigen values and eigenvectors – diagonalisation – characteristic equation and Cayley Hamilton theorem.	9
III	Partial differential equation - Second order linear homogeneous differential equations – solution by power series method– important partial differential equations in Physics relevant problems – solutions by the separation ofvariables.	10
IV	Special functions – Bessel functions – generating functions – recurrence relations – Legendre differential equation – Power series solution – Legendre polynomials – generating functions – recurrence relations.	10
V	Beta – Gamma functions – Fourier series - and Fourier transforms and applications - Summing of Infinite Series, Term-by-Term - differentiation and integration of Fourier Series, Parseval Identity.	9

References	**Text Books** Mathematical Physics, H.K.Dass, Fourth revised edition 2003. Unit I : Pages 336– 389 Unit II : Pages 196 – 199, 250 – 259 and PP 271 – 277, Unit III : Pages 601 – 604, and 637– 664, Unit IV : Pages 548– 551, 562 – 573, 581 – 594 Unit V : Pages 778 – 782, 861 – 874, 1086 – 1101
	Reference Books 1. Introduction to Mathematical Physics – Charley Harper – PHI India. 2. Mathematical Physics – P.K. Chattopadhyoy – Wiley Eastern Ltd., 3. Advanced engineering Mathematics – Erwin Kreyzik – Wiley Ltd.
Course outcomes	**On completion of the course, students should be able to do** **CO 1:** To make the students to explore the conceptualization of the scalar and vectorial functions using different vector operators, through the vector dot and vector cross product. **CO 2:** To give the students the highly perspective transformation theorems to make them understand the configurational geometry ofsystems. **CO3:** To know the matrix methods of diagonalization, finding inverse, and to find the eigenvectors by utilizing Cayley– Hamilton theorem. **CO 4:**To give knowledge on the basic behaviours of the systems and to understand through first order, second order linear homogenous differential equations and to ease them through partial differential equation via variable separable method. **CO 5:** To solve the differential equations and obtaining solutions for them in terms of power series method. To learn the concepts of Fourier series and Fourier transforms and its related applications besides gammaand beta functions.

Mapping of COs with PSOs:

CO \ PSO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3
CO2	2	3	3	2	2
CO3	2	3	2	2	3
CO4	1	3	3	–	2
CO5	2	3	3	–	3

Mean = 58/ 25= 2.32

Semester	**IV**	Course Code	**24PHUC2211**
Course Title	**PRACTICAL – IV**		
No. of Credits	2	No. of contact hours per Week	6
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To understand the heat conduction phenomena through some standardexperiments. 2. To evaluate the current sensitivity and voltage sensitivity of voltmeters and ammeters through some experiments . 3. To understand the AC circuit phenomena of active and passive discrete component 4. Comprehensive coverage of requisite practicals for 2 sessions (Minimum 16)		

UNIT	Content	No. of Hours
I	1. Measurement of temperature using various principlesexpansion of solids – liquids and gases – resistance thermocouple – Selection of thermometer for different purposes. 2. Measurement of heat energy – method of mixtures – Specific heat capacity of solids – liquids – Latent heat of fusion of ice and latent heat ofvaporization of water – Barton's correction. 3. Cooling curve for wax / naphthalene – Melting point. 4. Measurement of heat energy – Electrical method – specific heat capacity of solids and liquids – Barton's correction. 5. Study and Measurement of Calorific value of fuels – Bomb Calorimeter 6. Thermal conductivity of a good conductor – Lee's Discmethod 7. Thermal conductivity of a good conductor – Forbe's method	3

	8. Verification of Stefan's law. 9. Figure of merit of a Table galvanometer 10. Conversion of a galvanometer into an ammeter and voltmeter and their calibration.	
	11. Figure of merit of a Table galvanometer 12. Suspended coil Galvanometer – i) Measurement of low voltage – emf of Thermocouple. ii)Measurement of current – conversion into milli–voltmeter iii)Measurement of resistance 13. Ballistic galvanometer i)Figure merit and measurement of charge ii)Capacitance of a capacitor iii)Self inductance of a coil iv)Mutual inductance between a pair of coils v)High resistance by leakage vi)Measurement of current and resistance 14. Measurement of time constants of circuits – LR, CR	

Semester	**IV**	Course Code	**24PHUA2201**
Course Title	**ELECTRICAL MEASUREMENTS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Ability Enhancement Course**		
Scope of the Course	• Basic Skill / Advanced Skill		
Cognitive Levels addressed by the Course	• **K– 1: (Understand)** • **K– 2: (Apply)** • **K– 3: (Analyze)**		
Course Objectives (Maximum: 5)	**The Course aims to** 1. The principle of operation of ac voltmeters and milli voltmeters with preamplifiers will be introduced.		

UNIT	Content	No. of Hours
I	Instruments accuracy – precision – sensitivity – resolution range etc. Errors in measurements and loading effects. Multimeter – Principles of measurement of dc voltage and dc current – ac voltage – ac current and resistance. Specifications of a multimeter and their significance. Electronic Voltmeter – Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage – measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter – Type of AC millivoltmeters – Amplifier – rectifier – and rectifier – amplifier. Block diagram AC millivoltmeter – specifications and their significance.	10

II	Block diagram of basic CRO – Construction of CRT– Electron gun – electrostatic focusing and acceleration (Explanation only – no mathematical treatment) – brief discussion on screen phosphor – visual persistence and chemical composition – Time base operation – synchronization – Front panel controls – Specifications of a CRO and their significance – Use of CRO for the measurement of voltage (dc and ac frequency) – time period. Special features of dual trace – introduction to digital Oscilloscope – probes – Digital storage Oscilloscope – Block diagram and principle of working.	10
III	Block diagram – explanation and specifications of low frequency signal generators – pulse generator – and function generator – Brief idea for testing – specifications – Distortionfactor meter– wave analysis.	8
IV	Block diagram of bridge – working principles of basic (balancing type) RLC bridge – Specifications of RLC bridge – Block diagram and working principles of a Q – Meter– Digital LCR bridges.	10
V	Principle and working of digital meters – Comparison of analog and digital instruments – Characteristics of a digital meter – Working principles of digital voltmeter – Digital Multimeter – Block diagram and working of a digital multimeter – Working principle of time interval – frequency and period measurement using universal counter/ frequency counter – time– base stability – accuracy and resolution.	10
References	**REFERENCE BOOKS:** A text book in Electrical Technology – B L Theraja – S Chand and Co. Performance and design of AC machines – M G Say ELBS Edn. DigitalCircuits and systems, Venugopal, 2011, Tata McGrawHill. Logic circuit design, Shimon P. Vingron, 2012, Springer. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning. Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc– Graw Hill Electronic circuits– Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India	

Course Outcomes	**On completion of the course, students should be able to do** CO1: Will have a sound knowledge of terms like precision and accuracy. CO2: Will be capable of testing and standardizing meters like voltmeter, ammeter and ohmmeter. CO3: Can make measurement of voltages, phase changes and frequencyusing CROs. CO4: Will be capable of testing the goodness of signal generators. CO5: Can work with resonant circuits and design them.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	1	3	2
CO2	3	3	1	3	2
CO3	3	2	1	3	2
CO4	3	2	–	3	2
CO5	3	2	2	3	2

Mean = 57/ 25 = 2.28

Semester	**IV**	Course Code	**24PHUA2202**
Course Title	**WEATHER FORECASTING**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Ability Enhancement Course**		
Scope of the Course (may be more than one)	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressedby the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques		

UNIT	Content	No. of Hours
I	**Introduction to atmosphere:** Elementary idea of atmosphere – physical structure and composition – compositional layering of the atmosphere – variation of pressure and temperature – with height – air temperature – requirements to measure air temperature – temperature sensors – types – atmospheric pressure – its measurement – cyclones and anticyclones – its characteristics.	10
II	**Measuring the weather:** Wind – forces acting to produce wind – wind speed direction – units – its direction – measuring wind speed and direction – humidity – clouds and rainfall – radiation– absorption – emission and scattering in atmosphere – radiation laws.	10
III	**Weather systems:** Global wind systems– air masses and fronts – classifications – jet streams – local thunderstorms – tropical cyclones – classification – tornadoes – hurricanes.	8

IV	**Climate and Climate Change:** Climate – its classification – causes of climate change – global warming and its outcomes – air pollution – aerosols – ozone depletion – acid rain – environmental issues related to climate.	10
V	**Basics of weather forecasting:** Weather forecasting – analysis and its historical background – need of measuring weather – types of weather forecasting – weather forecasting methods – criteria of choosing weather station – basics of choosing site and exposure – satellites observations in weather forecasting – weather maps – uncertainty and predictability – probability forecasts.	10
References	**Text Books :** 1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books 2. The weather Observers Hand book, Stephen Burt, 2012, CambridgeUniversity Press. 3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur. 4. Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers,Nagpur. 5. Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London. 6. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.	
Course Outcomes	**On completion of the course, students should be able to do** CO 1: Define the physical structure and compositional layering of theatmosphere. CO 2: Explain the variation of pressure and temperature at the atmosphere.CO 3: Define characteristics of cyclones and anticyclones. CO 4: State the measuring methods of wind speed and direction. CO 5: Explain about the radiation, absorption, emission and scattering in theatmosphere.	

Mapping of Cos with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	2	1	2	2
CO 2	3	2	2	2	1
CO 3	3	3	3	2	–
CO 4	3	2	2	2	1
CO 5	3	3	1	3	2

Mean = 53/25 = 2.12

Semester	IV	Course Code	**24PHUA2203**
Course Title	**INTRODUCTION TO ASTROPHYSICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Ability Enhancement Course**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course objectives (Maximum: 5)	**The Course aims** 1. To get a insight about a milky way galaxy. 2. To get knowledge about Surface temperatures of the stars through various physical models.		

UNIT	Content	No. of Hours
I	**Astronomical Instruments:** Light and its Properties –The Earth's Atmosphere and the Electromagnetic Radiation – Optical Telescopes – Radio Telescopes –The Hubble Space Telescope (HST) – Astronomical Spectrographs – Photographic Photometry – Photoelectric Photometry – Spectrophotometry – Detectors and Image Processing.	10
II	**Distances of stars:** Stellar Magnitude Sequence – Absolute Magnitude and the Distance Modulus – The Bolometric Magnitude – Different Magnitude Standards – The UBV system and six – colour Photometry – Radiometric Magnitudes – The colour – index of a star – Luminosities of Stars– Stellar Parallax (Trignometric) and the Units of Stellar Distances – Stellar Positions – The Celestial Coordinates – Stellar Motions –The Solar Motion and the Peculiar Velocities of Stars – The Velocity Dispersion – Statistical Parallax – Moving Cluster Parallax.	10

III	**Radio Galaxies:** Techniques of Identification of Radio Objects – Structures of Radio Galaxies – Classification of Radio Galaxies and Their Typical Characteristics – Energy Processes in Radio Galaxies – Radio Galaxies in Evolutionary Sequence – Some Important Radio Galaxies – Seyfert Galaxies Quasars – The Discovery – Radio Properties – Optical Properties – The Red Shift of Quasars – Active Galactic Nuclei.	10
IV	**Milky way Galaxy:** Rotation of the Galaxy – Differential Rotatio – Determination of the Rotation Parameters in the Solar Neighborhood – Radio Observation of the Galaxy at 21– cm Wave Length – The Rotation Curve of the Galaxy –The General Rotation Law – Density Distribution of Gas and Spiral Structure of the Galaxy – Radio and Optical Data –The General Structure of the Galaxy – The Mass of the Galaxy – Magnetic Field in the Galaxy – Cosmic Rays – Continuous Radio Emission in the Galaxy.	10
V	**Cosmology:** Redshift and the Expansion of the Universe – Matter Density in the Universe and the Deceleration Parameter – The Cosmological Principle – Fundamental Equations of Cosmology – The Current Theories – Some Important Models of the Universe – Observational Tests of Cosmological Models – The Cosmic Microwave Background Radiation.	8
References	**Text Books** An Introduction to Astro Physics – Baidyanath Basu, Tanuka Chattopadhyay, sudhindra Nath Biswas, Second Edition (2010), PHI Learning Private Limited. Unit I : Chapter 1 Pages 1to26 Unit II : Chapter 3 Pages 56 to 76 Unit III : Chapter 19 & 20 Pages 506 to 535 Unit IV : Chapter 16 Pages 390 to 426 Unit V : Chapter 21 Pages 536 to 565	
	Reference Books 1. A beginner's guide to the universe – Chaisson, E. and McMillan, S., 1998.Astronomy:. Prentice Hall. 2. Fundamental astronomy – Karttunen, H., Kröger, P., Oja, H., Poutanen, M. andDonner,K.J. eds., 2016. Springer. 3. Astrophysics: stars and galaxies – Abhyankar, Krishna Damodar. UniversitiesPress, 2002. 4. Mathematical cosmology and extragalactic astronomy. Segal, Irving Ezra.Vol. 68.Academic Press, 1976. 5. James Binney – Astrophysics a very short introduction – Oxford university press 6. Extragalacic astronomy and Cosmology – An introduction. Peter Schneider, Springer 7. An introduction to modern astrophysics. Carroll, Bradley W., and Dale A. Ostlie. Cambridge University Press, 2017.	

Course Outcomes	**On completion of the course, students should be able to** **CO 1:** View and visualize stellar atmosphere throughvarious sections. **CO 2: A**nalyze the Surface temperatures of the stars through various physical models and hence to classify various stars. **CO 3:** interpret the internal structures of the stars suggested by various theoretical models. **CO 4:** Explore the properties of the Milky Way galaxy through various theoretical information. **CO 5:** Find the status of the universe through various theoretical models and to understand the status of the universe in the past, in thepresent and in the future**.**

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	1
CO2	3	3	1	2	2
CO3	3	2	2	2	1
CO4	3	2	1	2	1
CO5	3	2	2	2	1

Mean = 67/25 = 2.68

Semester	V	Course Code	24PHUC3112
Course Title	ATOMIC PHYSICS AND LASERS		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	➢ Basic Skill / Advanced Skill ➢ Skill Development		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. The development of Physics concepts are introduced in the order of the development of concepts. Also the advanced level optics utilization principles areintroduced in the form of lasers.		

UNIT	Content	No. of Hours
I	**Particle properties of waves:** Electromagnetic Waves – Black body radiation – Photoelectric Effect –What is Light–Compton Effect. Waves Properties of Particle – deBroglie waves– waves of Probability– The general formula for waves–Phase and group Velocities–Particle Diffraction.	13
II	**X– rays:** Waves nature of X– rays – Diffraction of X– rays by crystals – Bragg's Law– reflection of X– rays – experimental methods of measuring μ for X– rays – Scattering of X– rays– Polarization of X– rays.	13
III	**Alkali Spectra:** Space quantization and normal Zeeman effect – Electron spin –vector model of atom – Doublet structure of the alkali spectral lines – Fine structure of the hydrogen spectral terms – Pauli's exclusion principle – periodic classification of elements – Arrangement of electrons in atoms – Energy levels of complex atoms – Anamalous Zeeman effect –Paschen–Back effect–Sternand Gerlach's experiment–Starkeffect.	13

IV	**Lasers:** Characteristics of laser - Spontaneous and stimulated emissions - Main Components of the laser – Optical Resonators–Einstein Coefficients and Optical Amplification – Population Inversion - Cavity Lifetime - Threshold Condition – The Line Shape Function–Ruby Laser– He– Ne Laser –Typical Parameters for a Rubylaser.	13
V	**FiberOptic communication:** Total Internal Reflection – The Optical Fiber–The Coherent Bundle – The numerical Aperture–Attenuation in Optical Fibers–Single Mode and Multimode Fibers –Spot size - Splice loss - Step index and parabolic index fibers - Pulse Dispersion - Ray dispersion - Material dispersion – Dispersion and Maximum Bit Rates –Waveguide Dispersion–Dispersion Compensating Fibers – FiberOptic Sensors.	12
Course Outcomes	**Oncompletionofthecourse,studentswill be able to** **CO 1:**realise theparticleand wavenatureandits behavior. **CO 2:**calculate the wavelength, refractive index ofX– rays. **CO3:**reason out theeffectofelectricandmagneticfields onthe moleculesandexplorationofspectraldata. **CO 4:**willbeawareofdifferentkindsoflaserandits importance. **CO5:**willbe able to use optical fibers for different applications.	
Reference	**TextBooks:** 1. Concepts of Modern Physics – Arthur Beiser, Tata McGraw– Hill PublishingCompanyLimited, Sixthedition.UnitI– pagenumber53– 79and93– 106. 2. AtomicPhysics –J.B.Rajam,S.Chand& CompanyLtd.,(2004) UnitII– PageNumber:267– 304. 3. AtomicPhysics(ModernPhysics)–S.N.Ghoshal,S.Chand& CompanyLtd., (2004)UnitIII:PageNumber:100– 141. 4. Optics, AjoyGhatak– (2005) by Tata Mc Graw– Hill, 2nd Edition2005. Unit IV:Chapter23,Pages23.3– 23.36. UnitV:Chapter24,Pages24.3– 25.3.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	-
CO2	3	–	3	3	2
CO3	3	3	2	3	3
CO4	3	2	3	2	2
CO5	2	2	2	2	2

Mean =59/25= 2.36

Semester	V	Course Code	24PHUC3113
Course Title	NUCLEAR PHYSICS		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	30%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To understand the fundamental properties of atoms. 2. It gives a tool to understand different types of detectors. 3. It provides the uses of radioactive elements in medicine, agricultural and industrial areas.		

UNIT	Content	No. of Hours
I	**THE CONSTITUENTS OF NUCLEUS AND SOME OF THEIR PROPERTIES:** Introduction – Rutherford scattering an estimation of the nucleus size – measurement of nuclear radius – constituents of the nucleus and their properties – discovery of neutrons – nuclear spin – moments and statistics– Alpha decay – Beta decay and Gamma decay (Qualitative explanation only)	10
II	**RADIOACTIVITY:** Introduction – properties of radioactive rays – The law of radioactive decay – unit of activity – Radioactive growth and decay – ideal equilibrium – transient equilibrium and secular equilibrium – radioactive series – radioactive isotopes of lighter elements – Artificial radioactivity – determination of the age of the earth – carbon dating – archaeological time scale – illustrative examples.	10

III	**NUCLEAR REACTIONS:** Types of nuclear reactions – conservation laws – nuclear reaction kinematics – nuclear transmutations – transmutation of alpha particles – transmutation of protons – transmutation of neutrons – nuclear fission and fusion – atom bomb and hydrogen bomb. **NUCLEAR MODELS AND REACTORS:** Nuclear models – liquid drop model and shell model only – nuclear reactors – general design of a nuclear reactors (basic reactors) – swimming pool reactor – fast breeder reactor – chain reactions – fissile materials.	10
IV	**NUCLEAR DETECTORS:** Introduction – ionization chamber – Geiger Muller counter – scintillation counter – cloud chamber – bubble chamber – nuclear emulsions. **PARTICLE ACCELERATORS**: Low energy cyclic accelerators – cyclotron (fixed frequency) – variable energy cyclotron – betatron – linear accelerator (electron linear accelerators only)– synchrotron (synchro cyclotron only)	8
V	**COSMIC RAYS:** Introduction – secondary cosmic rays – geomagnetic effects – effects of sea level and low altitudes – effects at high altitudes – interpretation of geomagnetic effects – absorption of cosmic rays – energy of mass measurements of secondary cosmic rays – showers – Cosmic ray primaries – Origin of cosmic rays **ELEMENTARY PARTICLES:** Introduction – classification of elementary particles – particles and anti particles – conservation laws – properties of elementary particles (basic properties only) – electron – proton and antiproton – neutron and antineutron – neutrino and antineutrino.	10

References	**Text Books** 1. Nuclear Physics An Introduction by S.B.Patel (New age international (P) Ltd publishers– New Delhi– (2nd Edition)). Pages 112– 132, 57– 66,70– 87 2. Nuclear physics by D.C. Dhayal (Himalaya Publishing House– Fifth revised and enlarged edition. Pages: 129– 133,143– 148,148– 152,156– 159,159– 162,165– 168, 482– 491,501– 505, 401– 408, 358– 360, 360– 362, 578– 579, 585, 592– 594, 626– 628, 633– 636, 638, 649, 674– 683,686– 688,690– 691, 692– 705,707– 712,713,714,725,745–
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** To give better insight to the students to provoke the fundamental radioactive decay, the concept of alpha, beta and gammaand learn about radioactive disintegration in terms of mean life, half life. **CO 2:** To know the types of Nucleons manifesting in isotopes, isobarsand isotones. Furtherance, to understand the classifications of the light nuclei andheavy nuclei through empirical observations of binding energy per nucleon. **CO 3:** To cover the description and utilization of different types of accelerators and viabilities and their limitations. **CO 4:** To give inquisitive importance of the detectors such as ionizationchambers, GM counters and photo multiplier tubes and their characterization. **CO 5:** To give complete a account of presenting the cosmic rays and their phenomenological effects on Earth's magnetic field, the latitudeand altitude effect.

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	–	2
CO2	3	3	3	2	2
CO3	2	3	3	1	2
CO4	2	2	1	2	3
CO5	3	3	–	1	1

Mean= 52/25=2.08

Semester	V	Course Code	24PHUC3114
Course Title	**CLASSICAL MECHANICS AND RELATIVITY**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	30%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Understand the Newton's law, virtual work and D'Alember's principleunderstand the dynamical system moving with the relativistic speed.		
UNIT	Content		No. of Hours
I	**LAGRANGIAN DYNAMICS:** basic concepts – constraints– Holonomic constraint – Nonholonomic constraint – Examples - force of constraints – difficulties introduced by the constraints andtheir removal – Generalized coordinates – principle of Virtual work – D'Alembert's principle – Lagrange's equations from D'Alembert's principle – Lagrange's equations in presence of Non– conservative forces –– Hamiltonian's principle and Lagrange's equations.		12

II	**VARIATIONAL PRINCIPLES:** Introduction – the calculus of variations and Euler– Lagrange's equations – deduction of Hamiltonian's principle from D'Alembert's principle – modified Hamiltonian's principle – deduction of Hamiltonian's equations from modified Hamiltonian's principle (or variational principle) – deduction of Lagrange's equations from variational principle for non – conservative systems (Holonomic constraints).	12
III	**TWO BODY CENTRAL FORCE PROBLEM:** Reduction of two – body central force problem to the equivalent one – body problem – central force and motion in a plane – equations of motion under central force and first integrals – differential equation for an orbit – inverse square law of force – Kepler's law of plantery motion and their deduction – stability and closure of orbit under central force – artificial satellites – Virial theorem.	12
IV	**NONINERTIAL AND ROTATING COORDINATE SYSTEMS:** Non– inertial frames of reference – fictitious or Pseudo force – centrifugal force – uniformlyrotating frames – free fall of a body on Earth's surface – Foucault's pendulum.	14
V	**SPECIAL THEORY OF RELATIVITY:** Introduction – Galilean transformation – principle of relativity – transformation of force from one inertial system to another – covariance of the physical laws – speed of light – the Michelson – Morley experiments – postulates of special theory of relativity – Lorentz transformation – consequence – length contraction – simultaneity – time dilation – addition of velocities.	14
References	**BOOKS FOR STUDY** Classical Mechanics by J.C.UPADHAYA Himalaya Publishing Housesecond revised edition. Unit– I : Page no 27– 53. Unit– II : Page no 138– 149. Unit– III: Page no103– 125. Unit– IV: Page no 320– 329. Unit– V : Page no 334– 353. **BOOKS FOR REFERENCE** 1. Classical Mechanics– H. Goldstein – II Edition, Narosa PublishingHouse, New Delhi – 1995. 2. Mechanics – Schaum's series : Third Edition Chapter VII P.	

Course Outcomes	**On completion of the course, students should be able to do** CO 1: Understand the Newton's law, virtual work and D'Alember's principle CO 2: Apply the Hamiltonian's and Lagrangian principle to solve the equationof motion for any mechanical problem. CO 3: Solve the mechanical problem of dynamical system moving withconstraints CO 4: Reduce the two– body problem to one – body problem CO 5: Understand the dynamical system moving with the relativistic speed.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	3	3	3	3	1
CO2	3	3	3	3	–
CO3	3	3	3	3	2
CO4	3	3	3	3	2
CO5	3	3	3	3	–

Mean= 65/25=2.6

Semester	V	Course Code	24PHUC3115
Course Title	PRACTICAL V		
No. of Credits	2	No. of contact hours per Week	6
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	1. Hands on training on sophisticated and ordinary instruments operation and theiruses have been exposed		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To giver Hands on training on sophisticated and ordinary instruments operation. 2. To understand about the Maintenance, reassembling and servicing. 3. Comprehensive coverage of requisite practicals for 2 sessions (Minimum 16)		

UNIT	Content	No. of Hours
1	1. Study of CRO and its uses and study of Functiongenerator. Testing of diodes, transistors. 2. Factors affecting induced emf in a coil and factors that determine the secondary emf and current in coupled coils – CRO 3. AC circuits – phase lead, phase lag and impedance 4. Measurement of inductance and capacitance – AC Bridges Maxwell and Owen. 5. Simple wiring 6. Study of Hysteresis of magnetic material 7. LCR circuits – series and parallel resonance –sharpness resonance and Q factor. 8. Study of motors 9. Maintenance, reassembling and Servicing ofBalances , Telescopes, MicroscopesRheostats Galvanometers, Ammeters & Voltmeters 10. Hands on training in using simple tools 11. 11.Voltage multipliers– diodes, Characteristic of a Transistor CE– mode– measurement of h parameters– loadline 12. FET characteristics – measurement of parameters 13. Design and study of a power supply with filter circuit 14. Design and study of a regulated power supply. 15. Design and study of a single stage voltage amplifier – BJT & FET. 16. Design and study of Hartley and Colpitt's oscillators Study of Transducers.	3

Semester	V	Course Code	24PHUB3101
Course Title	PHYSICS OF SOUND AND ACOUSTICS		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	NEW	If revised, Percentage of Revision effected (Minimum 20%)	-
Category	Minor		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed bythe Course	• **K– 1: (Remember)** • **K– 2: (Understand)** • **K– 3: (Apply)** • **K– 4: (Analyze)** • **K– 5: (Evaluate)** • **K– 6: (Create)**		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To understand about basic ideas of sound. 2. To give understanding about electronic instruments in sound.		

UNIT	Content	No. of Hours
I	**BASIC IDEAS OF SOUND:** Wave motion – types of waves – simple Harmonic motion – Properties of sound waves – reflection – refraction – diffraction and interference of sound – velocity of sound – standing waves – Beats – Resonance.	14
II	**PROPERTIES OF SOUND:** The ear – pitch loudness and quality of musical notes – just noticeable difference in pitch – barrel hearing – aural or combination tones – subjective tones – subjective music – vibrato and tremolo – pitch range of musical instruments – quality – Fourier's theorem.	14
III	**SOUND INSTRUMENTS**: String instruments – frequency of stretched strings – longitudinal vibration in strings – plucked – bowed and struck stringed instruments – one example for each from Carnatic Hindustani and western. Wind Instruments modes of oscillation in open and closed pipes – Different types of wind instruments – examples from Carnatic and western – Vibrations in Stretched Membranesand Plates. Drums – cymbals etc.	14
IV	**ELECTRONIC INSTRUMENTS OF SOUND:** Microphones (carbon and crystal) – pickup – Loud speaker – Amplifiers –Addition of sound – santoors INSTRUMENT	9

V	**ACOUSTICS OF BUILDINGS:** Tape recording and playback equalizers – Recording and reproduction of sound in cine films. Acoustic of Buildings – Acoustics – Reverberation and Reverberation time – Acoustic measurements – Acoustic intensity level – Acoustic pressure level – Factors affecting the acoustics of buildings – sound distribution inan Auditorium – Requisites for good acoustics.	13
References	**Text Books** 1. Physics of Musical sounds – Askill.J 2. Physics for you – Johnson. K 3. Waves – Berkely 4. Sound and Ultra sound – Freeman I.M. 5. Home Science Physics – Renganayakiamma 6. Musical Instruments of India – Krishnasami. S 7. Text book of Sound– Brijlal and Subramanyam 8. Instrumentation and Analysis – Nakra and Choudry.	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Explain the types of wave motion **CO 2:** Indicate the different Properties of sound waves **CO 3:** Describe the musical scales and frequency rates. **CO 4:** Explain the modes and vibrations in stretched membranes. **CO 5:** Determine the acoustic intensity and pressure level of an auditorium.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	–	1	1
CO2	3	3	1	2	2
CO3	3	2	–	3	2
CO4	3	3	1	2	2
CO5	3	3	1	2	2

Mean = 51/25 = 2.04

Semester	VI	Course Code	24PHUC3216
Course Title	**ELECTROMAGNETICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected (Minimum 20%)	20%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims** 1. Tomakethestudentsunderstandthebasicconceptsinvolvedinelectrostaticsandelectromagnetics 2. To enable the students to solve problems involving electric field intensity,electricpotentialundervarioussituations 3. Togiveaknowledgeonthefundamentalsofelectromagneticssothattheycanbeemployedinfuturehigherstudies. 4. Toeducatethestudentstoapplytheknowledgeofelectromagneticinductioninrealtimeproblems		

UNIT	Content	No. of Hours
I	**Electrostatic fields in vacuum**: Coulombs law– Gauss's law – the average potential over a spherical surface– Poisson and Laplace equations– conductors – calculation of electric field produced by a simple charge distribution – Field due to a uniform spherical charge distribution – calculation of electric field inside and outside – Electric dipole – Linear Quadrupole – Multipole – Electric field inside and outside an arbitrary charge distribution – potential energy of a charge distribution – energy density in an electricfield – forces on conductors – parallel plate capacitors.	14
II	**Electrostatic fields in dielectric medium**: Electric polarization – electricfield at an exterior point– electricfield at an interior point– electricfield intensities due to distant and near dipoles– relative permittivity and	13

	Poisson's equation for dielectrics– calculation of electricfield involving dielectrics– dielectric insulated parallel plate capacitor– free charge density– bound charge density and electric displacement at a dielectric conductor boundary– dielectric sphere with a point charge at its center – Bar electret.	
III	**Steady currents and nonmagnetic materials**: Magnetic forces – magnetic induction B – Biot – Savart law – magnetic induction due to a current flowing in a long straight wire – forces between two long parallel wires– circular loop– Force on a point charge moving in a magneticfield – Halleffect in semiconductors– TheHodoscope- divergence of the magnetic induction – vector potential – long straight wire– pair of long parallel wires curl of the magnetic induction – ampere's circuit allaw– long cylindrical conductor– long solenoid– short solenoid.	13
IV	**Magnetic Induction and magnetic energy**: Faraday's law of induction –Induced electricfield intensity in terms of vector potential – electromotance induced in a loop by a pair of long parallel wires – induced electromotance in a moving system – electromotance induced in a fixed loop in a time dependent magnetic field – electromotance induced in a loop rotating in a fixed magnetic field– mutual inductance– self– inductance of a long solenoid – mutual inductance between two coaxial solenoids – coefficient of coupling.	12
V	**Magnetic materials:** Magnetization –Magnetic induction at an exterior point – at an interior point – Magnetic field intensity –Magnetic susceptibility and relative permeability – Hysteresis –energy dissipated in a hysteresis cycle. **Maxwell'sequations**: Differential form–Integral form– Duality – Lorentz's Lemma–Non– homogeneous equations for E and B.	12

References	**Text Books (with chapter number &pagenumber, wherever needed):** Electromagnetic fields and Waves– Paul Lorrain and Dale Corson, IIEdn. CBSPublishers and Distributors(1986). Pre– requisite: Chapter1. Unit 1.Chapter2:Pages40– 81 Unit 2.Chapter3:Pages91– 115 Unit 3Chapter 7:Pages292 –323 Unit4.Chapter8:Pages332 – 364 Unit5:Chapter9:Pages383 to400&Chapter 10:Pages 439to450.
	ReferenceBooks: 1. Electromagnetic waves and Radiating systems, II Edn. Edward C. Jordon&KeithG..Balmain,PrenticeHallofIndiaPvt.Ltd.,NewDelhi (1993). 2. TheFeynmanLecturesonPhysics,Vol.2 Feynman,LeightonandSands NarosaPublishingHouse,1964,Reprint(1993).
	RelatedOnlineCourses–MOOC https://www.edx.org/course/dian– ci– xue– electromagnetism– tsinghuax– uphys3xhttps://www.edx.org/course/electricity– and– magnetism– magnetic– fields– and– forceshttps://www.edx.org/course/electricity– and– magnetism– electrostaticshttps://www.edx.org/course/preparing– ap– physics– c– electricity– georgetownx– phyx152x– 1 https://www.edx.org/course/apr– physics– 2– part– 2– electricity– ricex– advphy2– 2x– 0
Course Outcomes	**Oncompletionofthecourse,students shouldbeableto** **CO1:**Apply Gauss'slaw and calculateelectric fieldintensityon different chargedistributions **CO2:**Calculate electric field involving dielectric and estimate the capacitance of dielectrics. **CO3:**Analysemagneticfieldsinclosedconductingwires likesolenoid,torroids,etc., **CO4:**Solveproblemsin movingsystemswiththeknowledgeofmagneticinduction **CO5:**Determine magnetization of different magnetic materials and apply Maxwell'sequations

Mapping of Cos with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	–	1
CO2	2	3	3	2	2
CO3	3	2	3	–	1
CO4	2	3	3	2	3
CO5	2	3	3	2	2

Mean = 55/25 = 2.2

Semester	VI	Course Code	**24PHUC3217**
Course Title	**FUNDAMENTALS OF SPECTROSCOPY**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	40%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• **K– 1: (Understand)** • **K– 2: (Apply)** • **K– 3: (Analyze)**		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Understanding the basics of spectroscopy and the interaction of atomswith electric, magnetic fields.		

UNIT	Content	No. of Hours
I	**Spectra of Atoms:** Hydrogen Spectrum – Angular Momentum – Larmor Precession – Energy of a Magnetic Moment in a Magnetic Field – The Vector Atom Model – Spin– Orbit Interaction – Spectra of Alkali Atoms – Angular Momentum of Many Electron Atoms – Energy Levels and Spectral Transitions of Helium – Spectral Terms of Equivalent Electrons – Normal Zeeman Effect – Anomalous Zeeman Effect – Paschen – Bach Effect – Influence of Nuclear Spin– Hyperfine Structure – Stark Effect – RydbergAtoms – Lamb Shift.	14
II	**Electronic Spectroscopy:** Electronic Spectra of diatomic molecules – The Born – Oppenheimer Approximation – Vibrational Coarse Structure – Franck – Condon Principle – Dissociation Energy and Dissociation Products – Rotational Fine Structure of Electronic– Vibration Transitions – Fortrat Diagram – Pre dissociation.	12

III	S**pectrophotometry:** Theory of spectrophotometry – Lambart's law – Beer's law – Deviation from Beer's law – Instrumentation– UV Visible and PL - Source – Filters and monochromators – Sample cells – Detection – photo electric colorimeters – single beam and double beam instruments.	14
IV	**FTIR:** The vibrating diatomic molecule – Energy of a diatomic molecule – simple harmonic oscillator – Anharmonic oscillator – Diatomic vibrating rotator – vibrations of polyatomic molecules – fundamental vibrations and their symmetry – Overtones and combination frequencies – Double and single beam I.R. spectrophotometer operation. postulates of quantum mechanics – simultaneous – measurability of observables – general uncertainty relation – relevant problems.	12
V	**Raman Spectroscopy:** Quantum and classical theory of Raman effect – Pure rotational Raman spectra of linear molecules – Rule of mutual exclusion – Vibrational Raman spectra – Rotational fine structure –Techniques andInstrumentation.	12
References	**BOOKS FOR STUDY AND REFERENCE:** 1. Molecular structure and Spectroscopy, G.Aruldhas, Prentice Hallof India Private Limited, New Delhi – 110 001, Third Printing. Unit I : Page No: 56 – 91 2. Fundamentals of Molecular Spectroscopy, C.N. Banwell andM.Mc. Cash, IVth Edition, Tata McGraw Hill (1996). Unit– III: Pages: 55–66; 71–75; 91–93, chapter 3. Unit– IV: Pages: 100–106; 112, 113–116; 119–124 .	
Course Outcomes	**On completion of the course, students should be able to do** **CO 1: W**ill become capable of understanding the basics of spectroscopy and the interaction of atoms with electric, magneticfields. **CO2:** Will be able to analyze and apply visible spectrometry. **CO 3:** Will be capable of understanding various kinds of vibrations ondifferent molecules and IR instrumentation. **CO 4:** Will be able to do structural exploration through IR and Ramanspectra. **CO 5:** Will be aware of electronic – vibration transitions and Born–Oppenheimer approximation	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	–
CO2	3	3	3	2	2
CO3	3	2	3	3	–
CO4	3	2	3	3	1
CO5	3	3	2	–	1

Mean = 55 / 25 = 2.2

Semester	VI	Course Code	24PHUC3218
Course Title	**FUNDAMENTAL CONCEPTS OF QUANTUM MECHANICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	1. Application of quantum mechanics as a tool to solve fundamental physics problems		

UNIT	Content	No. of Hours
I	**Origin of the Quantum Theory:** Limitation of classical physics– Planck`s quantum hypothesis – Einstein`s theory of photoelectric effect – Compton effect – quantum theory of specific heat – Bohr theory of Hydrogen atom– existence of stationary states – Wilson – Somerfield quantization rule – particle in a box – the correspondence principle - the Stern – Gerlach experiment.	14
II	**Wave Mechanical Concepts:** Wave nature of particle – the uncertainty principle – the principle of superposition – De Broglie concept – Heisenberg Concept - wave packet – time dependent Schrodinger equation – interpretation of wave function – Eherenfest theorem – time independent Schrodinger equation – Stationary states – admissibility condition on the wave function.	14

III	**General Formalism of Quantum Mechanics:** Linear operator – Eigen function and eigen values – Hermitian operator – postulates of quantum mechanics – simultaneous measurability of observables – general uncertainty relation – relevant problems.	12
IV	**One Dimensional Energy Eigen value Problems:** Square – well potential with rigid walls – square well potential with finite walls – square potential barrier – alpha emission – linear harmonic oscillator.	12
V	**Three Dimensional Energy Eigen value Problems:** spherically symmetric potential – Hydrogen atom - Rigid rotator– three dimensional square well potential.	12
References	**BOOKS FOR STUDY AND REFERENCE:** Quantum Mechanics by G.Aruldhas (PHI) –revised edition 2008. Unit I : Pages: 1 to 21 of chapter 1. Unit II : Pages 22 to 48 of chapter 2. Unit III : Pages 53 to 62 of chapter 3. Unit IV : Pages 81 to 90 and pages 95 to 100. Unit V : Pages 114 to 130 and 132 of chapter 5.	
	BOOK FOR REFERENCES: 1. Quantum Mechanics by J.L. Powell and B. Crasemann, Oxford & IBHPublishing (1961). 2. A Text book of Quantum Mechanics by P.M.Mathews andK.Venkatesan,TMH (1971)	
Course Outcomes	**On completion of the course, students should be able to do** CO1: Understand the limitations of classical physics and the need ofquantum theory **CO2: U**nderstand the importance of wave– particle duality and de braglie concept **CO3:** Understand the general formalism of quantum mechanics, uncertainty principle and Schrödinger wave equation **CO4:** Apply the quantum mechanical formalism and Schrödinger equation to solve problems one dimensional, three dimensional eigen value problems: square well potential, harmonic oscillator and hydrogen atom **CO 5:** Understand the applications of quantum mechanical tunnelling to alpha particle emission, tunnel diode, TEM etc. and to appreciate the same.	

Mapping of COs with PSOs:

CO \ PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	2	3
CO5	1	1	1	1	3

Mean = 66/25=2.64

Semester	VI	Course Code	24PHUC3219
Course Title	**SOLID STATE PHYSICS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels Addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Acquire the knowledge of fundamental principles, phenomena and concepts in solid state physics. 2. Understand and describe the different experimental X– ray diffraction methods and lattice vibration, free– electron, band theories of solids. 3. Explain the theories underlying dielectric, optical, magnetic andsuperconductive properties. 4. Classify the properties of semiconductors, dielectrics, optical, magnetic andsuperconductive materials. 5. Apply the theories to explain the properties of solids.		
UNIT	Content		No. of Hours
I	**Crystals:** basis – lattice – unit cell - lattice parameters – Reciprocal Lattice - Bravais lattices – crystal systems - symmetry operations – symmetry elements in cubic crystals – five – fold rotation is not possible proof - combination of symmetry elements – Rotation – Inversion axis – translation symmetry elements – Space groups – the Bravais space lattices – Metallic crystal structure – Relation between the density of crystal Material and Lattice constants in a cubic lattice – Other cubic structures.		10

II	**Crystal Planes:** Directions –Miller Indices – significance – important planes with triggers in cubic crystal - distribution of atoms in the atomic plane of simple cubic crystal **X-ray methods:** Braggs X– ray Spectrometer – Powder Crystal method – Rotating Crystal Method.	9
III	**Lattice specific heat**: – Classical theory – Einstein's theory of Specific Heat – Debye's theory of Specific Heat – vibrational modes of a continuous medium – density of vibrational modes – Debye approximation.	9
IV	**Superconductivity**: – Definition - Joule heating – Mechanism of superconductors – Effect of Magnetic field – A.C. Resistivity – Critical currents – Meissner Effect – Thermal properties – The Energy Gap – mechanical effects – The penetration depth – classification of superconductors – London Equations.	10
V	**Semiconductors:** Introduction – The Band structure of Semiconductors – Intrinsic semiconductors – Conductivity and temperature – Statistics of electrons and holes in intrinsic semiconductors – statistics of extrinsic semiconductors – mechanism of current conduction in semiconductors.	10
References	**BOOKS FOR STUDY AND REFERENCE:** Solid State Physics by S.O. Pillai , New Age International Publishers, V Edn (2002) Unit I : Pages 100 to 127. Unit II : Pages 127 to 138, and Pages 154 to 166. Unit III : Pages 375 to 395 Unit IV : Pages 400 to 425 Unit V : Pages 595 to 640.	
	BOOK FOR REFERENCES: 1. Introduction to Solid State Physics by C. Kittel , Wiley Eastern (1984) 2. Elements ofSolid State Physics by Ali Omar, Addison Wesley (1998)	

Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** Will be aware of basics of crystallography and its symmetry operations. **CO 2:** Will be able to understand the concept of reciprocal lattice and importance of X– ray diffraction. **CO 3:** Will become capable of using various theories on specific heatand its behavior to specific applications. **CO 4:** Will become capable of understanding the phenomena of superconductivity and its impact due to magnetic, thermal and mechanical effects. **CO 5:** Capable of utilizing the properties of semiconductors and its behavior for device applications.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	1	3
CO2	3	3	1	–	3
CO3	3	3	3	2	–
CO4	3	3	3	–	2
CO5	3	3	2	–	–

Mean = 52 / 25 = 2.08

Semester	VI	Course Code	24PHUC3220
Course Title	**PRACTICAL – VI**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Practical VI**		
Scope of the Course	**Major**		
Cognitive Levels addressed by the Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Explore to elemental presence by spectroscopy techniques. 2. To understand the various performances of logic gates in electroniccircuits. 3. Comprehensive coverage of requisite practicals for one session (Minimum 10)		

UNIT	Content	No. of Hours
I	1. Photography – Developing and printing 2. CDS – Photographing arc spectra– Hartmann's formula 3. Solar Spectrum – Spectrometer 4. Rydberg's constants. 5. Ellipic and hyperbolic frings – Determination of Elastic constants 6. Determination of Plank's constant 7. Determination of charge of an electron 8. Design of regulated power suppliers – IC 723, IC 7805 and studyof regulation 9. Study of Basic Logic gates – Transistor and IC version 10. OPAMP – 741 as amplifier, inverting, non– inverting – Unit gain buffer. Integrator, differentiator, summer, solution of equations,wave form generator 11. Multi vibrators – Transistor, OPAMP and IC 555. 12. Study of 555 Timer 13. Study of trouble shooting in some simple electronic circuits 14. Michelson interferometer 15. Study of Doppler Effect 16. Verification of Boolean relations DeMorgan's theorem –Combinational Logic 17. Half adder, full adder and half subtractor	3

Semester	VI	Course Code	24PHUB3202
Course Title	**WAVES AND OSCILLATIONS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. To impart knowledge about waves and oscillations and sound. 2. To understand the principles and methods of finding the properties.		

UNIT	Content	No. of Hours
I	Simple Harmonic Motion – Characteristics of S.H.M., Differential equation of S.H.M., K.E., P.E. and Total Energy of a vibrating particle – Energy of Vibration – Oscillations with one degree of freedom – Linearity and superposition principle – Simple pendulum – Compound pendulum – Bar pendulum – LC Circuit – Lissajous figures – Composition of two SHM(s) of frequency ratio 2:1 – Experimental methods for obtaining Lissajous figures – Uses of Lissajous figures	14
II	Free – Forced and Resonant Vibrations – Free Vibrations – Undamped Vibrations – Damped Vibrations – Damped S.H.M. in an electrical circuit – Forced Vibrations – Resonance and Sharpness of Resonance – Phase of Resonance – Quality Factor – Examples of Forced and Resonant Vibrations.	12
III	Wave motion – Characteristics of wave motion – Transverse wave – motion – Longitudinal wave motion – Differential equation of wave motion – Particle velocity – Wave velocity – Principle of superposition – Interference of Sound waves – Quicke's tube Seebeck's tube – Beats – Decibel – Doppler effect – Applications.	12

IV	Reflection of Sound – Reflection of a plane wave at plane surface – Experimental determination of reflection of sound – Whispering Galleries – Echo – Applications – Refraction of plane wave front at plane surface – Experimental demonstration of refraction of sound – Diffraction of sound – Fresnets Assumptions – Intensity of sound at a point due to plane wavefront – Dopper effect – Applications.	14
V	Ultrasonics – Production of ultrasonics by magnetostriction and piezoelectric methods – detection of ultrasonic waves –Acoustic grating – Applications of ultrasonic waves.	12
References	**Text Books** Brijlal and Subramanyam -Waves and Oscillations, S.Chand and Co.,1974. Unit I : Pages: 1– 30, 37– 38, 45, 56– 63 Unit II : Pages: 65– 83 Unit III : Pages: 82– 88, 92– 93, 135– 141, 211 to 220) Unit IV : Pages: 192– 198, 202– 209 Unit V : Pages: 282– 293	
	Reference Books 1. Sound, M.Narayanamurti, N.Gosakan and T.Rajagopalan, The National Publishing Co, Madras, First Edition, 1978. 2. A Textbook of Sound with Theory of Oscillation and Waves, D.R.Khanna and R.S.Bedi, Atma Ram & Sons, Delhi, 1984	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** Understand the concept of SHM **CO2:** Explain the free forced and damped vibration **CO3:** Acquire the knowledge of wave motion **CO4:** Know the properties of sound **CO5:** Apply the knowledge to ultrasonic services.	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	–	2
CO2	3	3	3	–	2
CO3	3	3	3	1	3
CO4	3	3	3	2	3
CO5	3	3	3	3	3

Mean = 63/25 = 2.52

Semester	**VI**	Course Code	**24PHUC3221**
Course Title	**INSTRUMENTS AND SERVICING**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Major**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K– 1: (Remember) • K– 2: (Understand) • K– 3: (Apply) • K– 4: (Analyze) • K– 5: (Evaluate) • K– 6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. This course will also provide a back ground on working with Meter Bridgeand potentiometer circuits. 2. The course will make the student understand thebasics about conversion of a galvanometer to an ammeter and calibrating them.		

UNIT	Content	No. of Hours
I	**GENERAL IDEAS:** DC power supply – fault finding and servicing – characterization of a power supply – use of measuring instruments – voltmeter – ammeter and ohm meter and multi tester understanding and testing for the correctness of specifications for instruments (audio Oscillator – cathode ray oscilloscope – voltmeter andammeter).	14
II	**INSTRUMENTS IN THE PHYSICS LABORATORY :** Theory and measurements with (i) meter bridge (ii) potentiometer (Comparison of emfs, resistances– measurement of potentials) fault finding in metre bridge and potentiometer circuits – power measurement using tree voltmeters – transformers principle – reflected impedanceand winding and transformers	14

III	**INSTRUMENTS IN THE PHYSICS LABORATORY II:** Moving coil / iron galvanometers – theory and characterization – conversion of a galvanometer into an ammeter/voltmeter and their calibration– ballistic galvanometer – construction – working (alignment) and characterization – measurement of – absolute capacity– High resistance by leakage of a capacitor and mutual inductance	12
IV	**RADIO AND TELEVISION:** Principles of radio transmission – simple receiver super heterodyne receiver and its servicing – basics of television receiver with a block diagram – simple fault finding in TV receivers and precautions to be adopted– high voltage measurement – magnetic tape recording principle and block diagram for the same – fault finding and servicing	12
V	**ELECTRICAL DEVICES AND OTHERS:** Earthling – tube light circuit and servicing –Emergency lamp and its operation – UPS (block diagram) – simple ideas about a digital clock – alarm and sleep – frequency meter (block diagram) – Item counter – automatic street light operation.	12
References	**BOOK FOR STUDY:** Modern Electronic Instrumentation and measurement techniques, A.D.Helfrick and W.D.Cooper, Prentice– Hall of India, New Delhi, 2002. Relevant portions	
Course Outcomes	**On completion of the course, students should be able to do** CO 1: Will be able to use a multimeter for measuring various electricalparameters CO 2: Will be trained in testing the goodness of specifications of audiooscillators and other instruments CO 3: Will be capable of converting a galvanometer for appropriatemeasurements CO 4: Will be able to make minor repairs on radio receivers and TVs CO 5: Can make minor repairs and maintain street lights, UPS and suchother systems.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	–	3	1
CO2	3	1	2	3	1
CO3	3	3	3	2	1
CO4	3	1	–	2	2
CO5	3	1	3	3	2

Mean = 52/ 25 = 2.08

Semester	VII	Course Code	24PHUC4122
Course Title	CLASSICAL MECHANICS AND DYNAMICS		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage ofRevision effected (Minimum 20%)	-
Category	Major		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Aims to give understanding about kinematics and dynamicsof rigid bodies • It stenches about lagragian, halimtanian and Hamiltonian Jocbidynamics. • It gives the rotational dynamics understanding		

UNIT	Content	No. of Hours
I	**KINEMATICS OF RIGID BODY MOTION:** Independent coordinates of a rigid body – orthogonal transformation – properties of the transformation matrix – Euler's angles – Euler's theorem on rigid body motion – finite and infinite rotations - the Coriolis Force.	13
II	**EQUATION OF MOTION OF A RIGID BODY :** Angular momentum and Kinetic energy of a motion of a particle – the inertia tensor and moment of inertia – Eigen values - principal axis transformation – solving rigid body problems - Euler's equation of motion – torque free motion of rigid body – heavy symmetrical top with one point fixed (Brief mathematical derivation only). **SMALL OSCILLATIONS**: The Eigen value equation - the principal axis transformation – frequencies of free vibration and normal coordinates – free vibrations of a linear triatomic molecule.	13

III	**HAMILTON'S EQUATIONS OF MOTION :** Legendre transformations and the Hamilton equations of motion – cyclic coordinates and conservation theorems – Routh's procedure and oscillations about steady motion– derivation of Hamilton's equations from variational principle.	13
IV	**CANONICAL TRANSFORMATIONS :** The equations of canonical transformation– examples of canonical – transformation – Poisson brackets and canonical invariance –angular momentum Poisson bracket relations – Liouville's theorem.	13
V	**HAMILTON JACOBI EQUATION** – The Hamilton Jacobi equation for Hamilton's principal function – Harmonic oscillator problem as an example of the Hamilton – Jacobi method – Hamilton – Jacobi equation for Hamilton's characteristic functions – separation of variables in the Hamilton – Jacobi equation – action angle variables in systems of one degree of freedom – the Kepler problem in action angle variables.	12
References	1.Classical Mechanics, Herbert Golstein, II Edition, Narosa Publishing (1989), New Delhi. Prerequisites: Chapters 1 to 3. Unit I: Chapter IV – pages 128 to 148, 158 to 212. Unit II: Chapter 5 – sections 5.1, 5.3 to 5.7, pages 188 – 192, 195 to 213 and chapter VI – pages 243 to 263. Unit III: Chapter VIII – pages 339 to 356, 362 to 365. Unit IV: Chapter IX – pages 378 to 390, 397 to 405,416 to 419, and 426 to 428. Unit V: Chapter X – pages 438 to 462, 472 to 484.	
	1. Classical Mechanics, T.W.B. Kibble 2. Mechanics, K.R. Symon 3. Mechanics, L.D. Landau and E.M. Lifshitz, Pergamon Press.	

Course Outcomes	**On completion of the course, students should be able to do** **CO1:** To cover the description of the motion of rigid body systems with the due importance of constraints with reference to the different degrees of freedom. **CO 2:** To illustrate and formulate physical parameters such as angular momentum, Kinetic energy and the state of art of the equilibrium of the rigid body so as to make the students to understand the oscillating mechanism exhibited by them. **CO 3:** To understand the behaviour of the conservative systems bestowed with Lagrangian and Hamiltonian and to formulate with the specific reference to configuration phase and phase space. **CO4:** To learn that the Poission bracket connotation signifies the invariance of canonical transformations. **CO 5:** To know that the Hamilton –Jacoby relativistic mechanics fuses Lagrangian as well as Hamiltonian in the new perspectives and hence to illustrate the periodic systems with the matrix algebraic formalism.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	–	3	3
CO2	3	3	2	3	3
CO3	3	3	–	3	3
CO4	1	3	2	2	2
CO5	3	3	–	3	3

Mean = 60 / 25 = 2.4

Semester	VII	Course Code	24PHUC4123
Course Title	**STATISTICAL MECHANICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage ofRevision effected **(Minimum 20%)**	-
Category	**Major**		
Scope of the Course	• Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • To understand the mechanics of macroscopic system as well asmicroscopic system. • It gives understanding about classical statistics and Quantumstatistics. • It gives fundamental understanding about partial functions.		

UNIT	Content	No. of Hours
I	**BASICS OF CLASSICAL STATISTICAL MECHANICS:** Introduction – phase space Ensemble – Ensemble average – Liouville theorem – Conservation of extension in phase – equation of motion and Liouville theorem – equal apriority probability – statistical equilibrium – micro canonical ensemble – Idealgas. Micro canonical ensemble – quantization of phase space – basic postulates – classical limit – symmetry of wave functions – Effect of symmetry on counting – Maxwell – Boltzmann – Bose – Einstein – Fermi – Dirac staticatics.	14
II	**STATISTICAL MECHANICS AND THERMOYNAMICS** Entropy – equilibrium conditions – quasistatic processes – Entropy of an ideal Boltzmann gas using the micro canonical ensemble – Gibbs paradox – Sackur Tetrode equation – entropy and probability – probability distribution and entropy of a two level system – Entropy and information theory.	12

III	**CANONICAL AND GRAND CANONICAL ENSEMBLES** Canonical ensemble – entropy of a system in contact with a heat reservoir – Ideal gas in canonical ensemble – Maxwell velocity distribution – Equipartition of energy – Grand canonical ensemble – Ideal gas in grand canonical ensemble – comparison of various ensembles – third law of thermo dynamics – photons Einstein's derivation of Planck's law – Maser and Laser – equation of statefor ideal quantum gases.	12
IV	**PARTITION FUNCTION:** Canonical partition function– molecular partition function – translational partition function–Rotational partition function – vibrational partition function–electronic and nuclear partition function – application of rotational partition function – Homonuclear molecules and nuclear spin – Application of vibrational partition function to solids vapour pressure – chemical equilibrium – Real gas	12
V	**IDEAL BOSE–EINSTEIN and FERMI DIRAC GAS:** Bose – Einstein distribution – Bose Einstein condensation – Thermodynamic properties of an ideal BE gas – Liquid Helium – two fluid model – F–D Distribution – degeneracy – electrons in metals – thermionic emission. **FLUCTUATIONS:** Introduction – mean square deviation – fluctuations in ensemble – concentration fluctuations in quantum statistics – one dimensional random walk – Random walk and Brownian motion – Fourier analysis of a random function – Electrical noise (Nyquist theorem) –	14
References	Statistical Mechanics by B.K. Agarwal and Melvin Eisner, New Age International(P)ltd, Third edition (2013). UNIT I: Chapter 1 and 2– page 1 to 41 UNIT II: Chapter 3– page 42 to 69 UNIT III:Chapter 4– page 70 to 102 UNIT IV:Chapter 5– page 103 to 132 UNIT V: Chapter 6, 7,10 and 11– page 133 to 150, 165 to 175, 223 to 236, 240 to 244 and 250 to 253.	
	1. Statistical Mechanics, Third reprint, Kerson Huang, Wiley Eastern, (1988) 2. Fundamentals of Statistical and Thermal Physics 16th Printing,Federick Reif, McGraw Hill, (1983). 3. Thermal Physics by C. Kittel and Kroemer, Publisher: W. H. Freeman, 1980. 4. Statistical Mechanics R.K.Pathria,3rd Edition, Elsevier(2011)	

Course Outcomes	**On completion of the course, students should be able to do** **CO 1:** To emphasise the classical perspective of statistical mechanics. **CO2:** To give a detailed understanding of the ensembles of different thermodynamic systems and the methodology of understanding ideal gas behaviour through the three fundamental statistics. **CO3:** To imbibe a better vision on the correspondence between the statistical mechanics and thermodynamics **CO 4:** To give a perception of the molecular partition function envisioning through translational, rotational and vibrational, also to understand the nuclear and electronic partition functions **CO 5:** To give coverage of ideal Bose – Einstein and Fermi–Dirac statistical approach to understand the thermodynamics of the gaseous systems.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	–	3	3
CO2	3	3	1	3	3
CO3	3	3	1	3	3
CO4	2	2	1	3	2
CO5	3	3	–	3	3

Mean = 59 / 25= 2.36

Semester	VII	Course Code	24PHUC4124
Course Title	**ELECTRONIC DEVICIES AND OPRETIONAL AMPLIFIERS**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	New	If revised, Percentage ofRevision effected **(Minimum 20%)**	-
Category	**Major**		
Scope of the Course	• Basic Skill • Employability		
Cognitive Levels addressed by the Course	• **K**–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to provide knowledge on the** • Electronic circuits so that the student will be able to design electroniccircuits for home and laboratory environment • Design of analog circuits using switching devices • Op–amp based circuits • Oscillators based on linear ICs and op–amps		

UNIT	Content	No. of Hours
I	**Power supplies:** General filter considerations– capacitor filter – RC filter – series voltage regulator – shunt voltage regulator – IC voltage regulators – adjustable voltage regulators – power supplies – battery charger circuits. – Voltage stabilizers – variac - window comparator type - serve stabilizer	8
II	**Field Effect transistors and special two terminal devices: Field effect devices:** Construction and characteristics of JFETs – voltage controlled resistor – transfer characteristics – Depletion type MOSFET – enhancement type MOSFET – V MOS - MOSFET handling – CMOS–MESFETs Special two terminal devices– Schottky barrier – varactor diodes – power diodes – tunnel diodes	10
III	**Thyristors and other devices:** Basic silicon controlled rectifier operation – SCR characteristics and rating – terminal identification – SCR applications – series static switch – variable resistor phase control – battery charging regulator – Emergency lighting system –Silicon controlled switch – gate turn off switch – light activated SCR – Schockley diode – Diac – triac – Uni–junction transistor – SCR triggering with UJT (relaxation oscillator) – phototransistor – opto isolators.	10

IV	**OPAMP circuits:** Opamp basics – virtual ground – inverting and non–inverting amplifier – voltage follower – summing circuit – integrator – differentiator – multistage amplifier using opamps – subtractor – voltage buffer – controlled sources – active filters – low pass – high pass – band pass and band reject (first order only) – analog computers using opamps – solution to simultaneous equations and second order differential equations	10
V	**Opamp circuits – II:** precision half and full wave rectifiers – square and triangle wave generators – Comparator – opamp as a comparator – window comparator – timer IC (555) – astable and monostable operation.	10
References	Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit theory, tenth edition, Pearson India (2009) Unit– I : Chapter 15, page 773 –796 Unit– II: Chapter 6, page 368 – 405 Unit – III: Chapter 17, page 831–875 Unit – IV: Chapter 13, 711 –731 Unit – V: Chapter11, page 607 – 625	
	1. Integrated circuits and semiconductor devices, Second Edition,Gorden J. Debooand Clifford, N. Burrows, McGraw Hill (NewYork) (1985). 2. Micro electronics, Jacob Millman, Tata McGraw Hill (1979). 3. Electronic circuits, II Edn, Schilling and Belove, McGraw Hill (1985). 4. Op–amp and linear Integrated Circuits, 3rd Edn, Ramakant,Gayakward, Prentice Hall of India (1995).	
	E–Resources(URLsofe–books/YouTubevideos/onlinelearningresources,etc.) http://nptel.ac.in/courses/115102014	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** Able to design power supplies for specific requirements. **CO 2:** Capable of fault finding and rectifying problems in DC power supplies. **CO 3:** Competent to implement switching circuits. **CO 4:** Knowledgeable to design OP–amp based analog computers **CO 5:** Competent to design OP– amp analog circuits.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	3	3
CO2	3	3	3	1	2
CO3	3	3	3	–	1
CO4	3	3	3	–	1
CO5	3	3	3	1	1

Mean = 58/25 = 2.32

Semester	VII	Course Code	24PHUC4125
Course Title	**PRACTICAL –VII**		
No. of Credits	2	No. of contact hours per Week	6
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Major**		
Scope of the Course	• Skill Development • Employability		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • It providesbasicunderstanding aboutUnipolarabsbipolar VI charterstics • It gives understanding about electron hole concept in semiconducting devices. • Comprehensive coverage of requisite practicals for 2 sessions (Minimum 16)		

UNIT	Content	No. of Hours
I	1. Errors and data analysis 2. FET – Characteristics 3. MOSFET – Characteristics – depletion and enhancement mode 4. Single stage amplifier – frequency response 5. Photo diode characteristics: Intensity and spectral analysis 6. SCR characteristics 7. Wave shaping and switching circuits using SCR 8.UJT characteristics 9. UJT relaxation oscillator 10. LDR characteristics and an application (Variation as a function of intensity of light) 11. Voltage series feedback – frequency response12. 12. Current series feedback 13.Voltage shunt feedback 14.Difference amplifier 15.Emitter follower 16.Cascade amplifier 17.Darlington amplifier 18.Operational amplifier characteristics19.Clipper and clamper 20. Schmitt Trigger 21. LVDT study and characteristics 22. Strain gauge characteristics	3

Semester	VII	Course Code	24PHUB4103
Course Title	**NANOPHYSICS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K-1: (Remember) • K-2: (Understand) • K-3: (Apply) • K-4: (Analyze) • K-5: (Evaluate) • K-6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Acquire knowledge on the various physical, chemical and biological techniques of synthesis of nanoparticles. 2. Get knowledge on the special types of nanomaterials and their applications.		

UNIT	Content	No. of Hours
I	**Physics of Nanostructures:** Matter Waves-Heisenberg's Uncertainty Principle-Arrangement of Atoms-Two Dimensional Crystal Structures-Three Dimensional Crystal Structures-Some Examples of Three Dimensional Crystals-Planes in the Crystals-Crystallographic Directions-Reciprocal Lattice – Quasi Crystal – Liquid Crystals	14
II	**Synthesis of Nanomaterials (Qualitative Description only):** *Physical Methods*: Mechanical Methods-Methods Based on Evaporation-Sputter Deposition-Chemical vapour deposition. *Chemical Methods*: Synthesis of Metal Nanoparticles by Colloidal Route-Synthesis of Semiconductor Nanoparticles by Colloidal Route-Sol Gel Method-Hydrothermal Synthesis-Sono chemical Synthesis. *Biological Methods*: Synthesis Using Microorganisms-Synthesis Using Plant Extracts-Use of Proteins, Templates Like DNA, S-Layers etc-Synthesis of Nanoparticles Using DNA.	16

III	**Types of Nanomaterials and Their Properties (Qualitative Description only)** Introduction – Clusters – Types of clusters-Semiconductor Nanoparticles – Optical properties – Plasmonic Materials-Nanomagnetism –Types of magnetic materials –Mechanical Properties of Nanomaterials – Structural Properties –Melting of Nanoparticles.	12
IV	**Analysis Techniques** Microscopes – Optical Microscopes – Electron Microscopes – Scanning Probe Microscopes – Diffraction Techniques – Diffraction from different types of samples –Dynamic Light Scattering – Spectroscopy – Optical Absorption Spectrometer – UV–Vis – NIR spectrometer – Infrared Spectrometer – Raman Spectroscopy – Luminescence – Photo Luminescence Spectrometer– X-ray and UV Photoelectron Spectroscopy – Auger Electron Spectroscopy – Magnetic Measurements –Mechanical Measurements	12
V	**Applications** Applications: Solar cells – Fuel cells – Hybrid energy cells -Automobiles- Sportsand Toys-Textiles-Cosmetics-Medical Field-Agriculture and food-Domestic Appliances -Space, Défense andEngineering-*Nanotechnologyand Environment*: Environmental Pollution and Role of Nanotechnology-Effect of NanotechnologyonHumanHealth.	10
References	**BOOK FOR STUDY** Nanotechnology:PrinciplesandPractices,ThirdEdition – SulabhaK.Kulkarni.Co-published by Springer International Publishing, Cham,Switzerland,with Capital PublishingCompany,NewDelhi,India. UnitI: Chapter1:Pg No.10-15,Chapter2: Pg No.31-44. UnitII:Chapter3:Pg. 55-73, Chapter4:Pg. 91-94, 103-107,Chapter-5: Pg.116-123. UnitIII:Chapter8:Pg.199-239. Unit IV: Chapter 7: Pg No. 135 -197. UnitV: Chapter12 &13: PgNo: 317-354.	
	BOOK FOR REFERENCE: 1) Nanoscience and Nanotechnology by M.S.Ramachandra Roa and Shubra Singh ,Reprint 2017 Wiley Publishers. 2) Introduction to Nanotechnology by Charles P.PooleJr and FrankJ.Owens, WileyIndia (2008)	

Course Outcomes	**Oncompletionofthecourse,studentsshouldbeableto** **CO1:** Be aware of the underlying Physics in nanomaterials **CO2:** Acquire knowledge on the various physical, chemical and biological techniques of the synthesis of nanoparticles **CO 3:** Analyze the different types and the unique properties of nanomaterials **CO 4: U**ndergo specific characterisation of the nanomaterials**.** **CO 5:** Get a knowledge on the varied applications of nanomaterials.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	2	2	3
CO2	3	3	3	3	3
CO3	3	2	2	3	-
CO4	3	2	3	3	3
CO5	3	2	3	3	3

Mean = 65 /25 = 2.6

Semester	**VII**	Course Code	**24PHUB4104**
Course Title	**PHYSICS OF CRYSTALS**		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K-1: (Remember) • K-2: (Understand) • K-3: (Apply) • K-4: (Analyze) • K-5: (Evaluate) • K-6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Give the Symmetry, properties and the crystal structures. 2. Give the basic understanding of crystals.		

UNIT	Content	No. of Hours
I	**Origin**: Introduction to crystals and minerals – Crystals in nature – mineral and crystal identification and its naming conventions – history of crystal mining – uses and applications of crystals	14
II	**Fundamentals of crystals** – Naturally Occurring Chemical Elements – Atomic and Ionic Radii – Crystals and crystal structures, Lattices, planes and directions – Pauling's Rules – Forces holding crystal structures together – Atomic substitutions.	14
III	**Crystallography:** Introduction – Symmetry elements and operations – Seven crystal systems – Crystal projections – Point groups – X-ray diffraction – Bragg's Law- Miller indices .	12
IV	**Liquid Crystals**: Introduction to liquid crystals – history behind the development of liquid crystals – physics of liquid crystals – development of Liquid Crystal Displays (LCD) and its applications.	10

V	**Precious crystals and its properties**: History of precious crystals – Diamond mining in India – Physical properties of diamonds and sapphire – Mechanical – optical and thermal properties of diamonds and sapphire – artificial diamonds – diamond polishing.	14
References	**BOOKS FOR STUDY AND REFERENCE:** 1. Chapters 1– 5 in Earth Materials – Introduction to Mineralogy and Petrology (2017) Cornelis Klein and Anthony R. Philpotts, Cambridge University Press,ISBN 978– 1– 107– 15540– 4 2. Crystals and Crustal Structures (2006) Richard J. D. Tilley, John Wiley & Sons Ltd, ISBN 13: 978– 0– 470– 01820– 0] 3. Liquid Gold – The Story of Liquid Crystal Displays and the Creation of an Industry (2005) Joseph A. Castellano, World Scientific Publishing Co. Pte. Ltd., ISBN 981– 238– 956– 3 4. Soap, science, and flat– screen Tvs (2011) David Dunmur and Tim Sluckin, Oxford University Press 5. Physical Properties of Diamond and Sapphire (2019) Roshan L. Aggarwal and Anant K. Ramdas, CRC Press, ISBN:13: 978– 0– 367– 23508– 6	
Course Outcomes	**On completion of the course, students should be able to do** CO1: Will give a comprehensive review about crystals. CO2: Will give the basic skeleton of crystals. CO3: Will give the Symmetry, properties and the crystal structures. CO4: Will give the basic understanding of crystals. CO5: Will provides the valuable information about precious crystals and their properties	

Mapping of COs with PSOs:

PSO / CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	3	2	1	1	2
CO 2	3	3	2	2	3
CO 3	2	2	3	2	3
CO 4	3	2	2	2	2
CO 5	2	3	2	2	2

Mean = 56/ 25= 2.24

Semester	VIII	Course Code	24PHUC4226
Course Title	MATHEMATICAL PHYSICS: TENSORS, COMPLEX ANALYSIS AND INTEGRAL TRANSFORMS		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revision effected **(Minimum 20%)**	-
Category	Core Course		
Scope of the Course	• Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed by the Course	• K-1: (Remember) • K-2: (Understand) • K-3: (Apply) • K-4: (Analyze) • K-5: (Evaluate) • K-6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1: Introduced tensor concepts and its basic applications so that, the students can apply the knowledge in various fields of Physics. 2: Gain applicative knowledge of complex numbers and complex variables. Also to learn C-R equation, Cauchy's theorem, Cauchy'sintegral, Taylors and Maclaurin series.		

UNIT	Content	No. of Hours
I	**COMPLEX ANALAYSIS :** Complex plane- Polar form of complex numbers- Derivative. Analytic functions - Cauchy Riemann Equations – Laplace's equation- Cauchy's integral theorem- Cauchy's integral formula – Derivatives of Analytic Functions(without proof) - Taylor and Maclaurin series – Laurent series. Residue integration - Singularities and zeroes – Residue integration method.	14
II	**TENSOR ANALYSIS:** Introduction, notation and convention, contravariant and covariant vector - tensors of second rank. Algebra of tensors: equality and null tensor, addition, subtraction, outer product and inner product of tensors, contraction of tensor – symmetric and antisymmetric tensors, Kronecker delta, quotient law, Cartesian tensor, stress, strain and Hooke's law, Moment of Inertia tensor. Covariant formulation of Electrodynamics: Lorentz gauge – Electromagnetic field strength tensor – Maxwell's equation – Transformation of	14

	electromagnetic field.	
III	**FOURIER SERIES, INTEGRALS AND TRANSFORMS:** Periodic functions -Fourier series – Functions of any period - Even and odd functions - Half range expansions – Complex Fourier series - Fourier Transform – Complex form of Fourier integral – Fourier Transform and its inverse-Linearity- Fourier transform derivatives-convolution theorem	12
IV	**LAPLACE TRANSFORMATION**: Laplace transform, Inverse transform, Linearity- First Shifting theorem-Existence of Laplace transforms- Laplace transform of derivatives and integrals- Differential Equations, initial value problems-Differentiation and integration of transforms-Convolution theorem-Partial fraction, Differential equations: Unrepeated factor, repeated factor, unrepeated complex factors.	12
V	**PROBABILITY AND STATISTICS**: Data-representation- average-spread-Graphical representation of data-mean-standard deviation-varianc. Probability-permutation and combinations-Binomial, Poisson and Hypergeometric distributions - Normal distribution-$\square^2$- Test-Regression Analysis-Correlation Analysis- Fitting straight lines-Least square method	12
References	**BOOKS FOR STUDY** Matrices and Tensors in Physics, Second Edition, A.W. Joshi, Wiley Eastern (2288). Unit I: Relevant chapters in Pages : 159 to 217, 196 to 212, 222 to 232 Advanced Engineering Mathematics, Erwin Kreyszing, Wiley Eastern, 8th Edition. Unit II: Chapter 12 Pages: 652-673, 713-726, 751-757, 770-786 Unit III: Chapter 10, Pages 526-549, 569-575 Unit IV: Relevant chapters from Chapter 5, Pages 250-286 Unit V: Chapter 22, Pages 1050-1054, 1058-1069, 1079-1090, Chapter 23 1137- 1140,1145-1153	
	BOOK FOR REFERENCES: 1. Mathematical Physics, H.K.Dass, Fourth revised edition 2003. 2. Mathematical Physics – P.K. Chattopadhyoy – Wiley Eastern Ltd., 3. Advanced engineering Mathematics – Erwin Kreyzik – WileyLtd.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	2	3	1	2	3
CO2	2	3	–	2	3
CO3	3	3	1	2	3
CO4	2	3	–	1	3
CO5	3	3	1	3	3

Mean = 55 /25 = 2.2

Semester	VIII	Course Code	24PHUC4227
Course Title	QUANTUM MECHANICS: TIME INDEPENDENT PROBLEMS		
No. of Credits	4	No. of contact hours per Week	4
New Course / Revised Course	New	If revised, Percentage of Revision effected (Minimum 20%)	-
Category	Major		
Scope of the Course	• Skill Development • Employability • Value–Added Courses imparting transferable and life skills		
Cognitive Levels addressed by the Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** • Imparts knowledge of basic quantum mechanics and gives a glimpse of perturbation methods for problem thatcannot be exactly solved		

UNIT	Content	No. of Hours
I	**SCHRODINGER WAVE EQUATION**: Development of the wave equation – interpretation of the wave function – energy eigen function – one dimensional square well potential – ehrenfests theorem. **EIGEN FUCNTIONS AND EIGEN VALUES:** Interpretative postulates and energy eigen functions – momentum eigen functions – motion of a free wave packet in one dimension.	12
II	**MATRIX FORMULATION OF QUANTUM MECHANICS**: Matrix algebra Transformation theory – Hilbert space – Dirac's Bra and Ket notation – equation of motion – Schrodinger picture – Heissenberg picture – interaction picture – Matrix theory of harmonic oscillator.	13
III	**ANGULAR MOMENTUM MATRICES:** angular momentum commutation relation for angular momentum – angular momentum matrices – combination of angular momentum states – CG Coefficient for (J = ½).	

	VARIATIONAL METHOD: Expectation value of energy – application to excited states – ground state of helium – electron interaction energy – variational parameter.	13
IV	**STATIONARY PERTURBATION THEORY**: Non degenerate case – first order perturbation – second order perturbation – perturbation of an oscillator – degenerate case – Removal of degeneracy – second order – Zeeman effect without electron spin – first order Stark effect in hydrogen – perturbed energy levels – occurrences of permanent electric dipole moment.	13
V	**WKB APPROXIMATION**: Classical limit –approximate solution – asymptotic nature of the solution – solution near the turning point – linear turning point – connection at turning point – energy levels of a potential well – tunneling through a barrier..	13
References	**BOOKS FOR STUDY** Quantum Mechanics by Leonard I. Schiff, McGraw Hill (1968) Unit I: page 19 to 44 of Chapter 2 and page 45 to 64 of Chapter 3 Unit II: page 148 to 215 of Chapter 6 and page 199 to 204 of Chapter 7 and 212 to 214 of Chapter 7 Unit IV: page 244 to 255 of Chapter 8 Unit V: page 255 to 259 of Chapter 8, page 268 to 279 of Chapter 8	
	BOOK FOR REFERENCES: 1. Quantum Mechanics, Second Edition, Merzbacher, John wiley,(1970) 2. Quantum Mechanics, Franz Schwabl, Narosa (1992) 3. Modern Quantum Mechancis, Sakurai, Addison–Wesley(1994) 4. Quantum Mechanics, Mathews and Venkatesan Publishers(2009)	
Course Outcomes	**On completion of the course, students should be able to do** CO1: To explain the basic postulates and formalism quantum physics.CO2: To solve eigen value problems in LHO, Spherical harmonics and Hydrogen atom. CO3:To give exposure on matrix formalism and its applications in LHOand angular momentum CO4:To discuss various approximation methods to solve Schrodinger equations and real time applications CO5: To solve He atom problem using variation technique.	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	1	3	3
CO2	3	3	–	3	3
CO3	3	3	1	3	3
CO4	3	3	–	3	3
CO5	3	3	1	3	3

Mean= 63/25 = 2.52

Semester	I / III	Course Code	24PHUB1101/ 24PHUB2101
Course Title	**Minor - I / III (Physics for Maths/Chemistry/Geology Students)**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Understand the basic concepts of acceleration due to gravity, determination and the factors affecting its values.		

UNIT	Content	No. of Hours
I	**ACCELERATION DUE TO GRAVITY AND GRAVITATION:** Acceleration due to gravity – compound pendulum – interchangeability of centres of suspension and oscillation – determination of 'g' using a bar pendulum – determination of radius of gyration – Factors affecting the values of 'g'' – effect of rotation – altitude – depth. **Gravitation:** Kepler's laws (No mathematical derivation) – Newton's law – density of Earth – mass of the Earth and the Sun – Gravitational Field – Gravitational Potential – Potential energy – Gravitational potential at a point distance 'r' from a body of mass – Gravitational potential outside a spherical shell and a solid sphere – Inertial and gravitational mass.	12

II	**VISCOSITY AND SURFACE TENSION:** Stream lined and turbulent motion – coefficient of Viscosity – Poiseuille's flow – Experimental determination of coefficient of viscosity – motion in a viscous medium – Stoke's law – comparison of viscosities – Ostwald Viscometer. Surface tension – Explanation – surface film and surface energy – Free energy of a surface – Excess of pressure inside the drops and bubbles – Rise of a liquid in acapillary tube – Experimental determination of surface tension – Jaeger's method – Drop weight method and capillary rise method.	10
III	**SOUND:** Velocity of longitudinal waves in gases – Newton's law of velocity of sound– Laplace's correction –Effect of density – humidity and wind – velocity of sound inwater and in air – measurement of sound intensity– idea of decibel – Ultrasonics – Production– Magnetostriction Method – Piezo – electric Effect – determination of velocity– Acoustic Grating– Applications of ultrasonics (any two)	10
IV	**Interference** – Condition for interference – Young's experiment – Fresnel biprism – Bi– mirror – Lloyd's singlemirror – Fringes with while light – Colours of thin films – Reflected and transmitted systems – Newton's rings – Airwedge – Testing of planes of a surface.	10
V	**Polarization** – Reflection and Refraction – Brewster's law –Double refraction – Nicol prism and its uses – Rotation of plane of polarization – specific rotatory power and saccharimetry.	6
References	**BOOKS FOR STUDY** 1. Elements of Properties of matter – D.S. Mathur 2. Fundamentals of Optics – Khanna and Gulati 3. A text book on Sound – Khanna and Bedi 4. Optics – Ajoy Ghatak 5. A text book of Optics – Subrahmanyam and Brijlal 6. A text book of Sound – Subrahmanyam and Brijlal 7. Properties of Matter– Subrahmanyam and Brijlal	
	BOOKS FOR REFERENCE 1. Physics – V Edition. Volume I David Halliday, Robert Resnick – Jearl Walker – Asian Books	

Course Outcomes	**On completion of the course, students should be able to do** CO 1: Understand the basic concepts of acceleration due to gravity, determinationand the factors affecting its values. CO 2: Learn the Kepler's laws of planetary motion and determine the mass & density of the Earth and Sun CO 3: Basics of ultrasonic production , measurement and application CO 4: Apply the principle of interference in forming Newton's ring and test thepaleness by air wedge method CO 5: Explain the principle of polarization and apply the principle to optical applications.

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	–	2
CO2	3	2	1	1	1
CO3	3	1	2	–	1
CO4	3	2	1	1	3
CO5	3	3	3	1	3

Mean = 62/45= 1.722

Semester	I / III	Course Code	24PHUB1102/ 24PHUB2102
Course Title	**Minor Practical – I / III (Physics for Maths/Chemistry/Geology Students)**		
No. of Credits	2	No. of contact hours per Week	6
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Basic knowledge about measuring instruments		

UNIT	Content	No. of Hours
I	1. Measuring instruments – Vernier caliper , Screw gauge , Vernier microscope 2. Single optic lever – measurements of thickness. 3. Surface tension – capillary rise method. 4. Viscosity – Poiseuille's method. 5. Bending of beams – cantilever, uniform and non–uniformbending. 6. Newton's law of cooling– verification, specific heat of liquid. 7. Specific heat of solid/ liquid method of mixture. 8. Lee's disc experiment – thermal conductivity of poor conductor. 9. Joule's law – specific heat of liquid. 10. Comparison of magnetic moments – field aiding, field opposing. 11. Meter bridge – resistance of coil, specific resistance. 12. Figure of merit of table galvanometer. 13. Focal length of long focus convex lens, concave lens. 14. Spectrometer – refractive of prism and liquid. 15. Compound pendulum – determination of g and radius of gyration. 16. Diode characteristics 17. Transistor characteristics.	

Semester	II / IV	Course Code	24PHUB1203/ 24PHUB2203
Course Title	**Minor- II / IV (Physics for Maths/Chemistry/Geology Students)**		
No. of Credits	3	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revisioneffected **(Minimum 20%)**	20%
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development • Employability • Entrepreneurship		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. The student should be able to gain enough knowledge to effectively learnthe subjects in which they will be majoring		

UNIT	Content	No. of Hours
I	**DC AND AC CIRCUITS:** Kirchoff's law on voltages and currents – maximum power transfer theorem Wheatstone's bridge – Carey Foster's bridge – capacitors action – parallel plate and cylindrical capacitors – parallel and series connection of capacitors – energy stored in capacitors. **AC CIRCUITS:** Peak, mean and rms values of ac – relation between current and voltage in capacitors and inductors – transformers – reflected impedance – losses in transformers – RC, LR circuits, and LCR circuits.	12
II	**ANALOG AND DIGITAL ELECTRONICS:** Semiconductor electronics – Diode– Zener diode – Half and Full wave rectifiers – ideas of filters – Transistors – biasing of a transistor – input and output characteristics – single stage CE amplifier and its frequency response – Feed – back and its effects – oscillators – Colpitt's and Hartley oscillator. Logic gates – their symbol and truth table – Universal gates NAND and NOR – Boolean Identities – De Morgan's theorem – Half – Adder and Full – Adder – solving Boolean equations using laws and theorems.	10

III	**Particle properties of waves**: Black body radiation – Photoelectric effect – Compton effect – de Broglie wave – phase and group velocities – wave nature of X– ray– Diffraction of X – ray by crystal – Bragg's Law – Vector atom model – fine structure of Hydrogen spectrum – Pauli's exclusion principle – Stern and Gerlack experiment.	10
IV	**Becquerel rays** – laws of radioactivity – decay constant– half life –mean life – carbon dating – age of the earth – basic ideas of equilibrium in radioactivity – discovery of neutron – properties – nuclear fission and fusion reactions – liquid drop model (qualitative treatment only) – nuclear reactor – fissile materials – moderators – chain reactions – application of radioisotopes in medicine and agricultural – accelerators – linear accelerators– cyclotron – synchro cyclotron – detector– ionization chamber – G.M. Counter.	10
V	**Lasers:** Introduction – Einstein coefficients – Light amplification – Threshold condition– Cavity resonator – Pumping – Ruby – He – Ne – Dye laser and diode laser – Basic ideas on optical communication – Optical fiber and types – Losses – Sources and detectors – Laser application in medicine industry and metrology.	6
References	**BOOKS FOR STUDY AND REFERENCE:** 1. Electricity and Magnetism with Electronics – K.K.Tiwari. 2. Concepts of Modern Physics, Arthur Beiser Tata McGraw Hill Co 3. Atomic Physics, J.B.Rajam, S.Chand Co 4. Modern Physics – Seghal, Chopra, Seghal, S. Chand, New Delhi. 5. Basic electronics and linear circuits – Bhargava Kulshreshtha and Gupta – TTTIPublications, Chandigarh 6. Digital Principles – Malvino and Leach, McGraw Hill. 7. Nuclear physics by D.C.Dhayal (Himalaya Publishing House– Fifth revised & enlarged edition.	
Course Outcomes	**On completion of the course, students should be able to do** **CO1:** Understand and apply AC and DC circuits. **CO2:** Design simple power supplies **CO3:** Apply logic gates for implementation of logical circuits **CO4:** Understand the particle wave duality **CO5:** Apply radio isotopes for specific applications like agriculture and medicine	

Mapping of COs with PSOs:

PSO / CO	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	1	3	2	2	3
CO2	–	3	2	3	3
CO3	–	3	2	2	3
CO4	3	–	2	–	–
CO5	3	3	1	–	1

Mean = = 2.16

Semester	II / IV	Course Code	24PHUB1204/ 24PHUB2204
Course Title	**M i n o r Practical- II / IV (Physics for Maths/Chemistry/Geology Students)**		
No. of Credits	1	No. of contact hours per Week	3
New Course / Revised Course	Revised	If revised, Percentage of Revision effected **(Minimum 20%)**	20%
Category	**Minor**		
Scope of the Course	• Basic Skill / Advanced Skill • Skill Development		
Cognitive Levels addressed bythe Course	• K–1: (Remember) • K–2: (Understand) • K–3: (Apply) • K–4: (Analyze) • K–5: (Evaluate) • K–6: (Create)		
Course Objectives (Maximum: 5)	**The Course aims to** 1. Basic knowledge about measuring instruments 2. Comprehensive coverage of requisite practicals one session (Minimum 10)		

UNIT	Content	No. of Hours
I	1.Study of depression and deflection of a cantilever a. Variation of deflection / depression with distance from fixed end b. Young's modulus 2. Young's modulus – Non uniform bending 3. Young's modulus – Uniform bending 4. Young's modulus – Koenig's method 5. Familiarisation with spectrometer – Refractive Index of solid and liquid. 6. Dispersive power of the material of a prism 7. i-d curve 8. i- i' curve and Stoke's formula 9. Radius of curvature – Newton's rings 10. Thickness of a wire – Air wedge 11. Wavelength of light – Biprism	3