B.Tech.

IN

ENGINEERING PHYSICS

CURRICULUM
AND
SYLLABI OF FIRST YEAR COURSES

(Applicable from 2023 Admission onwards)

Department of Physics
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
Kozhikode - 673601, KERALA, INDIA

The Program Educational Objectives (PEOs) of B.Tech. in Engineering Physics

PEO1	The graduates will develop appreciation for fundamental Physics and its applications to natural phenomena
PEO2	The graduates will develop sound scientific and mathematical foundation and practical laboratory experience leading to a career of research in basic/applied Physics and related industry
PEO3	The graduates will acquire competitive edge, communication skills and interpersonal team spirit necessary to take up challenging research projects in future advanced education and career
PEO4	The graduates will develop technical and entrepreneur skills, and confidence necessary for contributing to the field of indigenous research and industry development

Programme Outcomes (POs) and Programme Specific Outcomes (PSOs) of B.Tech. in Engineering Physics

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1	Analyze and develop models of the physical world relevant to industry and society
PSO2	Formulate and investigate open ended problems in Physical Sciences and contribute to academic research

CURRICULUM

Total credits for completing B.Tech. in Engineering Physics is 150.

COURSE CATEGORIES AND CREDIT REQUIREMENTS:

The structure of B.Tech. programmes shall have the following Course Categories:

Sl. No.	Course Category	Number of Courses	Minimum Credits
1.	Institute Core (IC)	8	22
2.	Program Core (PC) and Program Electives (PE)	29-30	82
3.	Open Electives (OE)	8	24
4.	Institute Electives (IE) (Entrepreneurship Innovation (EI) + Digital / Automation Technologies (DA) + Humanities, Social Science, Management (HM))	6	18
5.	Activity Credits (AC)	--	4

COURSE REQUIREMENTS

The effort to be put in by the student is indicated in the tables below as follows:
L: Lecture (One unit is of 50 minute duration)
T: Tutorial (One unit is of 50 minute duration)
P: Practical (One unit is of one hour duration)
O: Outside the class effort / self-study (One unit is of one hour duration)

1. INSTITUTE CORE (IC)

a) Mathematics

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	MA1002E	Mathematics I	3	1*	0	5	3
2.	MA1012E	Mathematics II	3	1*	0	5	3
3.	MA2002E	Mathematics III	3	1*	0	5	3
4.	MA2012E	Mathematics IV	3	1*	0	5	3
		Total	**12**	**4***	**0**	**20**	**12**

*Optional for Students (can be replaced by self-study)

b) Basic Sciences and Drawing

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	CY1004E	Chemical Bonding and Structure	3	0	0	6	3
2.	ME1011E	Engineering Graphics	2	0	2	5	3
		Total					**6**

c) Professional Communication and Professional Ethics

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	MS1001E	Professional Communication	3	0	0	6	3
2.	PH2101E	Professional Ethics	1	0	0	2	1
		Total	**4**	**0**	**0**	**8**	**4**

2A. PROGRAMME CORE (PC)

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	PH1101E	Mechanics	3	0	0	6	3
2.	PH1102E	Thermodynamics	3	0	0	6	3
3.	PH1191E	General Physics Lab	0	0	3	3	2
4.	ME1391E	Workshop-I (Mech)	0	0	2	1	1
5.	PH1111E	Classical Mechanics	3	0	0	6	3
6.	PH1112E	Analog Electronics	3	0	0	6	3
7.	PH1113E	Electromagnetics	3	1	0	5	3
8.	PH1192E	Electronics Lab-I	0	0	3	3	2
9.	PH1193E	Electromagnetics Simulation lab	0	0	3	3	2
10.	PH2102E	Quantum Physics-I	3	1	0	5	3
11.	PH2103E	Digital Electronics	3	0	0	6	3
12.	PH2191E	Microwave lab	1	0	3	5	3
13.	PH2192E	Electronics Lab-II	0	0	3	3	2
14.	PH2111E	Applied Optics	3	0	0	6	3
15.	PH2112E	Quantum Physics-II	3	1	0	5	3
16.	PH2113E	Statistical Mechanics	3	0	0	6	3
17.	PH2193E	Optics Lab	0	0	3	3	2
18.	PH3101E	Atomic and Molecular Physics	3	0	0	6	3
19.	PH3102E	Computational Physics	2	0	3	7	4
20.	PH3103E	Condensed Matter Physics	3	0	0	6	3
21.	PH3191E	Solid State Physics Lab	0	0	3	3	2
22.	PH3111E	Lasers and Applications	3	0	0	6	3
23.	PH3112E	Nuclear Science and Engineering	3	0	0	6	3
24.	PH3192E	Project	0	0	0	9	3
25.	PH4192E	Summer Internship	0	0	0	6	2
		Total					**67**

2B. LIST OF ELECTIVES

Following courses may be credited under the categories mentioned in the table below, in addition to the Programme Electives.

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Additional Categories			
								PE	EI	DA	HM
1.	PH2121E	Computer Programming	2	0	2	5	3	N	N	Y	N
2.	PH2122E	Innovation and Entrepreneurship	3	0	0	6	3	N	Y	N	N
3.	PH3121E	Interfacing and Simulation	2	0	2	5	3	N	N	Y	N
4.	PH3122E	Electrodynamics	3	0	0	6	3	Y	N	N	N
5.	PH3123E	Topics in Condensed Matter Physics	3	0	0	6	3	Y	N	N	N
6.	PH3124E	Physics of Elementary Particles	3	0	0	6	3	Y	N	N	N
7.	PH3125E	Fiber Optics	3	0	0	6	3	Y	N	N	N
8.	PH3126E	Atmospheric and Environmental Physics	3	0	0	6	3	Y	N	N	N
9.	PH3127E	Optical Engineering	3	0	0	6	3	Y	N	N	N
10.	PH3128E	Thin film technology	3	0	0	6	3	Y	N	N	N
11.	PH3129E	Vacuum Science and Technology	3	0	0	6	3	Y	N	N	N
12.	PH3130E	Modern Optics	3	0	0	6	3	Y	N	N	N
13.	PH3131E	Experimental Techniques in Physics	3	0	0	6	3	Y	N	N	N
14.	PH3132E	Sensors and Actuators	3	0	0	6	3	Y	N	N	N
15.	PH4121E	Optoelectronics	3	0	0	6	3	Y	N	N	N
16.	PH4122E	Relativity and Gravitation	3	0	0	6	3	Y	N	N	N
17.	PH4123E	Light-Matter interaction in Resonators	3	0	0	6	3	Y	N	N	N
18.	PH4124E	Critical phenomena	3	0	0	6	3	Y	N	N	N
19.	PH4125E	Microprocessors and Microcontrollers	2	0	2	5	3	Y	N	N	N
20.	PH4126E	Advanced Quantum Mechanics	3	0	0	6	3	Y	N	N	N
21.	PH4127E	Solid State Devices	3	0	0	6	3	Y	N	N	N
22.	PH4128E	Physics of Nanostructures and Nanoscale Devices	3	0	0	6	3	Y	N	N	N
23.	PH4129E	Lithography Techniques	3	0	0	6	3	Y	N	N	N
24.	PH4130E	Weak Interactions and Standard Model	3	0	0	6	3	Y	N	N	N

25.	PH4131E	Semiconductor Physics	3	0	0	6	3	Y	N	N	N
26.	PH4132E	Quantum Mechanics for Quantum Computing	3	0	0	6	3	Y	N	N	N
27.	PH4133E	Soft matter	3	0	0	6	3	Y	N	N	N
28.	PH4134E	Optics and Photonics Workshop	2	0	2	5	3	Y	N	N	N
29.	PH4135E	Astronomy and Astrophysics	3	0	0	6	3	Y	N	N	N
30.	PH4136E	Advanced Statistical Mechanics	3	0	0	6	3	Y	N	N	N
31.	PH4137E	Metamaterials	3	0	0	6	3	Y	N	N	N
32.	PH4138E	Plasmonics and Graphene Photonics	3	0	0	6	3	Y	N	N	N
33.	PH4139E	Speckle Phenomena and Imaging	3	0	0	6	3	Y	N	N	N
34.	PH4140E	Fourier Optics and Holography	3	0	0	6	3	Y	N	N	N
35.	PH4141E	Differential Geometry and Group Theory for Physicists	3	0	0	6	3	Y	N	N	N
36.	PH4142E	Advanced Topics in Analytical Mechanics	3	0	0	6	3	Y	N	N	N
37.	PH4143E	Nanoelectronics Device Technology	3	0	0	6	3	Y	N	N	N
38.	PH4144E	Computational Modeling of Materials	2	0	2	5	3	Y	N	N	N

3. OPEN ELECTIVES (OE)

Courses offered by Other Departments/Schools/Centres or Approved Online Platforms, with a limit on the maximum number of courses from such platforms specified as per BTech Ordinances and Regulations. In addition, PE courses offered by the Parent department shall be included in this category for students of the Parent department.

4. INSTITUTE ELECTIVES (IE)

In case of the Institute Electives, courses in the appropriate categories offered by other departments/schools/centres also can be credited instead of the courses offered by the Department of Physics, subject to the approval from the Course Faculty and Faculty Advisor.

a) Entrepreneurship / Innovation Basket (EI):

Courses proposed by the Departments/Schools/Centres and approved by Institute Innovation Council. Total credits required is 3.

b) Digital Automation Technologies (DA):

Courses related to programming / automation tools & techniques / Industry 4.0. Total credits required is 6.

c) Humanities, Social Science, Management (HM):

Courses such as Indian and Foreign languages, Economics, Engineering Management, Financial Management and Design Thinking. Total credits required is 9.

5. ACTIVITY CREDITS (AC)

A minimum of 80 Activity Points are to be acquired for obtaining the 4 Activity Credits required in the curriculum.

Activity points acquired should be a minimum of 20 at the end of S4.
Activity points acquired should be a minimum of 40 at the end of S6.

PROGRAMME STRUCTURE

Semester I

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA1002E	Mathematics I	3	1	0	5	3	IC
2.	CY1004E	Chemical Bonding and Structure	3	0	0	6	3	IC
3.	ME1011E	Engineering Graphics	2	0	2	5	3	IC
4.	PH1101E	Mechanics	3	0	0	6	3	PC
5.	PH1102E	Thermodynamics	3	0	0	6	3	PC
6.	PH1191E	General Physics Lab	0	0	3	3	2	PC
7.	ME1391E	Workshop-I (Mech)	0	0	2	1	1	PC
		Total					**18**	

Semester II

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA1012E	Mathematics II	3	1	0	5	3	IC
2.	MS1001E	Professional Communication	3	0	0	6	3	IC
3.	PH1111E	Classical Mechanics	3	0	0	6	3	PC
4.	PH1112E	Analog Electronics	3	0	0	6	3	PC
5.	PH1113E	Electromagnetics	3	1	0	5	3	PC
6.	PH1192E	Electronics Lab-I	0	0	3	3	2	PC
7.	PH1193E	Electromagnetics Simulation lab	0	0	3	3	2	PC
		Total					**19**	

Semester III

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA2002E	Mathematics III	3	1	0	5	3	IC
2.	PH2101E	Professional Ethics	1	0	0	2	1	IC
3.		DA Elective-I	3	0	0	6	3	DA
4.		Open Elective-I	3	0	0	6	3	OE
5.	PH2102E	Quantum Physics-I	3	1	0	5	3	PC
6.	PH2103E	Digital Electronics	3	0	0	6	3	PC
7.	PH2191E	Microwave lab	1	0	3	5	3	PC
8.	PH2192E	Electronics Lab-II	0	0	3	3	2	PC
		Total					**21**	

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	MA2012E	Mathematics IV	3	1	0	5	3	IC
2.		Entrepreneurship Innovation elective	3	0	0	6	3	EI
3.		Open Elective-II	3	0	0	6	3	OE
4.	PH2111E	Applied Optics	3	0	0	6	3	PC
5.	PH2112E	Quantum Physics-II	3	1	0	5	3	PC
6.	PH2113E	Statistical Mechanics	3	0	0	6	3	PC
7.	PH2193E	Optics Lab	0	0	3	3	2	PC
8.		Minor Course – 1	3	0	0	6	$3^{\#}$	MC
		Total (Excluding the Minor Courses)					**20(+3$^{\#}$)**	

Semester V

Sl. No	Course Code	Course Title	L	T	P	O	Credits	Category
1.		Humanities Elective-I	3	0	0	6	3	HM
2.		Open Elective-III	3	0	0	6	3	OE
3.		DA Elective-II	3	0	0	6	3	DA
4.	PH3101E	Atomic and Molecular Physics	3	0	0	6	3	PC
5.	PH3102E	Computational Physics	2	0	3	7	4	PC
6.	PH3103E	Condensed Matter Physics	3	0	0	6	3	PC
7.	PH3191E	Solid State Physics Lab	0	0	3	3	2	PC
8.	--	Minor Course – 2	3	0	0	6	$3^{\#}$	MC
		Total (Excluding the Minor Courses)					**21(+3$^{\#}$)**	

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.		Humanities Elective-II	3	0	0	6	3	HM
2.		Open Elective-IV	3	0	0	6	3	OE
3.		Open Elective-V	3	0	0	6	3	OE
4.		Program Elective-I	3	0	0	6	3	PE
5.	PH3111E	Lasers and Applications	3	0	0	6	3	PC
6.	PH3112E	Nuclear Science and Engineering	3	0	0	6	3	PC
7.	PH3192E	Project	0	0	0	9	3	PC
8.		Minor Course – 3	3	0	0	6	$3^{\#}$	MC
		Total (Excluding the Minor Courses)					**21(+3$^{\#}$)**	

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.		Humanities Elective-III	3	0	0	6	3	HM
2.		Open Elective-VI	3	0	0	6	3	OE
3.		Open Elective-VII	3	0	0	6	3	OE
4.		Open Elective-VIII	3	0	0	6	3	OE
5.		Program Elective-II	3	0	0	6	3	PE
6.	PH4191E	Project/Internship/ Programme Elective III	0 / 3	0	0	9/6	3	PE
7.	PH4192E	Summer Internship	0	0	0	*	2	PC
8.	..	Minor Course - 4	3	0	0	6	3[#]	MC
Total (Excluding the Minor Courses)							**20(+3[#])**	**--**

* Decided by the organization in which the internship is done.

Semester VIII

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	PH4193E	Project / Internship / Programme Electives – IV & V	0 / 6	0	0	18/ 12	6	PE
2.		Activity Credits (minimum of 80 points)					4	AC
Total							**10**	**--**

MA1002E MATHEMATICS I
(Common to CSE/EP branches)

Pre-requisites: Nil

L	T	P	O	C
3	1	0	5	3

Total Lecture sessions : 39

Course Outcomes:

CO1: Find the limits, check for continuity and differentiability of real valued functions of one variable.
CO2: Find the limits, check for continuity and differentiability of real valued functions of two variables.
CO3: Find the maxima and minima of real valued functions of one variable or two variables.
CO4: Find the parametric representation of curves and surfaces in space and evaluate integrals over curves and surfaces.

Functions of one variable: limit, continuity - differentiability - local maxima and local minima - mean value theorems - Taylor's theorem - L'hôpital's rule - integration - fundamental theorem of calculus - volume - area - improper integrals - Gamma and Beta functions. Parameterised curves in space - arc length - tangent and normal vectors - curvature and torsion.

Functions of several variables: limit - continuity - partial derivatives - partial differentiation of composite functions - directional derivatives - gradient - local maxima and local minima of functions of two variables - critical point - saddle point - Taylor's formula for two variables - Hessian - second derivative test - method of Lagrange multipliers - Evaluation of double integrals - improper integrals - change of variables - Jacobian - polar coordinates - triple integral - cylindrical and spherical coordinates - mass of a lamina - center of gravity - moments of inertia.

Vector field: divergence - curl - identities involving divergence and curl - scalar potential - Line integral - independence of path - irrotational and solenoidal vector fields - Green's theorem for plane - parameterized surface - surface area and surface integral - flux - Gauss' divergence theorem - Stokes' theorem.

References:

1. H. Anton, I. Bivens and S. Davis, *Calculus*, (10th edition) John Wiley & Sons, New York, 2015.
2. G. B. Thomas, M.D. Weirand J. Hass, *Thomas' Calculus*, (12th edition) Pearson Education, New Delhi, India 2015.
3. E. Kreyszig, *Advanced Engineering Mathematics*, (10th edition) John Wiley & Sons, New York 2015.
4. Apostol, *Calculus Vol 1*, (1st edition) Wiley, New Delhi 2014.

CY1004E CHEMICAL STRUCTURE AND BONDING

Pre-requisites: Nil

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Demonstrate the application of fundamental laws of quantum mechanics to solve chemical problems
CO2: Calculate eigenvalues and wave functions of quantum systems
CO3: Apply the theories and models of chemical bonding to molecules and materials

Dual nature of light and matter – de Broglie's relation – Electron diffraction by crystals – Double slit experiments with light and matter – Schrödinger equation – Operators – Postulates of quantum mechanics – Solutions of Schrödinger equation for a free particle.

Particle-in-a-box – applications of particle-in-a-box solutions for describing electronic levels and spectra in conjugated molecules – Schrödinger equation for the hydrogen atom (qualitative description of solutions) – concepts of orbitals and quantum numbers – Qualitative description of many-electron systems.

Chemical Bonding – Valence bond and molecular orbital descriptions of bonding – Linear com- bination of atomic orbitals (LCAO) approach – Hybridization – Bonding in homonuclear diatomic molecules of the second period – Bond orders – Bond lengths and Bond strengths - Bonding in heteronuclear diatomic molecules - Concepts of g and u symmetries of molecular orbitals – Polarity and electronegativity – Bonding in boron halides, PF_5, SF_6, interhalogens, and xenon fluorides – Bent's rule – Berry pseudorotation.

References:

1. D. A. McQuarrie, *Quantum Chemistry*, Viva Student Edition, Viva, 2011.
2. P. Atkins, J. de Paula and J. Keeler, *Atkins' Physical Chemistry*, Oxford University Press, (International Eleventh edition), 2018.
3. J. Barrett, *Structure and Bonding*, Wiley-Royal Society of Chemistry, 2002.
4. T. Engel and P. Reid, *Physical Chemistry*, (3rd Edition) Pearson, 2013.
5. R. J. Silbey, R. A. Alberty and M. G. Bawendi, *Physical Chemistry, (*4th Edition) Wiley, 2006.
6. P. Atkins, T. Overton, J. Rourke, M. Weller, F. Armstrong and M. Hagerman, *Shriver and Atkins' Inorganic Chemistry,* (5th Edition) New York: W. H. Freeman and Company, 2010.

ME1011E ENGINEERING GRAPHICS

Pre-requisites: Nil

L	T	P	O	C
2	0	2	5	3

Total Sessions: 26L + 26P

Course Outcomes:

CO1: Use Indian Standard Code of Practice in Engineering Drawing.
CO2: Represent engineering objects by orthographic views.
CO3: Convert orthographic views of an engineering object into the isometric view.
CO4: Use software for drawing and visualizing engineering objects.

Introduction to Engineering Graphics and Scales
Drawing instruments and their uses, lines, lettering and dimensioning, Engineering drawing using software - Geometrical construction – Importance of Scales in engineering graphics.

Orthographic Projections
First and third angle projections (using software) - Orthographic projection of points on principal, profile, and auxiliary planes - Orthographic projection of straight line in simple and oblique positions - Application of orthographic projection of line - Orthographic projection of planes in simple and oblique position on principal and profile planes - Orthographic projection of lines and planes on auxiliary planes - Orthographic projection of solids in simple and oblique positions on principal and profile planes - Orthographic projections of solids in oblique position using auxiliary plane method

Section, Development and Isometric view
Orthographic projection of solids in section - Development of surfaces of solids - Method of isometric projection (Using software).

References:

1. N. D. Bhatt, *Engineering Drawing*, (54th edition), Charotar Publishing House, 2023
2. B. Agrawal and C. M. Agrawal, *Engineering Drawing*, (3rd edition) McGraw Hill Education, 2019
3. K. Venugopal and V Prabhu Raja, Engineering Drawing + Auto CAD, (6th Edition) New Age Intl. Pvt Ltd., 2022

PH1101E MECHANICS

Pre-requisites: Nil

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Solve problems in Mechanics and Oscillations using Newton's equations of motion.
CO2: Describe oscillatory behavior under different conditions.
CO3: Formulate the dynamics of rigid bodies using Euler angles.
CO4: Interpret the dynamics of fluids by treating it as a continuous medium.

Newtons Equations
Review of Newtonian Mechanics: Force, Newton's II law and equations of motion, examples – Conservative and non-conservative systems – system of particles, Center of Mass – Central Forces, Kepler's Law, trajectories in Gravitational systems

Oscillations and Waves
Oscillations, Simple Harmonic Oscillations, Forced oscillations, damping, resonance – Waves, sound waves, elastic waves

Non inertial frames and rigid body motion
Motion in non-inertial frames, Coriolis and Centrifugal forces, Foucault pendulum – Independent Coordinates for a Rigid body, Euler angles – The Inertia tensor and Moment of Inertia – Principal Axis transformation

Fluid Mechanics
Fluid as a continuum – Velocity Field – Stress field – Viscosity, Newtonian and non-Newtonian fluids – Surface tension – Continuity equation – Dimensionless numbers in fluid mechanics – Laminar and Turbulent flow

References:

1. D. Kleppner and R. J. Kolenkow, *An Introduction to Mechanics* (1st Edition), McGraw Hill, 2017.
2. D. J. Morin, *Introduction to Classical Mechanics: With Problems and Solutions*, Cambridge University Press, 2008.
3. K. R. Symon, *Mechanics* (3rd Edition), Pearson, 2016.
4. Spiegel M. R., *Theoretical Mechanics*, (Schaum Series), McGraw Hill, 2017.
5. R. W. Fox, A. T. McDonald, P. J. Pritchare and A. W. Mitchel, *Fluid Mechanics* (9th Edition), John Wiley & Sons, 2011.

PH1102E THERMODYNAMICS

Pre-requisites: Nil

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Identify thermodynamically relevant variables for macroscopic systems and set up equations of state.
CO2: Apply the first and second law of thermodynamics to thermodynamic systems in practice.
CO3: Analyze thermodynamic properties of a system using appropriate thermodynamic potentials.
CO4: Apply the conditions of phase equilibrium and thermodynamic stability to analyze phase transitions.

Equations of State and First Law

Spatial and temporal nature of macroscopic measurements - thermodynamic equilibrium - measurability of energy - quantitative definition of heat - equation of state: ideal gas - real gas - non-PVT systems – PVT surfaces - expansivity and compressibility – first law of thermodynamics - configuration and dissipative work - mechanical equivalent of heat - heat capacity - enthalpy – consequences of the first law of thermodynamics - energy equation - Gay-Lussac-Joule experiment - Joule-Thomson experiment of free expansion - reversible adiabatic processes - Carnot cycle.

Entropy and Second law

Entropy and second law of thermodynamics - thermodynamic temperature - entropy changes in reversible and irreversible processes - temperature-entropy diagrams - principle of increase of entropy - Clausius and Kelvin-Planck statement of second law – Combined first and second laws - TdS equations - properties of pure substances - ideal gas and van der Waals gas - liquids or solids under hydrostatic pressure - Joule and Joule-Thomson experiments - Euler Equation - Gibbs-Duhem relation.

Thermodynamic potentials)

Thermodynamic potentials - Helmholtz and Gibbs Function - Maxwell relations - stable and unstable equilibrium - third law of thermodynamics - chemical potential - conditions of equilibrium - maximum work theorem - energy minimum principle - Legendre transformations - minimum principle for thermodynamic potentials.

Stability and Phases

Intrinsic stability of thermodynamic systems - stability conditions for thermodynamic potentials - physical consequences of stability - Le Chatelier's principle – First-order phase transitions in single component systems - phase-coexistence - Clausius-Clapeyron equation - unstable isotherms - general attributes of first-order transitions - first-order phase transitions in multi-component systems - phase equilibrium and Gibbs phase rule - critical constants for van der Waal's gas – qualitative discussion on second-order phase transitions.

References:

1. M. W. Zemansky and R. H. Dittman, *Heat and Thermodynamics*, (8^{th} Edition) McGraw-Hill, 2017.
2. F. W. Sears and G. L. Sallinger, *Thermodynamics, Kinetic theory and Statistical Thermodynamics*, Narosa, New Delhi, 1995.
3. H. B. Callen, *Thermodynamics and an Introduction to Thermostatics*, (2^{nd} Edition) Wiley, 1985.
4. E. Fermi, *Thermodynamics*, Dover Publications, 2000.
5. A. Y. Cengel and A. M. Boles, *Thermodynamics: an engineering approach (5^{th} Edition)*, TMH, 2006.

PH1191E GENERAL PHYSICS LAB

Pre-requisites: Nil

L	T	P	O	C
0	0	3	3	2

Total Practical Sessions: 39

Course Outcomes:

CO1: Apply principles of mechanics, quantum and atomic theory for experimentation.
CO2: Develop skills for data analysis and interpretation.
CO3: Set up experiments, take observations and relate it with a suitable theory.
CO4: Build ability for group discussion and critical thinking for collaborative work.

List of Experiments:

1. To determine the moment of inertia of a flywheel.

2. To determine the charge to mass ratio of the electron.

3. To determine the moment of inertia of the disc of the torsion pendulum and the rigidity modulus of the material of the given metallic wire using torsional oscillations and a uniform ring.

4. To determine the acceleration due to gravity using a symmetric compound pendulum, the radius of gyration about the center of gravity (CG) and the moment of inertia of the bar about the CG.

5. To study the splitting of spectral lines of atoms in the presence of magnetic field.

6. To determine the threshold frequency for photo electric emission, work function of the photo emissive material and to evaluate the Planck's constant.

7. To study the existence of discrete atomic energy levels using Franck-Hertz experiment.

8. To determine the ultrasonic velocity in the given liquid.

9. To determine Young's modulus and Poisson ratio of a transparent material (glass) by Cornu's method.

10. To study the variation of the magnetic field along the axis of a current carrying circular coil using a deflection magnetometer and to determine the value of B_h at the place.

References:

1. A.C. Melissinos, J. Napolitano, *Experiments in Modern Physics (2nd Edition)*, Academic Press, 2003
2. R. A. Dunlop, *Experimental Physics,* Oxford Univ. Press, 1988

ME1391E MECHANICAL WORKSHOP

Pre-requisites: Nil

L	T	P	O	C
0	0	2	1	1

Total Practical Sessions: 26

Course Outcomes:

CO1: Identify and use various tools used in a machine shop and perform the basic lathe operations such as turning, facing, chamfering, knurling etc.
CO2: Identify and use various tools used in fitting and welding and perform operations such as chipping, filing, cutting, drilling, etc., and prepare multiple joints and welds
CO3: Identify and use various tools in carpentry & sheet metal work and perform multiple operations for the preparation of joints using wood and fabrication using sheet metal
CO4: Identify and use various tools in smithy & foundry and to practice forging, moulding and casting

The course is intended to expose the student to various manufacturing processes through hands on training in different sections of Central Workshop. During the course, the student learns the properties and selection of different materials and acquires the skill in using various tools and measuring devices.

1. **Machine Shop**: Study of the basic lathe operations. Turning, step turning, facing, chamfering, thread cutting, grooving, knurling etc.
2. **Fitting**: Study of tools- chipping, filing, cutting, drilling, tapping, about male and female joints, stepped joints. Cutting and edge preparation for lap and butt joints.
3. **Welding**: Study of arc and gas welding, accessories, joint preparation. Welding of lap and butt joints, Single V and Double V.
4. **Carpentry**: Study of tools and joints – planing, chiseling, marking and sawing practice, one typical joint- Tee halving/cross halving/Mortise and Tenon/ Dovetail.
5. **Sheet Metal**: Study of tools, selection of different gauge sheets, types of joints. Fabrication of a tray or a funnel.
6. **Smithy**: Study of tools. Forging of square or hexagonal prism/chisel/bolt.
7. **Foundry**: Study of tools, sand preparation. Moulding practice using the given pattern and demonstration on casting

References:

1. W. A. J. Chapman, *Workshop Technology - Parts 1 & 2,* (4th Edition) New Delhi, India, CBS Publishers & Distributors Pvt. Ltd.2007
2. *Welding Handbook (9th Edition)*, American Welding Society, 2001.
3. J. Anderson, *Shop Theory* New Delhi, India, Tata McGraw Hill 2002
4. J. H. Douglass, *Wood Working with Machines* Illinois, McKnight & McKnight Pub. Co.1995
5. W.A. Tuplin, *Modern Engineering Workshop Practice* Odhams Press1996
6. P. L. Jain, *Principles of Foundry Technology* (5th Edition) New Delhi, India, Tata McGraw Hill2009

MA1012E MATHEMATICS II
(Common to CSE/EP branches)

Pre-requisites: Nil

L	T	P	O	C
3	1	0	5	3

Total Lecture sessions: 39

Course Outcomes:

CO1: Acquire sufficient knowledge about convergence of sequences and series and various methods of testing for convergence.
CO2: Solve linear ODEs with constant coefficients.
CO3: Test the consistency of the system of linear equations and solve it.
CO4: Acquire sufficient knowledge about vector spaces, linear transformation and theory of matrices.
CO5: Diagonalise symmetric matrices and use it to find the nature of quadratic forms.

Numerical sequences - Cauchy sequence - convergence of sequences - series - convergence of series - tests for convergence - absolute convergence. Sequence of functions - power series - radius of convergence - Taylor series. Periodic functions and Fourier series expansions - half-range expansions.

Existence and uniqueness of solution of first order ordinary differential equations (ODEs) - methods of solutions of first order ODE - linear ODE - linear homogeneous second order ODEs with constant coefficients - fundamental system of solutions - Wronskian - linear independence of solutions - method of undetermined coefficients - solution by variation of parameters.

System of linear equations: Gauss elimination method - row echelon form - row space - row rank - existence and uniqueness - homogeneous system - solution space - rank-nullity relation for homogeneous linear system. Abstract vector space - subspace - linear independence and span - basis - dimension - linear transformation - kernel - range - rank-nullity theorem.

Coordinates - matrix representation of linear transformation - base changing rule - eigenspace - diagonalisation of linear operator. Eigenvalues and eigenvectors of a matrix - Cayley-Hamilton theorem - diagonalisation of symmetric matrices - quadratic forms - transformation into principal axes - eigenvalue method of solving system of first order linear ODEs with constant coefficients.

References:

1. H. Anton, I. Bivens and S. Davis, *Calculus,* (10th edition) John Wiley & Sons, 2015.
2. Apostol, *Calculus Vol 1*, (1st edition) Wiley New Delhi, 2014.
3. E. Kreyszig, *Advanced Engineering Mathematics*, (10th edition) Wiley, 2015.
4. Gilbert Strang, *Differential Equations and Linear Algebra*, Cambridge Press, 2014.
5. Stephen W. Goode, Scott Annin*, Differential Equations and Linear Algebra* Pearson Prentice Hall, 2007.
6. O.Bretscher. *Linear algebra with applications*, New Delhi, Prentice Hall, 1997.

MS1001E PROFESSIONAL COMMUNICATION

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Distinguish the role and purpose of communication at the workplace and for academic purposes.
CO2: Decide strategies and modes for effective communication in a dynamic workplace.
CO3: Combine multiple approaches for successful and ethical information exchange.
CO4: Estimate best communication practices to assist productivity and congeniality at the workplace.

Listening and Reading Comprehension

Conversation starters: introductions and small talk - Seek and provide information, clarification, polite enquiries, requests, congratulate people, apologise, give and respond to feedback - Describe graphs, tables, and charts - Words often confused: Lexicon and Meaning - Sense Groups - Listening for specific purposes: Listening to lectures, Summarise academic lectures for note-taking - Appropriate Language to Request and Respond - Public Speaking

Vocabulary and Speaking

Developing professional vocabulary - Basic Sentence Structures from Reading Texts - Concord - Functions of Auxiliary Verbs and Modals - Strategies for Effective Reading - Skimming and Scanning, Determine themes and main ideas, Predicting content using photos, images and titles - Critical Reading: Discussing and Summarising text points - Understanding Text Structures: sequencing, comparing and contrasting, relating cause and effect, problems and problem-solving - Discussing Rhetorical and Cultural Aspects in Texts - Text Appreciation: Drawing inferences, Framing Opinions and Judgments on Reading Text

Effective Writing

Note Making and Summarising: Prepare notes from reading texts, Paraphrasing - Use of Multimedia for Assistive Purposes - Paragraph Writing: cohesive devices to connect sentences in a paragraph - transitional devices - Use Text Structures in Paragraphs: sequencing, comparing and contrasting, relating cause and effect, problems and problem-solving - Avoiding Ambiguity and Cleft Sentences - Applications- Writing Instructions, Descriptions and Explanations - Official Letters of Request and Denial - Official E-mails - Abstract Writing - Digital Resources for Effective Communication

Communication at Workplace

Communication Theory - Process of Communication - Modes of Communication - Verbal and Non-Verbal Communication - Tone in Communication - Formal and Informal Communication at Workplace - Passive, Assertive and Aggressive Styles of Communication - Positive Body Language - Group Discussions - Presentation - Workplace Communication - Active Listening - Giving Feedback - Communication Etiquette - Persuasion - Negotiation - Tone and Voice - Telephone etiquette - Establishing Credibility in Conversations - Digital Communication and Netiquette: Conducting Oneself in Virtual Interactions, Constructive use of Social media - Ethical and Culturally Sensitive Communication: Ethical considerations in professional communication, Addressing diversity, Inclusive Communication Practices

References:

1. N. Bhatnagar and M. Bhatnagar, *Communicative English for engineers and professionals*, Dorling Kindersley, 2010.
2. M. Foley and D. Hall, *Longman advanced learners 'grammar: A self-study reference & practice book with answers*, Pearson Education, 2018.
3. B. A. Garner, *HBR Guide to better business writing: Engage readers, tighten and Brighten, make your case,* Harvard Business Review Press, 2012.
4. M. Hewings, *Advanced grammar in use: A reference and practice book for Advanced learners of English,* Cambridge University Press, 2013.
5. M. Ibbotson, *Cambridge English for Engineering.* Cambridge University Press, 2015.
6. S. Kumar and P. Lata, *Communication Skills,* Oxford University Press, 2015.
7. Sudarshana, N., & Savitha, C. *English for Technical Communication*, Cambridge English, 2016.

PH1111E CLASSICAL MECHANICS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Apply Calculus of Variations and Lagrangian method for problems in Classical Mechanics.
CO2: Utilize the symmetry properties of systems to simplify the description of a system.
CO3: Describe oscillatory behavior under different conditions.
CO4: Implement special relativity and identify the discerning features.

Lagrangian method

Constraints - Generalized Coordinates - Virtual Displacements - D'Alembert's Principle - Calculus of Variations, examples - Lagrangian, Euler-Lagrange Equations, examples - Central force motion - Orbits and Scattering.

Hamilton's equations and Canonical Transformations

Legendre transformations - Hamilton's equations and examples - Cyclic coordinates – Symmetry - Conservation principles and Noether's theorem - Canonical transformations - Poisson bracket formulation

Normal Modes of Oscillation

System of oscillators - eigenvalue problem and normal modes - damping - forced oscillations and resonance - Dynamical stability.

Special Relativity

Special theory of relativity - Lorentz transformation - Consequences of Special Relativity - Relativistic mechanics and dynamics - Four-vectors, tensors, metric - Space-time diagrams.

References:

1. H. Goldstein, C. P. Poole and J. Safko, *Classical Mechanics* (3rd Edition), Pearson, 2011.
2. Landau and Lifshitz, *Mechanics: Course of Theoretical Physics Vol-I* (3rd Edition), Butterworth-Heinemann, 2010.
3. D. Kleppner and R. J. Kolenkow, *An Introduction to Mechanics* (1st Edition), McGraw Hill, 2017.
4. Spiegel M. R., *Theoretical Mechanics*, (Schaum Series), McGraw Hill, 2017.
5. D. A. Wells, *Lagrangian Dynamics*, (Schaum Outlines Series) McGraw-Hill, 1967.

PH1112E ANALOG ELECTRONICS

Pre-requisites: Nil

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Apply circuit theorems and solve physics problems in terms of equivalent circuits.
CO2: Explore the fundamentals of operational amplifiers and design wave-shaping circuits, oscillators, mathematical operations, voltage regulators, current sources, and instrumentation amplifiers.
CO3: Apply the fundamentals of the 555 timers and realize various timing and clock circuits.
CO4: Realize various active filters through transfer function formalism and Design band-pass, band-reject (Notch) filters.
CO5: Employ the concepts of special purpose diodes and FET, MOSFET transistors in physical measurement systems.

Voltage and current sources – circuit theorems- superposition theorem – Thevenin's theorem – Norton's theorem – Thevenin-Norton conversions – maximum power transfer theorem – star-delta transformations – Equivalent circuit and its applications in physics.

Open-loop operational amplifier configurations – feedback configurations- voltage series and voltage shunt feedback amplifiers – differential amplifiers- differential amplifier with one op-amp and two op-amps – current to voltage converter – input offset voltage – input bias current – input offset current – total output offset voltage – common mode rejection ratio – compensating networks – slew rate- causes of slew rate – slew rate equation – the effect of slew rate in applications.

Summing – scaling – and averaging amplifiers – subtractor – integrator – differentiator – instrumentation amplifier – voltage to current converter – Oscillators- basic principle of the sinusoidal oscillator – phase shift – and Wein bridge oscillators – Comparators – Schmidt trigger – the 555 timer – the 555 as a monostable – and as an astable multivibrator – applications – Phase Locked Loop (PLL)- operating principles and applications – voltage regulators.

Filter theory – transfer function – poles and zero-filter responses –design of low-pass, high-pass, band-pass and band-stop (Notch) active filters using Op-amps, Special diodes: Schottky diode, LED, varactor diode, Photo diode, tunnel diode, FET, MOSFET, Diac, Triac and SCR.

References:

1. A. Malvino, D. Bates and P. Hoppe, *Electronic principles* (9th Edition), McGraw-Hill, 2020.
2. T. L. Floyd and D. M. Buchla, *Basic operational Amplifiers and Linear Integrated Circuits*, Pearson Education Asia, 2003.
3. R. A. Gayakwad, *Op-amps and Linear Integrated Circuits*, Prentice Hall of India, 2009.
4. W. D. Stanley, *Operational amplifiers with linear integrated circuits*, Pearson, 2004.
5. R. F. Coughlin and F. F. Driscoll, *Op- Amps and Linear Integrated Circuits* (4th Edition), Prentice Hall of India, 2003.
6. A. S. Sedra and K. C. Smith, *Microelectronic Circuits* (6th Edition), Oxford University Press, 2011.

PH1113E ELECTROMAGNETICS

Pre-requisites: Nil

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Apply concepts of vector calculus to describe Electric and Magnetic fields.
CO2: Identify simplifying principles like symmetry to compute Electric and Magnetic fields.
CO3: Formulate and solve problems involving time dependent electromagnetic fields using Maxwell's equations.
CO4: Analyze propagation of electromagnetic waves in vacuum and dielectric media

Electrostatics

Electrostatic force and field: scalar and vector fields - Coulomb's law - flux of the electric field and Gauss law - divergence of electric field - electric potential - line integral of the field - curl of the electric field - Poisson and Laplace equation - electrostatic work and energy - conductors and electric fields - field and potential of dipoles - electric polarization vector - Gauss law for a dielectric medium - electrostatic boundary conditions.

Magnetostatics

Electric current - current density - surface and volume currents - continuity equation - magnetic field - Biot-Savart law - divergence and curl of magnetic field - Ampere's law - field due to a magnetic dipole - magnetic dipole in external magnetic field - magnetostatic energy -magnetized materials - magnetostatic boundary conditions.

Time dependent Electric and Magnetic fields

Electromotive force - Faraday's law - Lenz law - electromagnetic induction - mutual and self- inductance - Maxwell's equations - Maxwell's correction to Ampere's law - displacement current- electromagnetic field – energy density - Poynting's theorem.

Maxwell's equations in free space - wave equation - plane wave solution - structure of the electro- magnetic wave - spherical waves - propagation in dielectric medium and refractive index.

References:

1. D. J. Griffiths, *Introduction to Electrodynamics* (4th Edition), PHI Learning - New Delhi, 2012.
2. E. Purcell and D. Morin, *Electricity and Magnetism* (3rd Edition), Cambridge University Press, 2013.
3. M. O. Sadiku, *Elements of Electromagnetics* (4th Edition), Oxford, 2009.
4. D. J. Cheng, *Field and Wave Electromagnetics* (2nd Edition), Pearson, 2014.
5. R. P. Feynman, R. Leighton and M. Sands, *Feynman Lectures on Physics Vol.-II* (Millenium Edition), Pearson, 2012.
6. J. Edminister, *Schaum's Outline: Theory and Problems in Electromagnetics* (2nd Edition), McGraw-Hill, 1979.

PH1192E ELECTRONICS LAB - I

Pre-requisites: Nil

L	T	P	O	C
0	0	3	3	2

Total Practical Sessions: 39

Course Outcomes:

CO1: Design inverting and non-inverting operational amplifiers.
CO2: Perform mathematical operations (differentiation and integration) using operational amplifier.
CO3: Construct various (low-pass, high-pass, band-stop) active filter circuits using operational amplifier.
CO4: Realize waveform generators and wave-shaping rectifier circuits.
CO5: Apply the fundamentals of 555 timer circuits and realize various timing and clock pulse circuits.

List of Experiments:

1. Inverting, non-inverting amplifiers, and voltage follower circuits using IC741
2. Voltage to the current converting amplifier
3. Differentiator and integrator using IC741
4. Half and Full-wave active rectifiers using IC741
5. Instrumentation amplifier using IC741
6. Wein bridge oscillator using IC741/Waveform generators (sine, square and triangular)
7. First order low-pass, high-pass Butterworth filters and Notch Filter
8. Astable multivibrator using IC741
9. Astable and monostable multivibrators using 555 timer
10. Voltage comparators and Schmidt Trigger

References:

1. T. L. Floyd and D. M. Buchla, *Basic operational Amplifiers and Linear Integrated Circuits*, Pearson Education Asia, 2003.
2. R. A. Gayakwad, *Op-amps and Linear Integrated Circuits*, Prentice Hall of India, 2009.
3. W. D. Stanley, *Operational amplifiers with linear integrated circuits*, Pearson, 2004.
4. R. F. Coughlin and F. F. Driscoll, *Op- Amps and Linear Integrated Circuits* (4th Edition), Prentice Hall of India, 2003.
5. A. S. Sedra and K. C. Smith, *Microelectronic Circuits* (6th Edition), Oxford University Press, 2011.
6. Virtual lab resources: https://www.vlab.co.in/broad-area-electronics-and-communications

PH1193E ELECTROMAGNETICS SIMULATIONS LAB

Pre-requisites: Nil

L	T	P	O	C
0	0	3	3	2

Total Practical Sessions: 39

Course Outcomes:

CO1: Employ finite-element method (FEM) and finite-difference-time-domain method (FDTD) to solve electromagnetic problems.

CO2: Simulate electrostatic and magnetostatic problems associated with capacitors and inductors, respectively.

CO3: Design electric dipole antenna, magnetic lens, and wire-grid polarizers and explore its functionalities numerically.

CO4: Perform complex electromagnetic computations and solve electromagnetic wave propagation problems numerically.

List of Experiments:

1. Solve the electrostatic boundary value problem for a given set of boundary conditions numerically and plot electric potential and electric field distributions (2-D, 3-D problems)
2. Simulate (i) capacitor fringing fields and (ii) Eddy current distributions when different kinds of metallic plates are placed near a 50 Hz AC conductor
3. Compute and plot the magnetostatic force between an iron rod and a permanent magnet
4. Design an electric dipole antenna and plot its electric field and radiation pattern
5. Design the Helmholtz coil and plot the magnetic field distribution associated with it
6. Study the Mie scattering of a lossless dielectric sphere and plot the differential radar cross-section
7. Find the eigenmode and quality factors of a dielectric ring resonator
8. Simulate Gaussian wave propagation in a nonlinear medium
9. Animate the electromagnetic mode of rectangular and slab waveguides
10. Compute Fresnel's coefficients for transverse electric (TE) and transverse magnetic (TM) wave incident on a dielectric slab from the air and compare them with analytical results
11. Design wire grid polarizers and verify cross-polarization conversion
12. Design a magnetic lens and plot the electron beam trajectories in a spatially varying magnetic field

References:

1. R. C. Rumpf, Electromagnetic and Photonic Simulation for the beginner, Artec Press, 2022.
2. A. Taflove, A. Oskooi and S.G. Johnson, Advances in FDTD Computational Electrodynamics: Photonics and Nanotechnology, Artech: Norwood, MA, 2013.
3. MEEP (Open source FDTD electromagnetic solver): https://meep.readthedocs.io/en/latest/
4. Comsol RF Module: www.comsol.com