Kavayitri Bahinabai Chaudhari
North Maharashtra University, Jalgaon

॥ अंतरी पेटवू ज्ञानज्योत ॥

A-Grade
NAAC Reaccredited
(4^{th} Cycle)

SYLLABUS

for

Master of Science (M. Sc.)

In

PHYSICS

As per NEP2020, for Affiliated Colleges

With Effect from - June 2023.

Semester I & II

Summary of Distribution of Credits
for
M.Sc. Physics

Sr. No	Type of course	Sem I	Sem II	Sem III	Sem IV
01	**Core**	**14 (03 T + 02 P)**	**14 (03 T + 02 P)**	**14 (03 T + 02 P)**	**12 (02 T + 02 P)**
02	**Elective**	**04**	**04**	**04**	**04**
03	**RM**	**04**	**--**	**--**	**--**
04	**OJT/Int**	**--**	**04**	**--**	**--**
05	**RP**	**--**	**--**	**04**	**06**
06	**Total Credits**	**22**	**22**	**22**	**22**

Subject Type	Core (T)	Practical (P)	Elective	RM	OJT/Int	RP	Total
Credits	**38**	**16**	**16**	**04**	**04**	**10**	**88**

Semester-wise Course Structure, Course Code and Credit distribution of Two Years/ One Year M. Sc PHYSICS Programme as per NEP2020, for Affiliated Colleges, w.e.f – June 2023.

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/Week			Marks (Total 100)			
					T	P	Total	Internal (CA)		External (UA)	
								T	P	T	P
SEMESTER – I, Level – 6.0											
DSC-25	DSC	PH-411	Mathematical Methods for Physics	4	4	--	4	40	--	60	--
DSC-26	DSC	PH-412	Quantum Mechanics-A	2	2	--	2	20	--	30	--
DSC-27	DSC	PH-413	Classical Mechanics	4	4	--	4	40	--	60	--
DSC-28	DSC	PH-414	Laboratory - I	2	--	4	4	--	20	--	30
DSC-29	DSC	PH-415	Laboratory – II	2	--	4	4	--	20	--	30
DSE-5	DSE	PH-416(A)	Applied Electronics	4	4	--	4	40	--	60	--
		PH-416(B)	Solar Thermal and Photovoltaic Systems	4	4	--	4	40	--	60	--
RM	RM	RM-417	Research Methodology	4	4	--	4	40	--	60	--
SEMESTER – II, Level – 6.0											
DSC-30	DSC	PH-421	Statistical Mechanics	4	4	--	4	40	--	60	--
DSC-31	DSC	PH-422	Quantum Mechanics-B	2	2	--	2	20	--	30	--
DSC-32	DSC	PH-423	Electrodynamics	4	4	--	4	40	--	60	--
DSC-33	DSC	PH-424	Laboratory - III	2	--	4	4	--	20	--	30
DSC-34	DSC	PH-425	Laboratory – IV	2	--	4	4	--	20	--	30
DSE-6	DSE	PH-426(A)	Electronic Instrumentation	4	4	--	4	40	--	60	--
		PH-426(B)	Sensors and Instrumentation	4	4	--	4	40	--	60	--
OJT	*OJT/Int	PH-427	On Job Training / Internship	4	--	8	8	--	40	--	60
Cumulative Credits for First Year – 44											

*** Students need to complete one month on job training (OJT) or internship in any industry related to major subject.**

Abbreviations:

DSC: Discipline Specific Core Course, **DSE:** Discipline Specific Elective, **OJT:** On Job Training/Internship, **T:** Theory Course, **P:** Practical course, **RM:** Research Methodology; **CA:** College Assessment; **UA:** University Assessment.

- **One credit means: One hour of theory or Two hours of laboratory work for a duration of a semester (13-15 weeks) resulting in the award of one credit.**

Program at a Glance

Name of the program (Degree) : M. Sc. Physics

Faculty : Science and Technology

Duration of the Program : Two years (four semesters)

Pattern : As per NEP-2020

Medium of Instruction and Examination : English

Examination Pattern : **For Course with 4-credits**

- University Assessment (UA) – 60 marks
- College Assessment (CA) – 40 marks

For Course with 2-credits

- University Assessment (UA) – 30 marks
- College Assessment (CA) – 20 marks

Passing standards : 40% marks in UA and CA separately.

Evaluation mode : CGPA

Total Credits of the program : 88 (Distribution of credits as given in structure)

Program Objectives

The objectives of this Programme are to develop:

• The students through high quality of education/study which enables them to succeed in career in which can understanding of Physics is relevant.
• The ability to think logically, to analyze problems and phenomena and to devise explanations or solutions.
• An appreciation of the role of mathematical modeling of physical phenomena to produce predictions which can be tested against experimental observations.
• An awareness of the importance of accurate experimentation in the understanding of natural phenomena.
• To develop practical and technical skills required for Physics experimentation.
• An awareness of the value and the power of computer-based techniques for experimentation, analysis and presentation and a familiarity in their exploitation.
• An ability to communicate the concepts and discoveries of Physics both orally and in writing.
• An ability to organize time and meet deadlines.
• An additional skill resulting from the experience of more extensive project work.
• An ability to integrate 'Information Communication Technology' with basic concepts of physics to promote relevant learning and hands on training.
• The qualities of adoptability, innovation and dynamism.

Program Outcomes

Upon successful completion of the M.Sc. program, student will be able to:

PO1	**Understand the basic concepts, fundamental principles, and the scientific theories related to various scientific phenomena and their relevancies in the day-to-day life.**
PO2	**Administer the skills in handling scientific instruments, planning and performing laboratory experiments.**
PO3	**Analyze the given scientific experimental data critically and systematically to draw the conclusions.**
PO4	**Develop various skills such as communication, managerial, leadership, entrepreneurship, teamwork etc. Express ideas and views clearly and effectively.**
PO5	**Model and formulate the problems and find solutions based on the knowledge acquired.**
PO6	**Adopt interdisciplinary approach in providing better solutions and new ideas.**

Semester – I

Course Code: PH-411

Course Title: Mathematical Methods for Physics

Course Code: PH-411	Course Category: Core
Course Title: Mathematical Methods for Physics	Type: Theory
Total Contact Hours: 60 (4/week)	Course Credits: 04
College Assessment (CA) Marks: 40 Marks	University Assessment (UA): 60 Marks

Course Objectives:

- This course has been developed to introduce students to some topics of Mathematical Methods for Physics which are directly relevant in different papers of M.Sc. Physics.
- Study the applications of the studied topics and solve applied problems.

Course Outcomes:

- Apply the concept and knowledge of Mathematical physics to understand and solve real life problems.
- Knowledge about Vector calculus, Bessel Functions, Legendre Differential equations, complex variable, Laplace transforms, Fourier Series etc and their physical significance is learnt by students. These mathematical concepts are widely used in various physics derivations.
- Understanding of the Basic Mathematical physics will create scientific temperament.

Course Content:

Unit 1: Vector spaces: (08 L, 08 M)

Introduction, definition, example of vector space, Sub spaces, Linear combinations of vectors,Linear span, Linear dependence and independence, Basis and dimensions, Linear transformations, Linear operator, Matrix representation of linear operator. Inner product space - Definition of inner product space, Properties (Conjugate symmetry, linearity, non-negativity), Norm of a vector, Cauchy's Schwarz's inequality, Triangle inequality, Law of Parallelogram, Orthogonally, Orthonormal set, Orthonormal basis, Gram-Schmidt Orthogonalization Process.

Unit 2: Matrix Algebra: (06 L, 06 M)

Definition of matrix, Types of matrices (Symmetric, Skew symmetric, Transpose of a matrix, Orthogonal matrix, Unitary, Hermitian, Skew Hermitian, Idempotent matrix, Periodic matrix, Nilpotent matrix, Involuntary matrix, Adjugate matrix), Eigen values and Eigen vectors of amatrix, Diagonalization of matrix, Caley-Hamilton theorem.

Unit 3: Fourier series (08 L, 08 M)

Periodic function; Euler Fourier formula; Dirichlet conditions; half range Fourier series; Change of interval; Parseval's identity; Few applications of Fourier series- Vibrating string, RLC circuit and other general applications in physics.

Unit 4: Integral transforms (18 L, 18 M)

Definition of Laplace Transform, Properties (Linearity, Shifting, Change of Scale), Laplace Transform of derivative, Laplace transform of integrals, Derivative of Laplace transform, initial and final values theorems, Multiplication by power of t, division by t, Inverse Laplace transform-

Definition, Proofs of Linearity, I[st] and II[nd] shifting theorem, Convolution theorem(Statement only), Applications to solution of differential equations. Definition of Fourier transformation, Fourier sine and cosine transforms.

Unit 5: Special Function: (14 L, 15 M)

Introduction, Spherical harmonics, Legendre polynomial [Recurrence relations, Rodrigue's formula and Orthogonality], Associated Legendre's polynomials [Differential equation, first and second kind function, recurrence relation, orthogonality], Hermit polynomials [Recurrence relation, orthogonality, Rodrigue's formula], Bessel function [Recurrence relations for $J_n(x)$, Integral representation for $J_n(x)$] ,Bessel's Function of half odd order [$J\pm1/2$ (x), $J\pm3/2$ (x)], Laguerre Functions [Generating functions, Recurrence relations, Orthogonally, Rodrigue's Formula, Integral formula for $L_n(x)$].

Unit 6: Complex Analysis (06 L, 05 M)

Introduction to complex number, Cauchy- Riemann condition, Cauchy's theorem, Cauchy's integral formula, Derivative of analytic function, Taylors theorem, Lorentz's theorem, Residue, Computation of residue, Cauchy's residue theorem, Evaluation of definite integrals (integration round the unit circle).

Reference Books:

1. Algebra By Seymour Lipschutz, Schaum outline series.
2. Theory & Problems of Matrices by Frank Ayres.
3. Mathematical Method For Physics by Arfken.
4. Mathematical Method in Physics by B. D. Gupta.
5. MMP by H.K.Das (S. Chand Publication).
6. Mathematical Physics by B. S. Rajput.
7. Fourier Series by Seymour Lipschutz ,Schaum outline series.
8. Laplace Transforms by Seymour Lipschutz ,Schaum outline series.
9. Complex Variables & Applications by J. W. Brown.
10. Mathematics for physical science by Mary Boas.
11. Ordinary and Partial differential equation by Dr. M.D. Raisinghania (S. Chand)

Course Code: PH-412

Course Title: Quantum Mechanics-A

Course Code: PH-412	**Course Category: Core**
Course Title: Quantum Mechanics-A	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA) Marks: 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To understand the basics principles of quantum mechanics.
- To understand the basic terms in quantum mechanics.
- To understand the Schrodinger wave equation, the wave function, its statistical interpretation, and time evolution of solutions.
- To understand the perturbation theory and its application for finding solutions to real quantum mechanical systems

Course Outcomes:

- To acquire mathematical skills, require to develop theory of quantum mechanics.
- To develop understanding of postulates of quantum mechanics and to learn to apply them to solve some quantum mechanical systems.

Course Content:

Unit 1: Foundations of Quantum Mechanics (06 L, 06 M)

Problem of black body radiation and its solution using quantum concept; Postulates of quantum mechanics; Formulation of time dependent and time independent Schrödinger wave equation, Physical significance of wave function, normalized and orthogonal wave functions, requirements of wave function. Numerical based on above topics.

Unit 2: Application of Schrodinger equation for 1-D problems (08 L, 08 M)

Finite square barrier and well potential Find R and T for each case, concept of zero-point energy. Square potential barrier application in alpha particle emission, introduction to other problems and solution using Schrodinger wave equation.

Unit 3: Time independent Perturbation theory (08 L, 08 M)

Basic theory; Non-degenerate and degenerate cases (upto2nd order); Applications: anharmonic oscillator, Zeeman effect, Stark effect; Numerical based on the above topics.

Unit 4: Time dependent Perturbation theory (08 L, 08 M)

Introduction; First order perturbation; Harmonic perturbation; Transition to continuum states, Absorption and emission of radiation, Einstein's coefficients, Fermi's golden rule; Numerical based on the above topics.

Reference Books:

1. Advanced Quantum Mechanics by Satya Prakash, Kedar Nath Ram Nath, Meerut Delhi.

2. Quantum Mechanics: Concept and Applications by Nouredine Zettili, A John Wiley and Sons, Ltd., Publication
3. Quantum Mechanics by Leonard I Schiff, McGraw-Hill Book Company Inc.
4. Quantum Mechanics by Chatwal, Anand, Himalaya Publishing House.
5. Quantum Mechanics: Theory and Applications by Ajoy K. Ghatak, S. Lokanathan, Macmillan Publishers India Ltd.
6. Quantum Mechanics: Powell and Crasemann, Addison-Wesley Pub. Co.

Course Code: PH-413

Course Title: Classical Mechanics

Course Code: PH-413	Course Category: Core
Course Title: Classical Mechanics	Type: Theory
Total Contact Hours: 60 (4/week)	Course Credits: 04
College Assessment (CA) Marks: 40 Marks	University Assessment (UA): 60 Marks

Course Objectives:

- To impart knowledge of basic concepts in Classical Mechanics.
- To provide the knowledge and methodology necessary for solving problems in Physics.
- The course also involves the related experiments based on the theory.

Course Outcomes:

- Apply the concept and use of knowledge of Classical Mechanics to real life problems.
- Understanding of the Classical Mechanics will create scientific temperament.
- The Lagrangian and Hamiltonian approaches in classical mechanics.
- The classical background of Quantum mechanics and get familiarized with Poisson brackets and Hamilton -Jacobi equation.

Course Content:

Unit 1: Mechanics of System of particles (14 L, 14 M)

Conservation of linear and angular momentum of system of particles, Relation between about any point and about Centre of mass, Discuss similar relations for kinetic energy also. Scattering of Particles: Elastic and inelastic collision, Lab. and C.M. system of coordinates, Differential and total cross section, Impact parameter, Rutherford's scattering, Relation of cross-section between C.M. and Lab Frame.

Unit 2: Lagrangian Formulation (12 L, 12 M)

Types of constraints, degrees of freedom, Generalized coordinates, Concept of virtual displacement and virtual work, D'Alemberts principle, Lagrange's equation from D'Alemberts principle, Properties of Lagrange's equation, Applications of Lagrange's equation (simple pendulum, linear simple harmonic oscillator, compound pendulum and Atwood's machine).

Unit 3: Hamilton's equation of motion (12 L, 12 M)

Introduction, Legendre's dual transformation, Hamilton's function and Hamilton's equations of Motion, Properties of the Hamiltonian and of Hamilton's equations of motion, Routhian, Configuration space, Phase space and State space, Lagrangian and Hamiltonian of relativistic particles and light rays.

Unit 4: Principle of Least Action and Hamilton's principle (12 L, 12 M)

Introduction, Principle of least action, Hamilton's principle, Comparison between Fermat's principle of least action in optics & Maupertuis' principle of least action in mechanics, Derivation of Euler-Lagrange equations of motion from Hamilton's principle, Derivation of Hamilton's equations of motion for holonomic systems from Hamilton's principle, Invariance of Hamilton's principle under generalized coordinate transformation.

Unit 5: Canonical transformations and Hamilton-Jacobi theory (10L, 10M)

Gauge transformation, Canonical transformation, Condition for transformation to be canonical, Poisson brackets, Canonical equations in terms of Poisson bracket notation, Infinitesimal transformation, Relation between infinitesimal transformations and Poisson brackets, The Hamilton - Jacobi equations, Solution of harmonic oscillator.

Reference Books:

1. Introduction to Classical Mechanics: R. G. Takwale and P. S. Puranik.
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw -Hill Publishing Co. Ltd.
3. Classical Mechanics: P. V. Panat, Narosa Publishing House.2008
4. Classical Mechanics: Gupta, Kumar and Sharma, Pragati Publication
5. Classical Mechanics: Herbert Goldstein, Narosa Publishing House.
6. Classical Mechanics: J. C. Upadhyaya, Himalaya Publishing House.

Course Code: PH-414

Course Title: Laboratory – I

Course Code: PH-414	Type: Laboratory	Course Category: Core
Course Title: : Laboratory – I (General Laboratory)		
Total Contact Hours: 60 (4/week)	Course Credits: 02	
College Assessment (CA) Marks: 20 Marks	University Assessment (UA): 30 Marks	
Course Objectives: • To impart knowledge of basic concepts in Laboratory Physics and Mechanics. • To provide the knowledge and methodology necessary for Practical in Physics		
Course Outcomes: • Apply the concept and use of knowledge of the Electronics Laboratory course to real life problems. • Students will have hand on experience of general physics.		

List of Experiment General Laboratory

1. λ by Michelson Interferometer.
2. Determination of wavelength of monochromatic source by Fabry -Perot Interferometer.
3. Determination of thickness of thin transparent sheet like mica using Michelson interferometer.
4. To determine ultrasonic velocity and to obtain compressibility of a given liquid.
5. Magnetic susceptibility of paramagnetic material by Quincke's method
6. "e/m" by Millikan oil drop method.
7. Diffraction at single and double slits using laser source
8. Determination of Rydberg constant using Hydrogen discharge tube.
9. Surface tension by ripples method.
10. Determination of elastic constants by Cornu's method.
11. To find the values of Cauchy's constants for the material of the given prism using Hg.
12. I-V characteristics of Solar cell.
13. Splitting of Sodium D-lines using diffraction grating.
14. Study of Power versus load characteristics of solar PV systems and study of series and parallel combination of solar PV panels.
15. Determination of bandwidth of given optical fiber,
16. Moment of Inertia by Bifilar suspension.
17. Study of effect of surrounding temperature and tilt angle on the performance of solar PV panel.
18. Study of series and parallel connection of solar panel and effect of shading.

Note: Perform any Ten experiments from the above list. More experiments can be added with prior permission of BoS Chairman.

Reference Books:

1. A Text book of Applied Electronics - Dr. R. S. Sedha, S. Chand Publication

2. Basic Electronics Solid State – B. L. Theraja, S. Chand Publication
3. Op-Amps and Linear Integrated Circuits - R G Gaikwad, Prentice Hall Publication.
4. Integrated Circuits – K. R. Botkar, Khanna Publishers.
5. Operational Amplifier – G. B. Clayton
6. Principles of Electronics by V. K. Mehta. S. Chand Publication
7. Laboratory manuals

Course Code: PH-415

Course Title: Laboratory – II

<table>
<tr><td>Course Code: PH-415</td><td>Type: Laboratory</td><td colspan="2">Course Category: Core</td></tr>
<tr><td colspan="4">Course Title: Laboratory – II
(Experiments on Applied Electronics OR Solar Thermal and Photovoltaic Systems)
Note:
If Student choose PH-416 (A) as an elective subject, then perform Experiments on “Applied Electronics”.
If Student choose PH-416 (B) as an elective subject, then perform Experiments on “Solar Thermal and Photovoltaic Systems”.</td></tr>
<tr><td colspan="2">Total Contact Hours: 60 (4/week)</td><td colspan="2">Course Credits: 02</td></tr>
<tr><td colspan="2">College Assessment (CA) Marks: 20 Marks</td><td colspan="2">University Assessment (UA): 30 Marks</td></tr>
<tr><td colspan="4">Course Objectives: Applied Electronics
To Design, Build and test wave-shaping circuits.
To Design, Build and test passive and active filters.
To Design, Build and test sinusoidal and non-sinusoidal oscillators using transistor and IC 741.
To Design, Build and test precision rectifiers.</td></tr>
<tr><td colspan="4">Course Outcomes: Applied Electronics
Designing and building of oscillators, filters and wave shaping circuits.
Working of oscillators, filters and wave shaping circuits.
Basic concepts in applied electronics and its applications
Advanced laboratory skills and techniques</td></tr>
<tr><td colspan="4">Course Objectives: Solar Thermal Photovoltaic Systems
To familiarize with different solar energy gadgets.
To study solar photovoltaic system
To study solar drying system, solar distillation, solar pond
To get acquainted with solar cell/module/Array modelling</td></tr>
<tr><td colspan="4">Course Outcomes: Solar Thermal Photovoltaic Systems
Express various experimental and computational tools thereby developing analytical abilities to address real world problems.
Adapt the skills related to academics, research, and industries.
Solve the various issues concerned to the laboratory work.</td></tr>
</table>

List of Experiments on Applied Electronics

1. Familiarization with different solar energy gadgets.
2. Design, Build, and Test positive and negative clamper using diode
3. Design, Build, and Test positive/negative biased clipper and clamper using diode.
4. Design, Build, and Test first order low-pass passive filter using RC–Network.
5. Design, Build, and Test first order high-pass passive filter using RC – Network.

6. Design, Build, and Test first order band-pass passive filer using RC – Network.
7. Design, Build, and Test first order notch passive filter using RC – Network.
8. Build and test first order low-pass active filter using IC-741 for the desired cut-off frequency.
9. Build and test first order high-pass active filter using IC-741 for the desired cut-off frequency.
10. Build and test first order band-pass active filter using IC-741 for the desired band of frequency.
11. Design, Build, and Test active first order notch filter using op-amp.
12. Design, Build, and Test Colpitts oscillator using transistor/ IC-741.
13. Design, Build, and Test Wien-Bridge oscillator using transistor/ IC-741.
14. Design, Build, and Test Phase shift oscillator using transistor/ IC-741.
15. Design, Build, and Test Crystal oscillators using transistor/ IC-741.
16. Build, and Test a Monostable multivibrator using IC-741 for the desired pulse width.
17. Build and test an astable multivibrator using IC-741 for the desired frequency of oscillation.
18. Setup and test astable multivibrator of a desired frequency using IC 555.
19. Setup and test monostable multivibrator of a desired pulse width using IC 555.
20. Design and construct a Schmitt trigger circuit using IC 741 and measure/verify the output wave forms.
21. Design, Build, and Test precision full wave rectifier.
22. Design, Build, and Test instrumentation amplifier and study its characteristics.

Note: Perform any Ten experiments from the above list. More experiments can be added with prior permission of BoS Chairman.

Reference Books:

1. A Text book of Applied Electronics - Dr. R. S. Sedha, S. Chand Publication
2. Basic Electronics Solid State – B. L. Theraja, S. Chand Publication
3. Op-Amps and Linear Integrated Circuits - R G Gaikwad, Prentice Hall Publication.
4. Integrated Circuits – K. R. Botkar, Khanna Publishers.
5. Operational Amplifier – G. B. Clayton
6. Principles of Electronics by V. K. Mehta. S. Chand Publication
7. Laboratory manuals.

List of Experiments on Solar Thermal Photovoltaic Systems

1. Effect of tilt of solar module along with Parallel combination of SPV modules.
2. To study of emissivity of various metals.
3. To determine phenomenon of heat transfer through lagged pipe.
4. Solar Cell Simulation Using PC-1D Simulator.
5. To study the efficiency measurement of stand alone solar PV system.
6. To study the efficiency of Flat Plate Collector (Forced circulation mode).
7. To carry out the measurement study of available solar energy.
8. To calculate the Figure of merit of solar cooker.
9. To construct a simple photovoltaic (PV) system, using a PV cell(s) and a DC ammeter.
10. To study about off-grid solar inverter with battery charging controller.

11. Case studies of Commercial/ Industrial/ Residential PV energy conservation systems and their economic analysis.
12. Solar insolation measurement using Optical pyranometer.
13. To determine fill factor, series resistance, shunt resistance of given solar PV system.
14. to study the power efficiency of photovoltaic array under shading condition using bypass diode.
15. To study of solar panel design using solar cells by interconnecting them to get desire voltage and power rating.
16. Effect of tilt of solar module along with series combination of SPV modules.

Note: Perform any Ten experiments from the above list. More experiments can be added with prior permission of BoS Chairman.

References:

1. Lab manual.
2. Solar Energy by S P Sukhatme, J K Nayak, McGraw Hill Education;
3. Solar Thermal Energy by A Sreekumar, New Age International Private Limited;
4. Solar Energy Utilization, G.D. Rai, Khanna Publishers (1996).
5. Solar Energy Conversion– A. E. Dixnon & J. D. Leslie.
6. Solar Cells, M.A. Green.
7. Energy Technology Non-Conventional, Renewable and Conventional, S. Rao, Dr.B.B. Parulekar, Khanna Publications, 3rdEd, 2005.
8. Non-Conventional Energy Sources, G. D. Rai, Khanna Publications, 2000.

Course Code: PH-416(A)

Course Title: APPLIED ELECTRONICS

Course Code: PH-416(A)	**Course Category: Elective**
Course Title: APPLIED ELECTRONICS	**Type: Theory**
Total Contact Hours: 60 (4/week)	**Course Credits: 04**
College Assessment (CA) Marks: 40 Marks	**University Assessment (UA): 60 Marks**

Course Objectives:

- To Design, Build and test wave-shaping circuits.
- To Design, Build and test passive and active filters.
- To Design, Build and test sinusoidal and non-sinusoidal oscillators using transistor and IC 741.
- To Design, Build and test precision rectifiers.
- To understand operational amplifier as an integrated circuit, analysis of simple OPAMP circuits and applications,

Course Outcomes:

- Comprehend the theory and working of oscillators, filters and wave shaping circuits.
- Comprehend the use of oscillators, filters and wave shaping circuits.
- Understand operational amplifier as an integrated circuit, analysis of simple OPAMP circuits and applications.
- Develop an understanding of the foundational circuit design aspects of electronic circuits.
- Recognize the difference between the sinusoidal and non-sinusoidal oscillators.

Course Content:

Unit 1: Wave shaping circuits **(12P, 12M)**

Introduction, types of wave-shaping circuits, linear wave shaping circuits, differentiating circuits, generation of square wave from triangular wave, integrating circuits, generation of triangular wave, generation of sawtooth wave from rectangular wave, positive clipper, negative clipper, bias clipper, combination clipper, clamping circuits, bias clamper.

Unit 2: Basic OP-AMP Applications **(12P, 12M)**

Introduction to OP-AMP, Block diagram of Op-amp, Schematic symbol and Pin diagram of IC 741, Characteristics of OP-AMP, Concept of virtual ground, inverting and non-inverting amplifier with gain expressions, off-set null, Applications: Adder, Subtractor, Integrator, Differentiator, Comparator, Schmitt trigger, Instrumentation amplifier, Precision rectifier (full-wave).

Unit 3: Filters **(12P, 12M)**

Introduction, types of filters, First order Passive filters (Low-pass, high-pass, bandpass, notch), First order Active filters (Low-pass, high-pass, band-pass, band-reject, notch),

Unit 4: Sinusoidal Oscillators **(12P, 12M)**

Introduction, Frequency of oscillatory circuit, frequency stability of an oscillator, Barkhausen Criteria, tuned circuit oscillators, transistor-based Hartley oscillator, Colpitts oscillator, Wien-Bridge oscillator, Phase shift oscillator, and Crystal Oscillators.

Unit 5: Non-Sinusoidal Oscillators (12P, 12M)

Introduction, classification, transistor as a switch, multivibrators, types of multivibrators, multivibrators using op-amp (monostable, bistable and astable), circuit operation of all multivibrators, Schmitt trigger, Block diagram and pin configuration of IC-555, Monostable and Astable multivibrator using IC-555.

Note: Designing perspectives is expected for all units.

References:

1. A Text book of Applied Electronics - Dr. R. S. Sedha, S. Chand Publication
2. Basic Electronics Solid State – B. L. Theraja, S. Chand Publication
3. Op-Amps and Linear Integrated Circuits - R G Gaikwad, Prentice Hall Publication.
4. Electronic devices and circuits An Introduction - Allen Mottershead, Prentice Hall Publication.
5. Integrated Circuits – K. R. Botkar, Khanna Publishers.
6. Operational Amplifier – G. B. Clayton
7. Principles of Electronics by V. K. Mehta.

Course Code: PH-416(B)

Solar Thermal and Photovoltaic Systems

Course Code: PH-416(B)	**Course Category: Elective**
Course Title: **Solar Thermal and Photovoltaic Systems**	**Type: Theory**
Total Contact Hours: 60 (4/week)	**Course Credits: 04**
College Assessment (CA) Marks: 40 Marks	**University Assessment (UA): 60 Marks**

Course Objectives:

- To understand nature of solar radiation available and methods for its measurements.
- To understand different ways of collecting solar thermal energy.
- To learn solar thermal energy applications: solar water heater and solar dryer.
- To study photovoltaic energy conversion and application.
- To study Solar photovoltaic cells and modules.

Course Outcomes:

- Understand nature of available solar radiation.
- Compare the different methods for solar radiation.
- Describe the principles of solar thermal energy collection.
- Analyze performance of solar thermal devices.
- Understand the Solar Photovoltaic Energy Conversion process.
- Understand working of solar cell.

Course Content:

Unit 1: Solar Radiation: Nature and its measurement **(14 L, 14 M)**

Solar constant, spectral distribution of extra-terrestrial radiation, variation of extra-terrestrial radiation, angles for tracking surfaces, extra-terrestrial radiation on a horizontal surface, Instruments for measuring solar radiation, introduction to relevant software, apparent motion of the Sun, sunrise, sunset and the day length, local apparent time, solar radiation on a tilted surface.

Unit 2: Solar Thermal Energy Collection **(12 L, 12 M)**

Introduction to solar thermal collectors, Energy balance equation, transmittivity of cover systems, transmissivity absorptivity product, overall loss coefficient and heat transfer correlations, Types of solar thermal collectors: Flat plate collectors, Evacuated Tube Collectors, concentrating collectors, tracking systems for concentrating collectors: Different modes of tracking, methods of tracking.

Unit 3: Solar Thermal Energy; Applications **(08 L, 08 M)**

Application 1: Solar fluid heating system, thermosyphon and forced flow, Testing of Solar Flat Plate Collector.

Application 2: Solar Dryers: Introduction, classification, components and design, Analysis and performance.

Unit 4: Solar Photovoltaic cells and modules **(14 L, 14 M)**

Principle and Working of solar cell and the importance of diode; Electrical characteristics of solar cells; the effect of combining modules; performance parameters and Factors affecting on performance of solar cells (temperature, irradiance) overview of types of solar cells and their differences: Crystalline (Mono-crystalline and polycrystalline); Thin film solar cells (Si, cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS).); structure of a solar module, Electrical protection (Bypass diodes, blocking diodes).

Unit 5: Solar Photovoltaic Energy: Conversion and applications **(12 L, 12 M)**

Present and future technologies in solar photovoltaic, Solar cell to solar module: Construction, specifications, concept of maximum power tracking Solar photovoltaic systems: Stand alone systems and Grid-connected systems: Basic building blocks and their role. Design of stand-alone SPV system, few examples on design.

Reference Books:

1. Solar Energy by S P Sukhatme, J K Nayak, McGraw Hill Education;
2. Solar Thermal Energy by A Sreekumar, New Age International Private Limited;
3. Solar Energy Utilization, G.D. Rai, Khanna Publishers (1996).
4. Solar Energy Conversion– A. E. Dixnon & J. D. Leslie.
5. Solar Cells, M.A. Green.
6. Energy Technology Non-Conventional, Renewable and Conventional, S. Rao, Dr.B.B. Parulekar, Khanna Publications, 3rdEd, 2005.
7. Non-Conventional Energy Sources, G. D. Rai, Khanna Publications, 2000.

Semester – II

Course Code: PH-421

Course Title: Statistical Mechanics

Course Code: PH-421	**Course Category: Core**
Course Title: Statistical Mechanics	**Type: Theory**
Total Contact Hours: 60 (4/week)	**Course Credits: 04**
College Assessment (CA) Marks: 40 Marks	**University Assessment (UA): 60 Marks**
Course Objectives: • To impart knowledge of basic concepts in Statistical Mechanics. • To provide the knowledge and methodology necessary for solving problems in Physics.	
Course Outcomes: • Understand correlation between thermodynamics and statistical mechanics. • Analyze the differences between classical and quantum statistics.	

Course Content:

Unit 1: Statistical Thermodynamics (10 L, 10 M)

Thermodynamic potentials, Maxwell's relations from thermodynamic potentials, Thermodynamic equilibrium, Constraints, Equilibrium conditions and constraints, Distribution of energy between systems in equilibrium, Boltzmann relation for entropy, Accessible states and first law of thermodynamics.

Unit 2: Phase Space and Ensembles (14 L, 14 M)

Phase space, Types of Ensembles, Partition function, Liouville's theorem, Principles of conservation of density and extension in phase space, Grand canonical ensemble, Physical interpretation of α, Chemical potential in the equilibrium state, Fluctuations in number of particles of a system in grand canonical ensemble, Gibb's paradox.

Unit 3: Classical and Quantum Statistical Mechanics (12 L, 12 M)

Brief outline of classical and Quantum statistics, Symmetry of wave functions, Maxwell Boltzmann statistics, Bose Einstein. Statistics, Photon statistics, Fermi Dirac statistics, The Boltzmann limit of Boson and Fermion gases, Evaluation of partition function for quantum monatomic gas, Partition function for diatomic molecules, Equation of state for an ideal gas.

Unit 4: Ideal Bose Systems (12 L, 12 M)

Photon gas: Black body radiation, radiation properties such as pressure, density, emissivity and equilibrium number of photons in a cavity. Einstein's derivation of Planck's law, Bose Einstein condensation, Specific heat from lattice vibrations, Debye's model of solids: Phonon gas.

Unit 5: Ideal Fermi Systems (12 L, 12 M)

Fermi energy, Mean energy of fermions at absolute zero temperature, Fermi energy as a function of temperature, Electronic specific heat, White Dwarfs, Compressibility of Fermi gas, Pauli paramagnetism, Relativistic degenerate gas.

Reference Books:

1. Fundamentals of Statistical Mechanics: B.B. Laud, New Age Int.l Publishers (2003).
2. Introduction to Statistical Mechanics: S. K. Sinha, Narosa Publication, New Delhi (2007).
3. Fundamentals of Statistical & Thermal Physics: F. Reif, Mcgraw Hill Company, (1965).
4. Statistical Mechanics: R. K. Patharia, Butterworth-Heinemann (Elsevier) (2/e Reprint 2004).
5. Statistical Physics: Harvey Gould and Jan Tobochnik.
6. Statistical Mechanics: Gupta and Kumar, Pragati Prakashan (2019),

Course Code: PH-422

Course Title: Quantum Mechanics-B

Course Code: PH-422	Course Category: Core
Course Title: Quantum Mechanics-B	Type: Theory
Total Contact Hours: 30 (2/week)	Course Credits: 02
College Assessment (CA) Marks: 20 Marks	University Assessment (UA): 30 Marks

Course Objectives:

- To impart knowledge of basic concepts and application of Quantum Mechanics.
- To provide the knowledge and methodology necessary for solving problems in microscopic and atomic Physics.
- The course also involves how to use quantum mechanics for real systems of physics problem.

Course Outcomes:

- Solve problems associated with Many Electron Atoms.
- Apply the Variational method for solving various numerical problems.
- Evaluate problems associated to WKB method.

Course Content:

Unit 1: Many Electrons Atoms (08 L, 16 M)

Indistinguishable particles; Pauli Principle; Inclusion of spin, Spin functions for two and three electrons; Example of hydrogen atom; Central field approximation; Thomas- Fermi model of the atom; Introduction to Hartee equation and Hartee-Fock equation. Numerical based on above topics.

Unit 2: Scattering Theory (06 L, 12 M)

Differential and total scattering cross sections, Born Approximation, condition for validity of Born Approximation, scattering by square well potential and perfectly rigid sphere. Numerical based on the above topics.

Unit 3: Variational Method (09 L, 18 M)

Variational method: Basic principles and applications to particle in box, simple harmonic oscillator, hydrogen atom. Numerical based on the above topics.

Unit 4: WKB Approximation (07 L, 14 M)

The WKB method; Connection formulas; Validity of WKB approximation, Barrier penetration; applications to α-particle field emission; Bound states in potential well; Numerical based on the above topics.

Reference Books:

1. Advanced Quantum Mechanics by Satya Prakash, Kedar Nath Ram Nath, Meerut Delhi.
2. Quantum Mechanics: Concept and Applications by Nouredine Zettili, A John Wiley and Sons, Ltd., Publication
3. Quantum Mechanics by Leonard I Schiff, McGraw-Hill Book Company Inc.
4. Quantum Mechanics by Chatwal, Anand, Himalaya Publishing House.
5. Quantum Mechanics: Theory and Applications by Ajoy K. Ghatak, S. Lokanathan, Macmillan Publishers India Ltd.
6. Quantum Mechanics: Powell and Crasemann, Addison-Wesley Pub. Co.

Course Code: PH-423

Course Title: Electrodynamics

Course Code: PH-423	**Course Category: Core**
Course Title: Electrodynamics	**Type: Theory**
Total Contact Hours: 60 (4/week)	**Course Credits: 04**
College Assessment (CA) Marks: 40 Marks	**University Assessment (UA): 60 Marks**

Course Objectives:

- To understand the basics of electrostatics, magneto statics, electrodynamics and the potential formulation of basic laws.
- To understand how to apply basic theories in electromagnetic waves and radiation.
- To understand the propagation of electromagnetic waves through the bounded and unbounded regions.

Course Outcomes:

- Interpret the basic theories governing the electricity and magnetism.
- Apply the basic theories in electromagnetic waves and radiation.
- Apply the basic theories to real problems.

Contents:

Unit 1: Electrostatics and Magnetostatics (12 L, 12 M)

The electric field, continuous charge distribution, divergence and curl of electrostatic fields, Gauss's law and applications, electric potentials, Poison's equations and Laplace equation, the potential of localized charge distribution, electrostatic boundary condition, work and energy in electrostatics. Biot-Savart's laws, divergence and curls of B, Amperes law and its applications, magnetic vectors potential: the vector potential, magnetostatic boundary conditions, multipole expansion of the scalar and vector potential.

Unit 2: Electromagnetic Waves (12 L, 12M)

Introduction, Maxwell equations, Energy in Electromagnetic field (Poynting Theorem), Poynting vector, Energy and momentum in electromagnetic waves, Plane Electromagnetic waves in matter, Plane Electromagnetic waves in anisotropic media, Polarization of Electromagnetic waves

Unit 3: Reflection, Refraction and scattering (12 L, 12 M)

Boundary conditions for the electromagnetic field vectors B, E, D and H at interface between two media, Reflection and Refraction at the boundary of two non-conducting media, Fresnel's equations-Incident wave polarized with its vectors E normal and parallel to the plane of incidence, The coefficients of reflection and transmission at the interface between two dielectrics, Brewster angle and degree of polarization, Rectangular wave guide, Basic concept about scattering, scattering by free electron (Thomson scattering)

Unit 4: Electromagnetic Fields and Radiating systems (12 L, 12M)

Electrodynamics potentials, Non uniqueness of Electrodynamics potentials and Gauge transformations Lienard-Wiechart Potentials, Electric and magnetic fields of charge in uniform rectilinear motion, Radiation due to non-relativistic charges and relativistic charges, Radiating systems, Radiation due to an oscillating electric dipole, Radiation due to a small current element.

Unit 5: Relativistic Electrodynamics (12 L, 12 M)

Introductions, Lorentz variance and invariance of ∇, ∇^2 and $\Box$-operators, Four vectors in electrodynamics. Four vectors of charge and potential: Covariance of Continuity equation and Lorentz condition, Maxwell's electromagnetic field tensor covariance of field equation, covariant form of electric and magnetic field- Electromagnetic field tensor.

Reference Books:

1. Introduction to Electrodynamics by D.J. Griffith, Prentice Hall of India.
2. Electromagnetic Field Theory Fundamentals by Guru And Hiziroglu, Cambridge University Press.
3. Introduction To Electromagnetic Fields by Paul And Nasar. McGraw Hill Company Pvt. Ltd.
4. Classical Electrodynamics by J.D.Jackson, Wiley India Pvt Ltd
5. Electricity And Magnetism by Edward Purcell, Tata McGraw Hill Publication Pvt. Ltd
6. Fundamentals Of Applied Electromagnetics by Fawwaz Ulaby, Prentice Hall of India Pvt. Ltd.
7. Electrodyanims by S. L. Gupta, S. P. Singh, V. Kumar, Pragati Prakashan Meerut.
8. Electromagnetics by B. B. Laud, New Age International Publishers.
9. Classical Electromagnetic Radiation by Jerry B. Marion, Academic Press.
10. Introduction to Electrodynamics by A. Z. Capri & P. V. Panat, Narosa Publishing House Pvt Ltd.
11. Classical Electricity & Magnetism by Panofsky Phillips, Addison-Wesley Publishing Company
12. Electromagnetic theory & Electrodynamics.

Course Code: PH-424

Course Title: Laboratory – III

Course Code: PH-424	Type: Laboratory	Course Category: Core
Course Title: Laboratory – III (General Laboratory)		
Total Contact Hours: 60 (4/week)	Course Credits: 02	
College Assessment (CA) Marks: 20 Marks	University Assessment (UA): 30 Marks	

Course Objectives:

- To gain practical knowledge of applying experimental methods to test/validate physics theory.
- To learn the usage of various instruments for measurements.
- To learn to analyze and interpret the data obtained from measurements.

Course Outcomes:

- Express various experimental and computational tools thereby developing analytical abilities to address real world problems.
- Adapt the skills related to academics, research and industries.
- Solve the various issues concerned to the laboratory work.

List of Possible Experiment (General Laboratory)

1. To determine the characteristics of G-M tube.
2. Determination of Planck's constant using LED.
3. To plot the frequency response of RC-Coupled Amplifier.
4. Measurement of Temperature dependent resistivity using Four Probe Method.
5. To study the wave form by using Oscillator/Multivibrators.
6. Linear Fitting using C programming.
7. Non-liner (Power and exponential) fitting using C programming.
8. Calculation of Standard deviation by C programming using given data.
9. Solution of differential equation using first Order Euler's Method.
10. Solution of differential equation using Fourth order Runge Kutta method
    (*Perform any 10 experiments)

Note: More experiments can be added to this list with prior permission of Chairman, BoS Physics.

Reference Books:

1. Introductory Electronic Devices and Circuits By Painter, New Jerky; Regents/Prentice Hall
2. Electronic Devices and Circuitsby Michael Hassul, Don Zimmerman, Prentice Hall
3. Introductory Methods Of Numerical Analysisby S.S. Sastri, Prentice Hall Of India Pvt. Ltd.
4. Laboratory manuals

Course Code: PH-425

Course Title: Laboratory – IV

<table>
<tr><td>Course Code: PH-425</td><td>Type: Laboratory</td><td colspan="2">Course Category: Core</td></tr>
<tr><td colspan="4">Course Title: Laboratory – IV
(Experiments on "Electronic Instrumentation" OR "Sensors and Instrumentation")
Note:
• If Student choose PH-426 (A) as an elective subject, then perform Experiments on "Electronic Instrumentation".
• If Student choose PH-426 (B) as an elective subject, then perform Experiments on "Sensors and Instrumentation".</td></tr>
<tr><td colspan="2">Total Contact Hours: 60 (4/week)</td><td colspan="2">Course Credits: 02</td></tr>
<tr><td colspan="2">College Assessment (CA) Marks: 20 Marks</td><td colspan="2">University Assessment (UA): 30 Marks</td></tr>
<tr><td colspan="4">Course Objectives: Electronic Instrumentation
• To gain practical knowledge of applying electronic instrumentation theory.
• To learn the usage of various electronic instruments for measurements.
• To learn to analyze and interpret the data obtained from measurements.</td></tr>
<tr><td colspan="4">Course Outcomes: Electronic Instrumentation
• Express and understand various electronic instrumentation tools.
• Adapt the skills related to academics, research and industries.
• Solve the various issues concerned to the electronic instrumentation work.</td></tr>
<tr><td colspan="4">Course Objectives: Sensors and Instrumentation
• To gain practical knowledge of applying experimental methods to test/validate sensors theory.
• To learn the usage of various instruments for measurements.
• To learn to analyze and interpret the data obtained from measurements.</td></tr>
<tr><td colspan="4">Course Outcomes: Sensors and Instrumentation
• Express and understand various sensor as instrumentation tools.
• Adapt the skills related to academics, research and industries.
• Solve the various issues concerned to the electronic instrumentation work.</td></tr>
</table>

List of Experiments on Electronic Instrumentation

1. To study Amplitude Modulation (AM) and Detection using diode.
2. Study of FM modulation.
3. To deign built and test pulse amplitude modulation (PAM) using IC-555 and IC-741.
4. Build and test PWM and PPM using IC-555.

5. Design, build and test digital multiplexer using IC 555 and IC 7400.
6. Design, build and test analog multiplexer.
7. Measurement of voltage and current using CRO.
8. Measurement of frequency using Lissajous figures.
9. Measurement of phase using Lissajous figures.
10. Measurement of resistance, capacitance and inductance using CRO.
11. Study of EGC and measure the different potentials using chart.
12. Study of EEG and measure the different potentials using chart.
13. Generation of sine, Square, triangular,
14. linear ramp & saw tooth waveforms.
15. Design, build and test saw tooth generator using IC-555.
16. Design, build and test saw tooth generator using IC-741.

Note: Perform any 10 experiments. More experiments can be added with prior permission of BoS Chairman.

Reference Books:

1. Transducers& Instrumentation: D. V. S. Murthy.
2. Instrumentation-Devices &system: C. S. Rangan, G. R. Sharma, V. S. V. Mani.
3. Principles of measurement and Instrumentation: Alan S. Morris.
4. Electronic Instrumentation: Kalsi
5. Electrical & electronic measurement Instrumentation: A.K. Sawhney.
6. Modern electronic instrumentation & measurement Technique: Helfrick Cooper.
7. Handbook of Bio-medical Instrumentation – R.S. Khandpur, TMH, New Delhi
8. Introduction to Bio-medical equipment Technology- J. J Carr, Pearson Pvt.Ltd.

List of Experiments on Sensors and Instrumentation

1. Calibration of capacitive transducer for angular displacement.
2. Study and calibration of LVDT transducer for displacement measurement.
3. Study of resistance temperature detector for temperature measurement.
4. Calibration of thermocouple for temperature measurement.
5. Calibration of hot wire anemometer for temperature measurement.
6. Calibration of Pressure Gauges
7. Calibration of strain gauge for temperature measurement.
8. Study and calibration of photo and magnetic speed pickups for the measurement of

speed

9. Study properties of thermocouple.
10. To study temperature dependence of resistance using RTD.
11. Temperature characteristics of LM 35 integrated circuit.
12. NTC thermistor characteristics.
13. Sample and hold circuit using Op-Amp.
14. Programmable Logic Controller: a) To implement ladder diagram b) To study Conveyor Control by PLC.

Note: Perform any 10 experiments. More experiments can be added with prior permission of BoS Chairman.

Course Code: PH-426(A)

Course Title: Electronic Instrumentation

Course Code: PH-426(A)	Course Category: Core
Course Title: Electronic Instrumentation	Type: Theory
Total Contact Hours: 60 (4/week)	Course Credits: 04
College Assessment (CA) Marks: 40 Marks	University Assessment (UA): 60 Marks

Course Objectives:

- To impart knowledge of basic concepts in Physics of Electronic Instrumentation.
- To provide the knowledge and methodology necessary for solving problems in Physics.
- The course also involves the related experiments based on the theory.

Course Outcomes:

- Apply the concept and use of knowledge of Physics of Electronic Instrumentation to understand and solve the real-life problems.
- Understanding of the course will create scientific temperament.
- Will learn:
    - Fabrication of integrated devices.
    - Applications of electronic system.
    - Bio-electric Signals and Electrodes.

Course Content:

Unit 1: Signal representation & generation (12 L, 12 M)

Periodic signals, periodic signals, modulated signals (A.M., F.M., P.M.), sampled data pulse Modulation (PWM, PAM, PPM), definition and their graphical representation. Generation of sine, Square, triangular, linear ramp & saw tooth waveforms.

Unit 2: Oscilloscope (14 L, 14 M)

Introduction, Detail study of CRT, Block diagram of general purpose CRO, Dual beam and dual trace oscilloscope, Digital Readout Oscilloscope, Digital Storage Oscilloscope (DSO).

Probes for CRO, attenuators, oscilloscope operating precautions, placing an oscilloscope in operation.

Measurement of voltage, current, resistance, capacitance & inductance using CRO. Frequency and phase measurement by Lissajous method.

Unit 3: Bio-electric Signals and Electrodes (10 L, 10 M)

Basic Physics of membrane potential, resting membrane potential of nerves, nerve action potential, origin of bio-electric signals, recording electrodes, polarization, skin contact impedance, electrodes for ECG, electrodes for EEG, electrical conductivity of electrodes jellies and creams, microelectrodes.

Unit 4: Telemetry System (10 L, 10 M)

Multiplexer: Analog & digital multiplexer, Sample and hold Circuit. Data transmission system. Telemetry system Block diagram, Characteristics, Land line Telemetry, Radio telemetry, Processing system, Frequency division multiplexing, Time Division Multiplesing.

Unit 5: Applications of electronic system (14 L, 14 M)

Frequency selective wave analyzer, Spectrum analyzer, Lock-in amplifier, Fiber optic sensors. Measurement of Humidity, Hygrometers (Resistive, Capacitance, Microwave and Piezoelectric), Microwave level detector, Nuclear instrumentation-types of radiation. Flow meters: Classification, working principle, electromagnetic flow meter, Ultrasonic flow meter.

Reference Books:

1. Transducers& Instrumentation: D. V. S. Murthy.
2. Instrumentation-Devices &system: C. S. Rangan, G. R. Sharma, V. S. V. Mani.
3. Principles of measurement and Instrumentation: Alan S. Morris.
4. Electronic Instrumentation: Kalsi
5. Electrical & electronic measurement Instrumentation: A.K. Sawhney.
6. Modern electronic instrumentation & measurement Technique: Helfrick Cooper.
7. Handbook of Bio-medical Instrumentation – R.S. Khandpur, TMH, New Delhi
8. Introduction to Bio-medical equipment Technology- J. J Carr, Pearson Pvt.Ltd.

Course Code: PH-426(B)

Course Title: Sensors and Instrumentation

Course Code: PH-426(B)	**Course Category: Core**
Course Title: **Sensors and Instrumentation**	**Type: Theory**
Total Contact Hours: 60 (4/week)	**Course Credits: 04**
College Assessment (CA) Marks: 40 Marks	**University Assessment (UA): 60 Marks**
Course Objectives: • To understand sensors: fundamentals, characteristics. Sensors for measurement of different physical parameters, working principle. • To understand details of processing of signal from sensors. • To learn about Programmable Logic Controllers and actuators.	
Course Outcomes: • Explain the conversion of physical quantity into electrical forms and science behind it. • Select proper sensor for specific application • Explain the signal processing steps involved • Design and build simple PLC based system	

Course Content:

Unit 1: Sensor fundamentals and characteristics (08 L, 08M)

Sensor classification, characteristics, performance parameters, Criteria for selection of a sensor, Selectivity, Sensitivity, Response Time, Recovery Time.

Unit 2: Sensors for measurements (12 L, 12 M)

Temperature sensors: Thermistors, RTD, thermocouples, Pressure sensors: High pressure sensors, Low pressure sensors, Optical Sensors: Pyrometer, Magnetic field sensors, Flow sensors, Displacement sensors, Gas Sensor and Photosensors.

Unit 3: Signal processing (12 L, 12M)

Sample and hold, Filtering: Need, methods, Amplification: Impedance matching, Differential Amplifier, Instrumentation amplifier, ADC: Methods, quantization, sampling frequency, resolution.

Unit 4: Introduction to PLC (18 L, 18 M)

Introduction to PLC, advantages of PLC, architecture of PLC, Functions of various blocks that make PLC, working principle of PLC, types of PLC, different types of input/outputs (analog and digital), programming methods, programming devices, basic instructions NO and NC contacts, Boolean gates-symbols and truth tables, Ladder logic.

Unit 5: Control Actuators **(10 L, 10 M)**

Working principal of electromechanical actuators, Hydraulic actuators, pneumatic actuators, solenoid valves.

Reference Books:

1. Modern Electronic and Measurement Techniques By A. D. Helfrick, W. D. Kooper, Prentice Hall Of India Pvt. Ltd.
2. Instrumentation: Devices and Systems By Rangan, Mani, Sharma, Tata McGraw Hill Publication Pvt. Ltd.
3. Introduction To Instrumentation and Control By A.K.Ghosh, Prentice Hall Of India Pvt. Ltd.
4. Programmable Logic Controllers By W. Bolton, Fourth Edition, ELSEVIER