

Module 1

Chapter 1 : Diffraction

1-1 to 1-43

Syllabus : (Prerequisites : Wave front and Huygen's principle, Reflection and refraction, Diffraction, Fresnel diffraction and Fraunhofer diffraction).

Diffraction : Fraunhofer diffraction at single slit, Diffraction grating, Resolving power of a grating; Applications of diffraction grating; Determination of wavelength of light using plane transmission grating.

1.1	Introduction.....	1-1
1.2	Types of Diffraction.....	1-2
1.3	Difference between Interference and Diffraction.....	1-3
1.4	Fraunhofer Diffraction at a Single Slit.....	1-3
1.5	Fraunhofer Diffraction at a Double Slit.....	1-8
1.6	Missing Orders in a Double Slit Diffraction Pattern.....	1-12
1.7	Fraunhofer Diffraction due to N Parallel Equidistant Slits Theory of Diffraction Grating.....	1-14
1.7.1	Theory of Plane Transmission Grating.....	1-14
1.8	Resolving Power of an Optical Instrument.....	1-19
1.9	Rayleigh's Criterion of Resolution.....	1-19
1.10	Resolving Power of a Grating.....	1-20
1.11	Application of Diffraction, Determination of Wavelength of Light.....	1-22

Module 2

Chapter 2 : Laser and Fibre Optics

2-1 to 2-48

Syllabus : (Prerequisites : Absorption, Recombination, Energy bands of p-n junction, Refractive index of a material, Snell's law).

(A) Laser : Spontaneous emission and stimulated emission; Metastable state, Population inversion, Types of pumping, Resonant cavity, Einstein's coefficient; Helium Neon laser; Nd:YAG laser; Semiconductor laser, Applications of laser- Holography.

(B) Fibre optics : Numerical Aperture for step index fibre; Critical angle; Angle of acceptance; V number; Number of modes of propagation; Types of optical fibres; Fibre optic communication system.

2.1	Introduction.....	2-1
2.2	Interaction of Radiation with Matter.....	2-1
2.2.1	Absorption.....	2-2
2.2.2	Spontaneous Emission.....	2-2
2.2.3	Stimulated Emission.....	2-3
2.2.4	Difference between Spontaneous Emission and Stimulated Emission.....	2-4



2.3	Active Medium	2-4
2.4	Population Inversion	2-4
2.5	Metastable States	2-5
2.6	Pumping and Pumping Types	2-6
2.7	Pumping Schemes	2-6
2.7.1	Three Level Pumping Scheme	2-6
2.7.2	Four Level Scheme	2-7
2.7.3	Two Level Scheme	2-8
2.8	Einstein's Co-efficient	2-8
2.9	Important Characteristics of Laser Beam	2-9
2.10	He-Ne Laser	2-11
2.11	Nd : YAG Laser	2-14
2.12	Semiconductor Diode Laser	2-15
2.13	Application of Lasers	2-17
2.13.1	Holography	2-17
2.14	Solved Problems	2-19
2.15	Introduction to Fibre Optics	2-24
2.16	What are Optical Fibres ?	2-25
2.17	Propagation of Light in Different Media	2-25
2.17.1	Total Internal Reflection	2-25
2.18	Basic Construction of Optical Fibre	2-26
2.19	Types of Fibres	2-27
2.19.1	Step Index Fibre	2-27
2.19.2	Graded Index Fibre	2-28
2.19.3	Comparison between SI and GRIN Fibre	2-29
2.19.4	Difference between SI and GRIN Fibre	2-29
2.20	Acceptance Angle and Numerical Aperture of a Fibre	2-30
2.21	Numerical Aperture for a Graded Index Fibre	2-33
2.22	V-Number	2-34
2.23	Applications of Fibre	2-35
2.24	Solved Problems	2-37

Module 3

Chapter 3 : Electrodynamics

3-1 to 3-26

Syllabus : (Prerequisites : Electric Charges, Coulomb's law-force between two point charges, Electric field, electric field due to a point charge, electric field lines, electric dipole, electric field due to a dipole, Gauss's law, Faraday's law)

Scalar and Vector field, Physical significance of gradient, Curl and divergence in Cartesian co-ordinate system, Gauss's law for electrostatics, Gauss's law for magnetostatics, Faraday's Law and Ampere's circuital law; Maxwell's equations (Free space and time varying fields).

3.1	Introduction.....	3-1
3.1.1	Scalar and Vector Field.....	3-1
3.1.1.1	Scalar Field	3-1
3.1.1.2	Vector Field	3-1
3.1.1.3	Difference between a Scalar and Vector Field.....	3-2
3.2	Del Operator.....	3-2
3.2.1	Significance of Gradient.....	3-2
3.2.2	Significance of Divergence.....	3-4
3.3	Curl of a Vector.....	3-7
3.4	Gauss's Law of Electrostatics	3-10
3.5	Gauss's Law for Magnetostatics	3-11
3.6	Faraday's Law	3-12
3.7	Ampere's Circuital Law.....	3-13
3.8	Maxwell's Equations in Differential or Point Form	3-14
3.8.1	Derivation of Maxwell's First Equation	3-15
3.8.2	Derivation of Maxwell's Second Equation.....	3-16
3.8.3	Derivation of Maxwell's Third Equation	3-16
3.8.4	Derivation of Maxwell's Fourth Equation.....	3-17
3.9	Maxwell's Equations in Integral Form.....	3-18
3.9.1	Maxwell's First Equation	3-18
3.9.2	Maxwell's Second Equation	3-19
3.9.3	Maxwell's Third Equation	3-19
3.9.4	Maxwell's Fourth Equation	3-19
3.10	Solved Problems	3-19

Module 4

Chapter 4 : Relativity

4-1 to 4-13

Syllabus : (Prerequisites : Cartesian co-ordinate system).

Special theory of Relativity : Inertial and Non-inertial Frames of reference, Galilean transformations, Lorentz transformations (Space-time coordinates), Time Dilation, Length Contraction and Mass-Energy relation.

4.1	Introduction	4-1
4.1.1	New Understanding Developed by Einstein for the terms like Gravity, Space, Time and Curvature of Space and Time	4-1
4.2	Special Theory of Relativity	4-2
4.3	Inertial and Non-Inertial Frames of Reference	4-3
4.3.1	Inertial Frames	4-3
4.3.2	Non-Inertial Frames	4-3
4.4	Galilean Transformations	4-4
4.5	Lorentz Transformation	4-5
4.6	Time Dilation	4-7
4.7	Length Contraction	4-8
4.8	Mass Energy Relation	4-9

Module 5

Chapter 5 : Nanotechnology

5-1 to 5-10

Syllabus : (Prerequisites : Scattering of electrons, Tunnelling effect, Electrostatic focusing, Magneto static focusing).

Nanomaterials : Properties (Optical, electrical, magnetic, structural, mechanical) and applications, Surface to volume ratio; Two main approaches in nanotechnology -Bottom up technique and Top down technique.

Tools for characterization of Nanoparticles : Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM).

Methods to synthesize Nanomaterials : Ball milling, Sputtering, Vapour deposition, Solgel.

5.1	Introduction	5-1
5.2	Nanomaterial Properties	5-2
5.2.1	Optical Properties	5-2
5.2.2	Electrical Properties	5-2
5.2.3	Magnetic Properties	5-2
5.2.4	Structural Properties	5-2



5.2.5	Mechanical Properties.....	5-2
5.3	Application of Nanomaterials.....	5-3
5.3.1	Applications in Mechanical Engineering	5-3
5.3.2	Applications in Electrical, Electronic and Communication Engineering	5-3
5.3.3	Applications in Computer Science Engineering and IT	5-3
5.3.4	Applications in Bio - Medical and Chemical Energy.....	5-3
5.4	Surface to Volume Ratio	5-4
5.5	Two Main Approaches in Nanotechnology – Bottom Up Technique and Top Down Technique	5-4
5.6	Tools for Characterization of Nanoparticles	5-5
5.6.1	SEM (Scanning Electron Microscope)	5-5
5.6.2	Transmission Electron Microscope (TEM)	5-6
5.6.3	Atomic Force Microscope (AFM).....	5-7
5.7	Methods to Synthesize Nanomaterials.....	5-8
5.7.1	Ball Milling	5-8
5.7.2	Sputtering	5-9
5.7.3	Vapour Deposition.....	5-9
5.7.4	SOL - Gel Technique	5-9

Module 6

Chapter 6 : Physics of Sensors

6-1 to 6-17

Syllabus : (Prerequisites : Transducer concept, Meaning of calibration, Piezoelectric effect)

Resistive sensors :

a) Temperature measurement : PT100 construction, Calibration,

b) Humidity measurement using resistive sensors.

Pressure sensor : Concept of pressure sensing by capacitive, Flex and inductive method, Analog pressure sensor : Construction working and calibration and applications.

Piezoelectric transducers : Concept of piezoelectricity, Use of piezoelectric transducer as ultrasonic generator and application of ultrasonic transducer for distance measurement, Liquid and air velocity measurement.

Optical sensor : Photodiode, Construction and use of photodiode as ambient light measurement and flux measurement.

Pyroelectric sensors : Construction and working principle, Application of pyroelectric sensor as bolometer.

6.1	Introduction.....	6-1
6.2	Resistive Sensors or Resistance Temperature Detectors (RTD).....	6-2
6.2.1	Temperature Measurement by PT 100 and its Calibration	6-2



6.2.2	Calibration	6-4
6.3	Humidity Measurement using Resistive Sensors	6-5
6.4	Pressure Sensors	6-6
6.4.1	Concept of Pressure Sensing by Capacitive Method	6-6
6.4.2	Concept of Pressure Sensing by Flex	6-7
6.4.3	Concept of Pressure Sensing by Inductive Method	6-7
6.5	Analog Pressure Sensor	6-8
6.6	Piezoelectric Transducer	6-8
6.6.1	Concept of Piezo Electric Effect	6-8
6.6.2	Use of Piezo electric Transducer as Ultrasonic Generator	6-10
6.6.3	Application of Ultrasonic Transducer for Distance Measurements	6-11
6.6.4	Application of Ultrasonic Transducer for Liquid and Air Velocity Measurements	6-12
6.7	Optical Sensors	6-12
6.7.1	Photodiode Construction and use of Photodiode as Ambient Light Measurement and Flux Measurements	6-12
6.7.2	Flux Measurement by Photodiode	6-13
6.7.3	Pyroelectric Sensors, Construction, Working Principle and Application of Pyroelectric Sensor as Bolometer	6-13
➤	Model Question Paper	Q-1 to Q-2

