Time: 2 Hours **Maximum Marks: 60**

N.B **i)** Question number 1 is compulsory

ii) Attempt any three questions from Q2 to Q6

iii) Assume suitable data wherever required

iv) Figures to the right indicate full marks for that question

Q1		**Attempt any five out of six (3 marks each)**	**15**
	A	What is a grating element? How is the condition for absent spectra obtained in a grating? Which spectra will be absent when the width of the opaque region is twice that of the transparent region?	**3**
	B	What is a resonant cavity? Explain its use in the generation of Laser beams.	**3**
	C	With the help of a diagram define the term acceptance angle. Calculate the acceptance angle for an optical fibre with 1.48 and 1.42 as the refractive indices of core and cladding respectively.	**3**
	D	Find the gradient at a point (1, -1, -2) for a scalar field $A = ½ (x^3y - xy^2)$.	**3**
	E	With what velocity should a rocket move, so that every year spent on it corresponds to 2.5 years on the earth?	**3**
	F	What is a sensor? What is calibration? Why is it necessary to calibrate a sensor?	**3**
Q2		**Attempt both the questions**	**15**
	A	Discuss with diagram the phenomenon of Fraunhofer diffraction at a single slit and write the conditions for its maxima and minima. Find the order of diffraction if a diffraction grating is used at normal incidence for a line 'A' of wavelength 5600 Å in a certain order being superimposed on another line 'B' of the next higher order having wavelength 4200 Å. Now if the angle of diffraction for the line A is 45°, then how many lines per cm are there in this grating for the above obtained order?	**8 (5+3)**
	B	With the help of a neat labelled diagram explain the two types of fibres, categorised on the basis of refractive index. How does a ray of light travel in these fibres? What is the significance of the 'V' number? A multimode step index fibre with core RI 1.53 and cladding RI 1.50 has a core radius of 10 micrometre. Calculate the normalised frequency of the fibre and the number of guided modes at an operating wavelength of 7000 Å.	**7 (4+3)**
Q3		**Attempt both the questions**	**15**
	A	What are scalar and vector fields? Give examples. Explain the term 'curl of a vector' and state its significance. Show that the divergence of the curl of a vector is zero.	**8 (4+4)**
	B	With neat and labelled diagrams explain the construction and working of a semiconductor laser. Give its application.	**7**

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Q4		**Attempt all three questions (5 marks each)**	**15**
	A	What do you understand by resolving power? Illustrate by drawing a neat diagram. How can the resolving power of a grating be increased? Find maximum order of diffraction if a grating having 6000 lines per cm is illuminated by a laser beam of wavelength 6000 Å.	**5**
	B	What is the divergence of a vector field? Give its physical significance. Find the divergence of a field $F = xz\,\hat{i} + y^2z^3\,\hat{j} - xyz\,k$ at a point (1, -1, 1). Interpret the result you obtain.	**5**
	C	Recall the term Nanotechnology. How are the nanomaterials classified on the basis of their dimensions? What are the applications, advantages and disadvantages of nanotechnology?	**5**
Q5		**Attempt all three questions (5 marks each)**	**15**
	A	What is length contraction? Express it mathematically. The length of a moving rod is found to be one third of its length when at rest. What is the speed of the rod relative to the observer?	**5**
	B	With a neat labelled diagram explaining the construction and working of an atomic force microscope. List its advantages over an electron microscope.	**5**
	C	With a neat labelled diagram explain the construction and working of a Piezoelectric Ultrasonic Transducer.	**5**
Q6		**Attempt all three questions (5 marks each)**	**15**
	A	Explain Gauss's laws for static electric and static magnetic fields in differential and integral forms.	**5**
	B	Explain the two main types of approaches used to synthesise a nanomaterial. Discuss in detail any one method with reference to the bottom up approach. Give the advantage of this method over other methods.	**5**
	C	With a neat labelled diagram explain the construction and working of a Photodiode as an optical sensor.	**5**

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