FE SEM. II Cscheme summer 2025 Date: 16/05/25

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

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? What is a grating element? Define resolving power of an optical instrument. **3**

B Explain metastable state and population inversion. Draw a basic three level pumping scheme diagram to represent the states. **3**

C Draw a neat labeled diagram to represent a critical angle. Calculate the acceptance angle for an optical fibre with 1.44 and 1.4 as the refractive indices of core and cladding respectively. **3**

D Find the gradient at a point (-1, -1, -2) for a scalar field $F = \frac{1}{2}(x^3y - xy^3)$. **3**

E Find the fractional increase in mass of a particle moving with a velocity of 0.2 times the speed of light. **3**

F What is a transducer? What is the piezoelectric effect and inverse piezoelectric effect? **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. **8**
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? **(5+3)**

B With the help of a neat labelled diagram explain the step index and graded index fibers. How does a ray of light travel in these fibres? **7**
What is the significance of the 'V' number? A multimode step index fibre with core RI 1.5 and cladding RI 1.45 has a core radius of 9 micrometre. Calculate the normalised frequency of the fibre and the number of guided modes at an operating wavelength of 7500 Å. **(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 Nd:YAG laser. Give its application.	7
Q4		**Attempt all three questions (5 marks each)**	15
	A	What is diffraction? Illustrate by drawing a neat diagram of any one type of diffraction. 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	What is the need of Nanotechnology? Classify nanomaterials on the basis of their dimensions? Explain the significance of surface area to volume ratio?	5
Q5		**Attempt all three questions (5 marks each)**	15
	A	What is time dilation? Derive 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, explain the construction and working of an transmission electron microscope.	5
	C	With a neat labelled diagram explain the construction and working of a Photodiode Optical Sensor.	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 top down approach. Give the advantage of this method over the other methods.	5
	C	With a neat labelled diagram explain the construction and advantages of a PT100.	5