

2m/PHY-150 (Th) Syllabus-2023

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(May-June)

FYUP : 2nd Semester Examination

PHYSICS

(Minor)

(Electricity and Magnetism, Optics and Electronics)

(PHY-150)

(Theory)

Marks : 56

Time : 3 hours

*The figures in the margin indicate full marks
for the questions*

Answer any eight questions

1. (a) Two small identical conducting spheres have charges $2.0 \times 10^{-9} \text{ C}$ and $-0.5 \times 10^{-9} \text{ C}$, respectively. When they are placed 4 cm apart, what is the force between them? If they are brought into contact and then separated by 4 cm, what will be the force between them? 3

- (b) Using Gauss' law in electrostatics, show that a uniformly charged solid sphere acts as if the whole charge were concentrated at its centre. 4
2. (a) Obtain the integral and differential forms of Gauss' law in the presence of dielectric. 4
- (b) An infinitely long solenoid has 5000 turns per metre of its length. If a current of 0.1 ampere flows through it, then find the strength of the magnetic field at the centre and at one end of the solenoid. Given, $\mu_0 = 4\pi \times 10^{-7}$ H/m. 3
3. Write down the Maxwell's equations in vacuum and in dielectric medium. Give the physical significance of Maxwell's time-varying equations in dielectric medium. 3+4=7
4. (a) An alternating e.m.f. $V_0 e^{i\omega t}$ is applied to the ends of the circuit containing resistance R , inductance L and capacitance C in series. Find the impedance and voltage of the circuit. 4
- (b) An a.c. circuit has inductance $L = 10$ mH, capacitance $C = 10 \mu\text{F}$ and resistance $R = 10 \Omega$ in series. Calculate the natural frequency, resonant frequency and impedance of the circuit at resonance. 3

5. Using Fermat's principle, establish the laws of reflection and refraction at a plane boundary. $3\frac{1}{2}+3\frac{1}{2}=7$
6. With the help of ray diagrams, explain the cardinal points of a thick lens. 7
7. (a) Find the focal length of a combination of two thin lenses of focal lengths f_1 and f_2 separated by a distance d . 3
- (b) Derive the lens-maker formula by matrix method. 4
8. (a) Describe the system matrix of a thick lens and hence obtain it for a thin lens. $3+1=4$
- (b) Consider a plano-convex lens of refractive index 1.5 and thickness 0.6 cm. The convex surface has a radius of curvature of 2.5 cm and is facing the incident light. Construct—
- the refraction matrix for the front surface;
 - the refraction matrix for the back plane surface;
 - the translation matrix for translation through the lens. $1+1+1=3$

9. (a) Convert the following binary number into decimal number and decimal number into binary number : $1\frac{1}{2} + 1\frac{1}{2} = 3$

(i) $(11011.101)_2$

(ii) $(29.625)_{10}$

- (b) Using 2's complement scheme method, evaluate (i) $A + B$, (ii) $A - B$, (iii) $-A - B$, where $A = 001001$ and $B = 000110$.

$$1 + 1\frac{1}{2} + 1\frac{1}{2} = 4$$

10. Draw neatly the circuit diagrams for realising AND and OR logic gates using diodes and explain their operations. $3\frac{1}{2} + 3\frac{1}{2} = 7$

11. (a) Simplify the Boolean expression

$$\bar{A}BC + A\bar{B}C + AB\bar{C} + ABC \quad 2$$

- (b) Draw a logic circuit using NOR gates to implement the Boolean expression

$$AB + \bar{B}\bar{C} \quad 3$$

- (c) What is meant by early effect in a transistor? 2

12. (a) What is a $p-n$ junction diode? How is depletion region formed in a $p-n$ junction diode? 1+2=3

- (b) Draw the circuit diagram of a $p-n-p$ transistor in CE mode. Explain how $\beta_{d.c.}$ and $\beta_{a.c.}$ of the transistor can be obtained from these curves. 1+3=4

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