

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

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(May-June)

FYUP : 2nd Semester Examination

PHYSICS

(Major)

**(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. State and prove Gauss's law in electrostatics. Apply this law to calculate the field due to a uniformly charged non-conducting sphere at a distance r from the centre of sphere where (i) $r > R$ and (ii) $r < R$, where R is the radius of the sphere. Also draw a graph showing the variation of electric field intensity with distance r .

1+5+1=7

(2)

2. (a) Use Biot-Savart law to calculate the magnetic field due to a long solenoid. 5
(b) An infinitely long wire carries a constant current of 1 A. Calculate the magnetic field at a distance of 10 cm from the wire. Given, $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$. 2
3. (a) State Faraday's laws of electromagnetic induction. Express the law in its integral and differential forms. 1+3=4
(b) Write down the four Maxwell's equations in vacuum as well as in a dielectric medium. 3
4. (a) What is the effect of introducing a dielectric slab in a parallel-plate capacitor? Derive the expression for capacitance of a parallel-plate capacitor with a dielectric slab of thickness t placed between the plates of separation d and $t < d$. 1+2=3
(b) Derive impedance of an electrical circuit. Calculate the impedance of a series L - C - R circuit when an alternative voltage $v = V_0 e^{j\omega t}$ is applied across the combination. 4
5. (a) State Fermat's principle, then use this principle to establish the laws of refraction at a plane boundary. 1+4=5
(b) Define cardinal points of an optical system. 2

(3)

6. Find the focal length of a combination of two thin lenses of focal lengths f_1 and f_2 separated by a distance d . Also discuss the positions of the cardinal points for this lens system. 3+4=7
7. Explain the terms 'translation matrix', 'refraction matrix' and 'system matrix' of an optical system for paraxial rays. Obtain the fundamental translation and refraction matrices of such a system. 1+1+1+2=7
8. (a) Convert $(21.9)_{10}$ into binary number. 2
(b) Perform the following arithmetic operations where the binary numbers are in 2's complement representation : 2×2=4
(i) $00011010 + 11101100$
(ii) $00110000 - 00010111$
(c) Find the decimal equivalent of the negative number 11010001 given in 2's complement representation. 1
9. (a) Draw the circuit diagram of an OR gate using resistor and diodes. Explain its operation. 2+2=4
(b) Show how NAND gate can be used to find OR and NOR gates. $1\frac{1}{2} + 1\frac{1}{2} = 3$
10. (a) State and explain De Morgan's theorem. 2
(b) Reduce the expression $\overline{AB} + \overline{A} + \overline{AB}$ using Boolean algebraic theorem. 3

(c) Show that

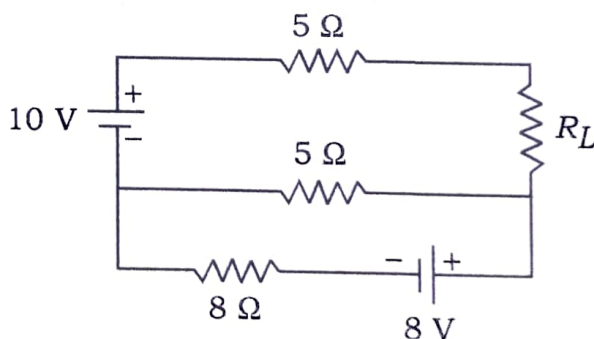
$$ABC + B\bar{C}D + \bar{A}BC = BC + BD \quad 2$$

11. (a) Discuss the use of p - n junction diodes in a full-wave rectifier. 2

(b) Discuss the origin of different current components in a transistor. Why is the base region of BJT made thin? 4+1=5

12. (a) Show that $\beta = \frac{\alpha}{1-\alpha}$ for a transistor, where the symbols have their usual meanings. 2

(b) Find the current in the load resistance $R_L = 10 \Omega$ in the following circuit : 3



(c) A transistor with $\alpha = 0.49$ is used in CE mode. If the emitter current is 2 mA, find the collector current. 2

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