

B.Sc. Part-II Honours Examination,2020

Sub.-PHSA

PAPER-III

FULL MARKS-50

Modalities

1. An examinee shall not attend her/his college in person to sit for the examination of a practical paper. Examinee shall
 - (a) write her/his answer with BLUE/BLACK INK only.
 - (b) must attach a scanned copy of her/his registration certificate at the end of the answer script. She/he may attach a scanned copy of the admit card of current examinations, if available.
 - (c) scan the whole answer script in a single .pdf file. If it is instructed to use separate answer scripts for different modules/units, if any, examinee must do accordingly, but she/he shall create a single .pdf file for the answer script. There will be exactly one .pdf file for each examinee.
 - (d) upload her/his answer script through proper web portal to submit.
2. The full marks and duration of examination of a paper shall be in accord with those specified by the University of Calcutta.
3. For examinations of a practical paper, examinees need not submit their laboratory work book, neither they have to face any viva. Examinees shall have to answer the questions following the instructions given in the question paper. Examinees shall use her/his own graph-papers to draw graphs(if any) in practical papers and attach them at proper positions of the answer script. Examinees shall draw circuits and graphs with BLUE/BLACK INK only.

Answer **any five** of the following questions:

2×5=10

1.

- (a) Distinguish between combinational and sequential logic circuits.
- (b) The highest audible frequency is 18 KHz. If the modulation index of an FM wave is 4.5, find the minimum bandwidth required for the detection of the FM wave.
- (c) What is eddy current?
- (d) Two coils have self inductance L_1 & L_2 and mutual inductance M . Show that $M^2 \leq L_1 L_2$.
- (e) Four similar point charges q are located at the vertices of a square with side a . Find the electrostatic energy of the system.
- (f) State boundary conditions on \vec{E} & \vec{D} prevailing at the interface of two dielectric media.
- (g) In Fresnel's biprism experiment why the base angles of the biprism are kept very small?
- (h) What is the difference between Fresnel and Fraunhofer class of diffractions?

Group-A

Answer **any two questions** from this group

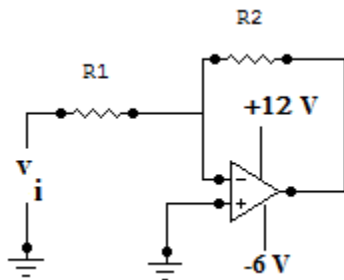
2.

- (a) Indicate the difference between class B and class C amplifier.

3

- (b) The positive and negative power supply attached to an OPAMP are of +12 volt and -6 volt respectively. An inverting amplifier is constructed with that OPAMP where the values of the resistances in the circuit are $R_1=1K\Omega$ and $R_2=10K\Omega$. Find the output when $v_i = +0.7$ volt and

$v_i = -0.7$ volt.



3

(c) Deduce an expression for the voltage gain and phase difference for a lead lag network. How this network is used to design a Wein-bridge oscillator ? 2+2

3.

(a) Draw a clocked S-R flip-flop circuit using two-input NAND gates and explain its operation with proper truth table. State with a proper diagram, how the ambiguity of the truth table can be removed in J-K flip-flop. 2+2+3

(b) Draw a diagram to show how a Mod-16 ripple counter can be modified to provide a Decade counter. 3

4.

(a) What do you mean by free current and bound current ? Establish the relation

$$\vec{J}_b = \vec{\nabla} \times \vec{M}, \text{ where } \vec{M} \text{ is magnetization vector.} \quad 1+4$$

(b) What is magnetic circuit? Establish a relationship between the magneto motive force, reluctance and magnetic flux. 1+2

(c) Obtain the integral form of Faraday's law and then show that $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$. 2

5.

(a) Find the self inductance per unit length of a long solenoid of radius r , carrying n turns per unit length. 3

(b) An alternating current $I = I_0 \cos(\omega t)$ flows down a long straight wire and back along a coaxial conducting cylinder of radius R .

(i) In what direction does the induced electric field point (radial, circumferential or longitudinal)?

(ii) Find \vec{E} as a function of r , where r is the distance from axis. 1+2

(c) An AC circuit connected to a 220V, 50 Hz supply contains a 20H coil of resistance 100Ω connected in series with $1\mu F$ capacitor. Calculate the power factor of the circuit. 3

(d) What is watt-less current ? 1

Group-B

Answer **any two questions** from this group

6

(a) The current I was announced as fourth fundamental dimension along with M, L, T. Farad is the unit of capacitance. The Coulomb law expressed as

$$E = \frac{Q}{4\pi\epsilon_0 r^2}$$

Show from dimensional analysis that ϵ_0 has the unit Farad/m.

3

(b) Define polarization vector \vec{P} for a dielectric substance. What are electric susceptibility and dielectric constant of a medium and how are they related ?

3

(c) A sphere of radius R carries polarizations $\vec{p}(\vec{r}) = k \vec{r}$ where k is a constant and \vec{r} is the vector of the centre

(i) Calculate bound charges σ_b and ρ_b .

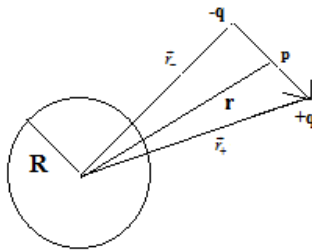
(ii) Find the field inside and outside the sphere.

4

7

(a) If a charge q is placed at a distance r from the center of a grounded conducting sphere of radius R , then the image charge of amount $q_i = -\frac{R}{r}q$ at the position $\vec{d} = \frac{R^2}{r}\hat{r}$ can represent the actual electrification. Now, if a dipole \vec{p} is placed at a distance \vec{r} with location \vec{r}_+ and \vec{r}_- for $+q$ and $-q$ charge for the dipole then show that the induced dipole moment will be

$$\vec{p} = \left(\frac{R}{r}\right)^3 \left[\vec{p} - \frac{3}{2} \frac{\vec{r} \cdot \vec{p}}{r^2} (\vec{r}_+ + \vec{r}_-) \right]$$



$$\left[\vec{r}_\pm = \vec{r} \pm \frac{\vec{r}_+ + \vec{r}_-}{2} \right]$$

(b) A dipole \vec{p} is at a distance r from a point charge q , and oriented so that \vec{p} makes an angle θ (neither 0 nor 90°) with the vector \vec{r} from q to \vec{p} . Calculate (i) the force on \vec{p} and also (ii) the force on q . 4

(c) Corners of a square of side 'a' are occupied by charges ($q, -q, q, -q$) in alternate fashion. How does the electric field vary with distance 'r' ($r \gg a$) for the charge distribution? 2

8.

(a) Why do you use a convex lens of large radius of curvature for producing Newton's ring ? 2

(b) A soap film of refractive index 1.33 and of thickness $1.4 \mu\text{m}$ is illuminated by white light and an angle of 60° . The reflected light by it contains a dark band corresponding to a wavelength of 5000\AA . Determine the order of interference dark band. 3

(c) In a single slit diffraction pattern the secondary maxima do not form exactly halfway between minima, but are quite close. Assuming they are halfway show that the intensity of the m th secondary peak is given approximately

$$I_m = I_0 \frac{1}{\left[m + \frac{1}{2}\right]^2}$$

If the exact value of β are $1.43\pi, 2.46\pi$ and 3.47π (instead of $1.5\pi, 2.5\pi$ and 3.51π) for the first three secondary maxima calculate the percentage of error in the calculation with the previous formula 2+3

9.

(a) How can you distinguish between an elliptically polarized light and partially polarized light ? 2

(b) A thin polaroid placed between two crossed polaroids is allowed to rotate at a rate ' ω ' about their common central axis. Determine the intensity of transmitted light in terms of intensity of unpolarized light. 3

(c) Give Fresnel's explanation of rotation of plane of polarization by an optically active substance. 3

(d) An unpolarized beam strikes the surface of a pond. Find out the angle of incidence, so that the reflected beam will be completely polarized with its **E**-field perpendicular to the plane of incidence. Given: Refractive index of the pond water is 1.33.

2