ANSWER KEY OF
F.E. Semester – II (RC 2019-20) Examination, July/Aug 2022
PHYSICS

Part – A

Answer **any two** questions:

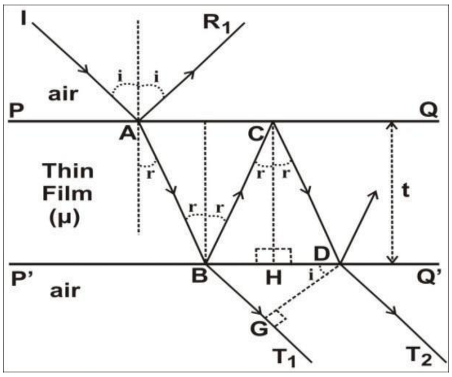
1. a) <u>Soft and hard ferromagnetic materials</u>

Soft magnetic materials – small hysteresis loop
Hard magnetic materials – large hysteresis loop } ⋯**1mark**

Any two properties of soft magnetic materials
Any two properties of hard magnetic materials } ⋯**2marks**

Any two applications of soft magnetic materials
Any two applications of hard magnetic materials } ⋯**2marks**

2. b) <u>Interference in parallel thin film due to transmitted light</u>



Ray diagram ……. **1mark**

Equation for path difference between rays T_1 and T_2:

$\Delta = \mu (BC + CD) - BG$ ……. **1mark**

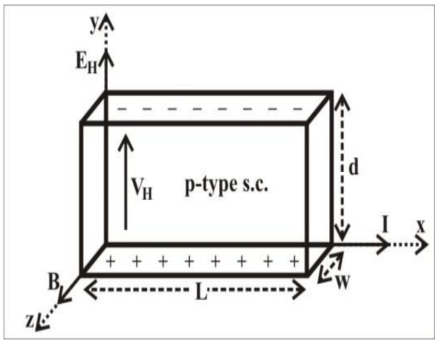
Simplifying and obtaining the expression:

$\Delta = 2\mu t \cos r$ …….**2marks**

Writing final conditions for maxima and minima:

$2 \mu t \cos r = n \lambda$ (maxima)
$2 \mu t \cos r = (2n+1) \lambda/2$ (minima) } ⋯**1mark**

c) <u>Hall Effect and expression for Hall Voltage</u>



Hall Effect definition …… **1mark**

Diagram ……**1 mark**

Explanation about magnetic and electric forces in opposite direction and obtaining $V_H = d v_d B$ ……. **1½marks**

Replacing v_d using expressions for current density and obtaining the final expression $V_H = \frac{IB}{pew}$ ……. **1½marks**

d) <u>Numerical Problem</u>

$$f_n = \frac{1}{2t}\sqrt{\frac{Y}{\rho}}$$ ….. **1mark**

$$= \frac{1}{2\times0.15\times10^{-2}}\sqrt{\frac{7.9\times10^{10}}{2650}}$$ …….. **2 marks**

$$= 1.82 \times 10^{6}\ Hz$$ ……. **2 marks**

2. a) <u>Magnetostriction oscillator</u>

Circuit diagram of magnetostriction oscillator …….**2 marks**

Explanation of working of circuit and generation of USW ……**3 marks**

b) <u>Diamagnetic & paramagnetic materials</u>

Five points of difference between diamagnetic & paramagnetic materials …..**1 mark each**

c) Diameter of bright rings in Newton's Rings for reflected light

Obtaining general expression for diameter of Newton's rings using theorem of intersecting chords. $D_n^2 = 8\,R\,t$ **....2marks**

Using the theory of interference in thin films for reflected light, condition for maximas is: $2\,\mu\,t\cos r = (2n+1)\lambda/2$
Using normal incidence assumption we get $2\,\mu\,t = (2n+1)\lambda/2$
$\Rightarrow t = \frac{(2n+1)\lambda}{4\,\mu}$ **.....1mark**

Substituting in general expression and solving we get,

$D_n = \sqrt{\frac{2\lambda\,R}{\mu}} \cdot \sqrt{(2n+1)}$

$= C \cdot \sqrt{(2n+1)}$ where $C = \sqrt{\frac{2\lambda\,R}{\mu}}$ is a constant **.....2marks**

Thus, $D_n \propto \sqrt{(2n+1)}$ (square root of odd natural numbers)

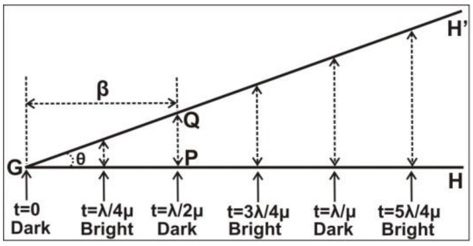
d) Numerical problem

Magnetic susceptibility, $\chi = \frac{M}{H}$ **.......1mark**

$= \frac{3300}{220} = 15$ **.......2marks**

Relative permeability, $\mu_r = 1 + \chi = 1 + 15 = 16$ **.......2marks**

3. a) Interference in Wedge shaped film



Ray diagram **.....1mark**

Applying the theory of thin film interference for reflected light, using conditions for minima & maxima:

$2\,\mu\,t\cos r = n\,\lambda$

$2\,\mu\,t\cos r = (2n+1)\frac{\lambda}{2}$ **..... 1mark**

Using normal incidence assumption and then putting n = 0,1,2,3.... and obtaining different values of 't' **..... 1mark**

From the figure, obtaining expression for fringe width:

$\beta = \frac{\lambda}{2\,\mu\,\theta}$ **....2marks**

b) Cathode ray oscilloscope (CRO)

Block diagram of CRO **......4marks**

Application to measure d.c. voltage **.......1mark**

c) Acoustic Diffraction Grating

Diagram of experimental setup **......1 mark**

Explanation of setup **.....1marks**

Applying the theory of diffraction we have for maxima,

$d\,sin\theta = n\,\lambda$ **......1 mark**

In the acoustic grating, the grating element,

$d = \lambda_u/2$ **......1 mark**

Combining the equations and obtaining

$\lambda_u = \frac{2n\lambda}{sin\theta}$

$v = f.\lambda_u$ **......1 mark**

d) Numerical problem

$\mu_h = \sigma . R_H = \frac{R_H}{\rho}$ **.......1mark**

$= \frac{3.66\times10^{-4}}{8.93\times10^{-3}}$ **.......1mark**

$= 0.041$ m^2/V-s **.......1mark**

$R_H = \frac{1}{pe}$ **.......1mark**

$\Rightarrow p = \frac{1}{R_H e} = \frac{1}{3.66\times10^{-4}\times1.6\times10^{-19}} = 1.71 \times 10^{22}$ /m^3 **.......1mark**

Part – B

Answer **any two** questions:

4. a) Ruby Laser

Diagram of Ruby laser setup **.......1marks**

Explanation of setup **....... 1½marks**

Energy level diagram of Ruby laser **.......1marks**

Explanation of working **....... 1½mark s**

b) Moseley's Law

Statement of Moseley's Law **..... 1 mark**

Equation of Moseley Law **.....1mark**

Significance of Moseley's Law: Correction of periodic table & determination of atomic number of new elements **.....3 marks**

c) Optical fibre communication system

Block diagram of one-way communication system using optical fibre link **....2 mark**

Explanation of the block diagram **....3 marks**

d) Numerical problem

Kinetic Energy of electron accelerated through a p.d. of 182 volts is:

$\mathrm{E} = \mathrm{eV}$ **...... 1 mark**

$= 1.6 \times 10^{-19} \times 182 = 2.912 \times 10^{-17}$ Joules **...... 1 mark**

de Broglie's wavelength,

$\lambda = \frac{h}{\sqrt{2mE}}$ **...... 1 mark**

$= \frac{6.63\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times2.912\times10^{-17}}}$ **...... 1 mark**

$= 9.1 \times 10^{-11}$ m **...... 1 mark**

5. a) Expression for Compton Shift

Brief explanation of Comton effect **...... 1 mark**

Diagram showing collision between photon and electron **....1mark**

Equation of law of conservation of energy,

$h\nu + m_0c^2 = h\nu' + mc^2$ **....1mark**

Equation of law of conservation of momentum along horizontal direction,

$\frac{h\nu}{c} + 0 = \frac{h\nu'}{c}cos\theta + mvcos\varphi$ **....½mark**

Equation of law of conservation of momentum along vertical direction,

$0 + 0 = \frac{hv'}{c} sin\theta - mvsin\varphi$ **....½mark**

Working on above equations and finally obtaining expression for Compton Shitf:

$\lambda' - \lambda = \frac{h}{m_0 c}(1 - cos\theta)$ **....1mark**

b) Structure of Optical fibre cable

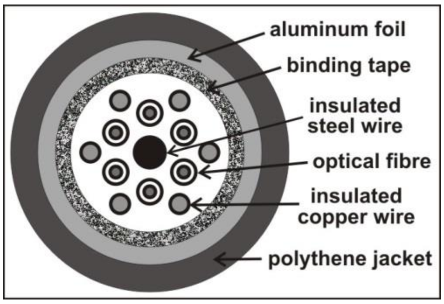


Diagram **...... 2 marks**

Explanation of different regions and their purpose **.........3marks**

c) Properties of x-rays

Any five properties of x-rays **....1mark each**

d) Numerical Problem

$E_2 - E_1 = h\nu = \frac{hc}{\lambda}$

$= \frac{6.63\times10^{-34}\times 3\times10^{8}}{6200\times10^{-10}}$

$= 3.21 \times 10^{-19}$ Joules **..... 2 marks**

$\frac{N_2}{N_1} = e^{-(E_2-E_1)/KT}$ **..... 1mark**

Taking natural logarithm on both sides:

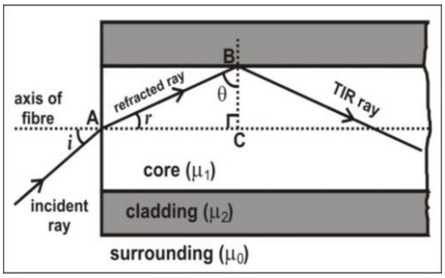
$\ln\left(\frac{N_2}{N_1}\right) = \frac{-(E_2-E_1)}{KT}$

$\Rightarrow T = \frac{-(E_2-E_1)}{K \times \ln\left(\frac{N_2}{N_1}\right)}$

$= \frac{-3.21\times10^{-19}}{1.38\times10^{-23}\times\ln(2.359\times10^{-34})}$

$= 300.4\ °K$ **..... 2 marks**

6. a) Expression for Acceptance Angle and Numerical Aperture



Ray diagram **...... 1 mark**

Limiting condition: when $i = i_{max}, \theta = i_c$ **...... 1 mark**

Using Snell's Law and critical angle formula and finally obtaining the expression:

$i_{max} = \sin^{-1}\left(\frac{\sqrt{(\mu_1^2-\mu_2^2)}}{\mu_0}\right)$ **...... 1 marks**

$N.A. = \sin i_{max} = \left(\frac{\sqrt{(\mu_1^2-\mu_2^2)}}{\mu_0}\right)$ **...... 1 mark**

$N.A. = \mu_1\sqrt{2\Delta}$ **...... 1 mark**

b) Continuous X-ray spectra

Diagram **...... 1 mark**

Explanation of origin of Continuous X-ray spectra **.....4 marks**

c) Properties & Applications of Laser

Any three properties of Laser **....1mark each**

Any two applications of Laser **....1mark each**

d) Numerical problem

Given R.I. of core, μ_1 = 1.55, R.I. of cladding, μ_2 = 1.50,

Assume surrounding medium as air, μ_0 = 1

Numerical Aperture, $\mathrm{N.A.} = \left(\frac{\sqrt{(\mu_1^2 - \mu_2^2)}}{\mu_0}\right)$ **.....1 mark**

$= \left(\frac{\sqrt{(1.55^2 - 1.50^2)}}{1}\right) = 0.39$ **....... 1½marks**

Critical Angle, $i_c = \sin^{-1}\left(\frac{\mu_2}{\mu_1}\right)$ **.....1 mark**

$= \sin^{-1}\left(\frac{1.50}{1.55}\right) = 75.4°$ **....... 1½marks**

Part – C

Answer **any one** question:

7. a) Step Index (SI) and Graded Index (GRIN) fibres

R.I. profile of Step Index (SI) fibre **....1 mark**

R.I. profile of Graded Index (GRIN) fibre **....1 mark**

Explanation of Step Index fibre **....... 1½marks**

Explanation of Graded Index fibre **....... 1½marks**

b) Davisson-Germer Experiment

Diagram of experimental setup **...... 1mark**

Brief explanation of setup **...... 1½mark**

Oservations, analysis and inference from experiment showing that electrons behave like waves **.......2½ marks**

c) Expression for conductivity of a semiconductor

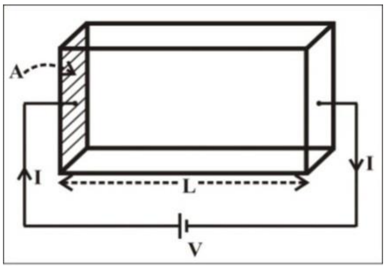


Diagram **........ 1mark**

Using definition of current (I =Q/t) obtaining expression for J:

$J = n\,e\,v_d$ **...... 1½marks**

Using Ohm's law obtaining another expression for J:

$J = \sigma E$ **..... 1½marks**

Combining the above two and obtaining final expression

$\sigma = n\,e\,\mu$ **...... 1mark**

d) Numerical Problem

In a parallel thin film, due to reflected light, condition for minima (dark) is:

$2\,\mu\,t\cos r = n\lambda$ **......1mark**

$\Rightarrow\ t = \frac{n\,\lambda}{2\mu\cos r}$

For smallest thickness, n = 1 } **1mark**

$t_{min} = \frac{\lambda}{2\,\mu\cos r} = \frac{5870\times10^{-8}}{2\times1.5\times\cos 60}$ **.......1mark**

= 3.91 x 10^{-5} cm **......2 marks**

8. a) Properties of Ultrasonic waves

Definition of ultrasonics **....... 3mark**

Any three properties of ultrasonic waves **....... 1mark each**

b) Bragg's Law of X-ray diffraction

Brief explanation of X-ray diffraction ......**1 mark**

Diagram ......**1 mark**

Path difference between the rays ABC & DEF is:

$\Delta = GE + EH$ ……**1 mark**

Obtaining expression for Δ and then using condition for constructive interference and finally obtaining:

$2dsin\theta = m\lambda$ ……**2 mark**

c) He-Ne Laser

Diagram of He-Ne laser setup **…….½marks**

Explanation of setup **……. 1mark**

Energy level diagram of He-Ne laser **…….1½marks**

Explanation of working **……. 2marks**

d) Numerical Problem

In Newton's rings, for dark rings due to reflected light, we have,

$D_n^2 = 4\, n\, \lambda\, R/\mu$ **……. 1mark**

Assuming air film, μ = 1
Thus, $D_n^2 = 4\, n\, \lambda\, R$
For 10th dark ring we get,
$D_{10}^2 = 4 \times 10 \times\ \lambda\, R$
} **……. 1mark**

$\Rightarrow R = \frac{D_{10}^2}{4\times10\times\lambda} = \frac{0.5^2}{4\times10\times\ 5000\times10^{-8}}$ = 125 cm **……. 1mark**

For 50th dark ring we have,
$D_{50}^2 = 4 \times 50 \times\ \lambda\, R$
$= 4 \times 50 \times\ 5000 \times 10^{-8} \times 125 = 1.25$
$\Rightarrow D_{50} = \sqrt{1.25}$ = 1.12cm
⇒ radius of 50th dark ring = $D_{50}/2$ = 0.56 cm
} **……. 2marks**

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