# RAMAKRISHNA MISSION VIDYAMANDIRA

**(Residential Autonomous College under University of Calcutta)**

**SECOND YEAR**

**B.A./B.SC. FOURTH SEMESTER (January – June) 2013**

**Mid-Semester Examination, March 2013**

Date : 04/03/2013 **PHYSICS (Honours)**

Time : 2 pm – 4 pm Paper : IV Full Marks : 50

**Use three answer scripts, one for each group.**

**Answer five questions from Gr-A , Gr-B and Gr-C**

## Group – A [ Thermal Physics – II ]

**Answer any one question.**

1.a) With the help of a rough sketch, show the nature of intermolecular interaction between molecules of a real gas. On the same graph draw the model potential for ideal gas approximation. Physically justify the ideal gas model. 4

b) Find out the expressions of critical constants of a van der Waal's gas. Hence derive the equation of corresponding state. 4+2

2.a) Starting from the expression of Helmholtz free energy F(T, V) show that $(\frac{\partial s}{\partial V})_T = (\frac{\partial P}{\partial T})_V$.

Find out the expression of $(\frac{\partial U}{\partial V})_T$. Show that for a van der Waal's gas $(\frac{\partial U}{\partial V})_T = \frac{a}{V^2}$.

Hence, find an expression of U for the gas. 2+4

b) Prove that $C_P - C_V = -T\,(\frac{\partial P}{\partial V})_T\,(\frac{\partial V}{\partial T})_P^{\,2}$ 4

## Group – B [ Physical optics and E.M. Theory ]

**Answer any two questions.**

3.a) Explain Maxwell's equations of electromagnetic wave in free space. 4

b) An electromagnetic wave is characterized by

i) $E_x = A\,Sin\left(\omega t - kz + \frac{\pi}{3}\right)$, $E_y = A\,Sin\,(\omega t - kz - \frac{\pi}{6})$

ii) $E_x = A\,Sin\,(\omega t - kz)$, $E_y = B\,Sin\,(\omega t - kz + \frac{\pi}{3})$

iii) $E_x = A\,Sin\,(\omega t - kz)$, $E_y = A\,Sin\,(\omega t - kz + ø)$,

where ø is a random function of time. Determine the state of polarization of the wave in each case. 6

4. a) Explain the action of a Nicol Prism as a polarizer and an analyzer. 4

b) Explain how a quarter wave plate can be used to distinguish between a circularly polarized and an unpolarized light wave. 6

5.a) Derive an expression for the intensity distribution at a point due to interference of two coherent monochromatic light beams of same wave length in Young's double slit experiment. 5

b) Obtain the conditions of maxima and minima in the interference pattern. 2

c) Light ( wave length 632.8 nm ) falls on two narrow slits with separation 0.2 mm.

A fringe pattern appears on the screen placed 100 cm away.

i) How far ( in radian and mm ) above and below the central axis are the first zeros of the intensity ? ii) How far ( in mm ) from the axis is the $5^{th}$ bright band ? 3

**Group – C [ Alt. Currents and Electronics –I ]**

**Answer one question from Q6 , Q7 and another question from Q8, Q9.**

6.a) A dc *emf* is suddenly applied to a circuit consisting of a resistance, inductance and a capacitance in series . Investigate the growth of charge in the circuit. When the growth is oscillatory, obtain an expression for the frequency of oscillation of the charge. 7

b) If L = 10H and R = 500 ohm in LR circuit, find the time required by current to attain 50% of its maximum value. What will happen if the switch in the circuit also has a small resistance of 10 ohm. 2

7. a) Explain how you can represent alternating current or voltage using complex number. What is phasor diagram. 3+1

b) Obtain an expression for the power factor of a circuit. Explain the term "watt less circuit".

What do you mean by bypass capacitor and blocking capacitor. 4+1+1

8.a) Explain with the circuit diagram the operation of a bridge rectifier. Find its dc and rms value of output voltage. 2+3

b) A sinusoidal voltage of 230V is applied to a half wave rectifier consisting of a diode of resistance 200 Ω and a load of 1 KΩ. Calculate dc output power and rectification efficiency. 4

c) Why a consideration of PIV is important for a source to be rectified ? 1

9.a) Define ripple factor.

How does a capacitor input filter smooth out ripple at the rectifier output ? 1+2

b) Draw the circuit diagram of a simple regulator. Design a Zener regulator to give an output of 12V over a load current 10 mA to 20 mA variation. Calculate also the power rating of Zener. Given supply voltage = 20V and knee current = 4 mA. 1+3

c) Discuss the breakdown mechanisms of a semiconductor diode. 3