RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2018

SECOND YEAR [BATCH 2017-20]

Date : 20/12/2018 **PHYSICS [General]**

Time : 11 am – 1 pm **Paper : III** Full Marks : 50

[Use a separate Answer Book <u>for each Group</u>]

<u>Group – A</u>

Answer <u>any three</u> questions from <u>question nos 1 to 5</u> : [3 × 5]

1. a) Show that for an ideal gas undergoing an adiabatic transformation, $P.\left(\frac{T}{P}\right)^{\gamma}$ = constant. Symbols are of usual significance. (3)

   b) Prove that the work done by an ideal gas with constant heat capacities during a quasi-static adiabatic expansion is

   i) $W = C_v\left(T_i - T_f\right)$

   ii) $W = \frac{P_i V_i - P_f V_f}{\gamma - 1}$

   where the symbols carry their usual meaning. (2)

2. a) Write down the expression for the efficiency of a Carnot cycle with proper indicator diagram. (2)

   b) State Stefan's law. Derive Newton's law of cooling from Stefan's law. (3)

3. a) What is the basic difference between 'real' and 'ideal' gas? Write down the van der Waals equation of state for real gas. (2)

   b) What is 'Boyle's temperature'? Deduce the expression for 'Boyle's temperature' in terms of critical constants. (3)

4. a) Write down Maxwell's law of distribution of velocity. Using above law find most probable velocity. Most probable velocity of a gas at 300K is 325 m/s. What will be its value at 1200K? (1+2+1)

   b) Explain the meaning of state function. (1)

5. a) Distinguish between reversible and irreversible process. (2)

   b) Prove the equivalence of Kelvin-Plank and Clausius statements of 'Second law of thermodynamics'. (3)

Group – B

Answer <u>any seven</u> questions from <u>question nos 6 to 16</u>: [7 × 5]

6. a) Write vectorial form of Coulomb's law. (3)

   b) The electric field just outside a conductor in vacuum is 10^2V/cm. What is the surface density of charge on the conductor in the region considered? $\varepsilon_0 = 8.85\times10^{-12}\,\mathrm{F/m}$ (2)

7. Find torque on an electric dipole placed in an electric field and hence calculate its energy. (3+2)

8. a) State Gauss's flux theorem of electrostatics. What is the advantage of flux theorem? (2+1)

   b) Calculate the electric field at a point near an infinite plane conductor having charge density σ . (2)

9. a) Show that electrostatic field is conservative in nature. (2)

   b) Find the relation between $\vec{D},\vec{E},\vec{P}$ for a dielectric medium, where symbols have their conventional meaning. (3)

10. a) Find the energy stored in the magnetic field of an inductance coil. (3)

    b) Find self-inductance of a solenoid. (2)

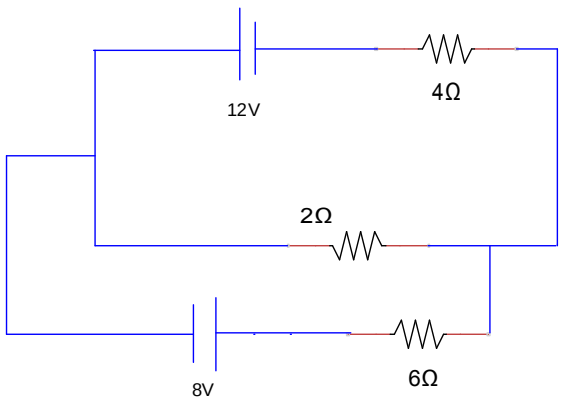
11. a) Define mutual inductance between two coils. Write down an expression of mutual inductance in terms of the self-inductances of the primary and secondary coils. (1+1)

    b) A solenoid 50 cm long and radius 3cm has 1500 turns. A second solenoid of 1000 turns is wound coaxially upon the middle point of the first solenoid. Calculate the mutual inductance of the two. (3)

12. A straight cylindrical wire lying along the x-axis has a length of 0.5m and a diameter of 0.2 mm. It is made of a material described by Ohm's law with a resistivity of $\rho = 4\times10^{-8}\Omega\mathrm{m}$. Assume that a potential of 4V is maintained at x = 0, and that V = 0 at x = 0.5m. Find (a) the electric field $\vec{E}$ in the wire, (b) the resistance of the wire, (c) the electric current in the wire, and (d) the current density $\vec{J}$ in the wire (Express vectors in vector notation). (e) Show that $\vec{E} = \rho\vec{J}$.

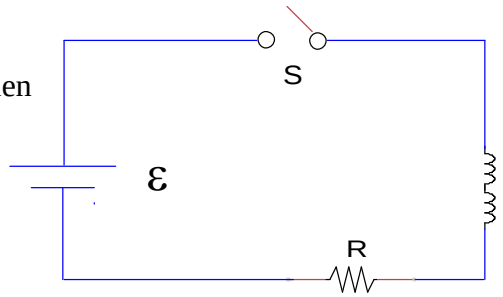
    (1+1+1+1+1)

13. For the circuit shown in figure, calculate the current in the 2Ω resistor by using (a) Kirchoff's voltage law and (b) Thevenin or Norton's theorem. (2+3)



(2)

14. a) Determine this expression of currents at any time t when the switch S is closed at time t=0 as shows in the figure.



(3)

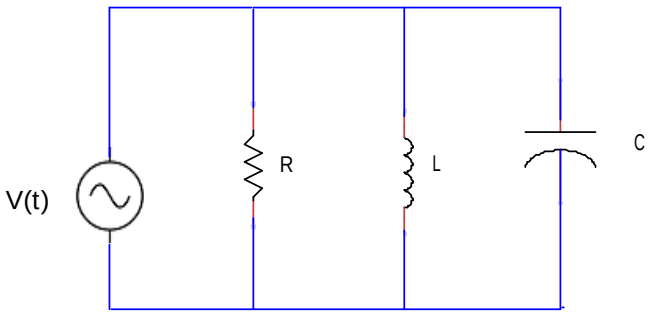
b) A 4V cell of negligible internal resistance is applied to coil of inductance 1 H and resistance 2Ω . What is the final steady current? Calculate the time required by the current to attain 1A. (2)

15. Find the expression of r.m.s. current of an electrical circuit containing L and R in series operating by an alternating E.M.F, $E = E_0 \sin \omega t$. (2)

Find the power dissipated in the circuit. What is power factor? (2+1)

16. a) Define the Q-factor of a resonant circuit. How the sharpness of a resonance depends on the Q-factor. (1+1)

b) Find the parallel resonant frequency for the parallel resonant LCR circuit as shown in figure. (3)



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