RAMAKRISHNA MISSION VIDYAMANDIRA
(Residential Autonomous College affiliated to University of Calcutta)

SECOND YEAR [BATCH 2015-18]
B.A./B.Sc. FOURTH SEMESTER (January – June) 2017
Mid-Semester Examination, March 2017

Date : 15/03/2017

Time : 11 am– 1 pm

PHYSICS (Honours)

Paper : IV

Full Marks : 50

Answer <u>any five</u> questions taking at least <u>one</u> from Group – B   [5×10]

<u>Group – A</u>

1. a) How can a Zener diode be used as a reference diode?   [1]

    b) Dynamic resistance of a pn junction diode is a function of diode current — explain with justification.   [2]

    c) With the help of dynamic characteristic curve explain the principle of operation of a halfwave rectifier.   [3]

    d) Derive an expression showing relation between ripple factor and rectification efficiency.   [2]

    e) Explain how a capacitor filter can improve the de output of a fullwave rectifier.   [2]

2. a) What do you mean by choking coil?   [1]

    b) A series RLC circuit can be used as pure resistive or pure capacitive or pure inductive circuit — explain.   [2]

    c) Derive expressions for resonant frequency and quality factor for parallel RLC circuit.   [3]

    d) A capacitor of capacitance C is connected by the leads of resistance r so as to be parallel with a coil of self-inductance L, the resistance of the coil and its leads being R. The arrangement is impressed with an e.m.f. $E = E_0 \sin \omega t$. Show that (i) the above arrangement can be replaced by a wire without self-inductance if

    $$R^2 - \frac{L}{C} = \omega^2 LC \left(r^2 - \frac{L}{C} \right)$$

    and (ii) the resistance of the equivalent wire is $\dfrac{\left(R\,r + \dfrac{L}{C} \right)}{R + r}$.   [4]

3. a) Show the current components in a PNP transistor when base-emitter junction is forward biased and base-collector junction is reverse biased.   [3]

    b) Define large signal current gain α.   [1]

    c) What is Early effect? What are its consequences?   [4]

    d) What is load line?   [2]

4. a) What is Q point? Why does Q point shift in an amplifier circuit?   [1+2]

    b) Draw a collector to base bias circuit and determine its temperature stability.   [1+3]

    c) Determine the Q point in the given circuit with si-transistor. Given $\beta = 100$, neglect I_{CBO}.   [3]
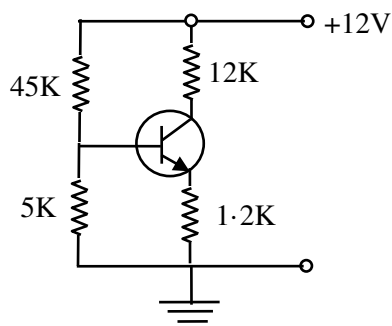
5. a) Give the characteristics of an ideal OPAMP. What is virtual ground? [3+1]

   b) Show how an OPAMP can be used as an integrator and a summing amplifier. [3+3]

6. a) Draw circuit diagram of half-adder, give its truth table. [1+2]

   b) Draw the circuit diagram of an SR flip-flop, given its truth table. [1+1]

   c) How SR flip-flop is modified to JK flip-flop, draw the circuit diagram. [4+1]

Group – B

7. a) State the essential difference between the first and the second law of thermodynamics. [2]

   b) A Carnot engine operates between T and T' with a gas as working substance whose equation of state is given by $p(V-b) = RT$. Work out expressions for the heat absorbed and the work done in each part of the cycle and show that the efficiency of the cycle is $\left(1 - \dfrac{T'}{T}\right)$. [5]

   c) Calculate the efficiency of the cycle ABCDA as depicted in the T-S diagram given in the figure, in terms of T_1 and T_2, given AC = BD. [3]
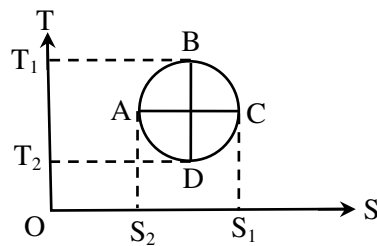
8. a) State and establish Clausius theorem. Show that the entropy of the 'Universe' increases in an irreversible process. [4+3]

   b) Derive Maxwell's thermodynamic relations and hence prove the relation

   $$C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V \left(\frac{\partial V}{\partial T}\right)_P.$$ [3]

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