RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

SECOND YEAR

B.A./B.Sc. FOURTH SEMESTER (January – June) 2015

Mid-Semester Examination, March 2015

Date : 18/03/2015 **PHYSICS (Honours)**

Time : 11 am – 1 pm Paper : IV Full Marks : 50

[Use a separate answer book for each group]

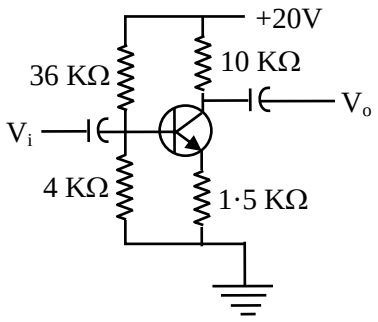
Group – A

Answer any three questions : [3×10]

1. a) Draw circuit diagram of an n-p-n transistor in CE mode from drawing output characteristics and explain how the two constants α and β can be obtained from these curves. [1+2]

   b) What do you mean by thermal stability of a transistor? Show that the thermal stability of a collector to base bias circuit is better than that of fixed bias circuit. [1+3]

   c) Find the collector current, base current and collector emitter voltage of the following circuit. [3]



   Given, $\beta = 150$ and I_{CBO} negligible.

2. a) Define four h-parameters of a small signal low frequency transistor. [2]

   b) Draw an equivalent circuit of transistor using these parameters. Simplify the circuit with proper assumptions. Determine the voltage gain and input impedance. [1+1+3]

   c) A bypass capacitor is connected across the emitter resistance $1{\cdot}5\,K\Omega$ in the circuit of previous question. Calculate the voltage gain and current gain. Given $h_{fe} = 140$ and $h_{ie} = 1100\,\Omega$. [3]

3. Find the condition of balance of an AC bridge. Give the circuit diagram of Anderson Bridge. Give its condition of balance and obtains an expression for inductance. [2+2+2+4]

4. a) Draw a circuit diagram of current mirror. Design it by using similar transistors and is to be provide a $0{\cdot}5A$ current with $V_{CC} = 10V$, $B_f = \beta_C = 125$. Determine the value of R. [2+3]

   b) In a common emitter amplifier circuit, a capacitor is connected between emitter and ground. Find the expression for lower frequency response of He amplifier. [5]

Answer any one question : [1×5]

5. Draw the circuit diagram of a fullwave rectifier and explain its operation. Also calculate the ripple factor. [1+2+2]

6. Find out an expression for the impedance of parallel resonance circuit. Determine how does the current vary with the variation of capacitance in the circuit. [3+2]

Group – B

Answer <u>any one</u> question : [1×10]

7. a) An ideal gas Carnot engine is made to operate as a refrigerator. Explain its operation with the help of an enthalpy-entropy diagram. Find a relation between coefficient of performance (COP] of the refrigerator and the efficiency of the Carnot engine. [4]

   b) In a cold country (environment temperature –13°C], to keep the inside of the room at a comfortable temperature of 17°C, a heat pump is installed instead of a room heater. Find the power of a heat pump assuming maximum efficiency. Assume that heat loss from the room is 435 W. [4]

   c) Write down the Kelvin-Planck Statement and the Clausius statement of the second law of thermodynamics. [2]

8. a) Derive the third TdS equation : $TdS = C_V\left(\frac{\partial T}{\partial P}\right)_V dP + C_P\left(\frac{\partial T}{\partial V}\right)_P dV = \frac{C_V\chi_T}{\beta}dP + \frac{C_P}{\beta V}dV$

   where χ_T and β are isothermal comprssibility and volume expansivity respectively. [3+2]

   b) Prove that Maxwell relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ Hence show that $\left(\frac{\partial C_V}{\partial V}\right)_T = T\left(\frac{\partial^2 P}{\partial T^2}\right)_V$. Find the value of $\left(\frac{\partial C_V}{\partial V}\right)_T$ for a vander Waals' gas. [2+2+1]

Answer <u>any one</u> question : [1×5]

9. State Clausius theorem.
   Show that in any irreversible process entropy change of the universe is always positive. [1+4]

10. Show that $C_P - C_V = T\left(\frac{\partial P}{\partial T}\right)_V\left(\frac{\partial V}{\partial T}\right)_P$. Find the value of $C_P - C_V$ for a van der Waals' gas under suitable approximation. [2+3]

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