RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2016

SECOND YEAR [BATCH 2014-17]

Date : 20/05/2016 **PHYSICS (Honours)**

Time : 11 am – 3 pm **Paper :** IV Full Marks : 100

[Use a separate Answer Book for each group]

Group - A

Answer <u>any seven</u> questions from question nos. <u>1 to 11</u> : [7×10]

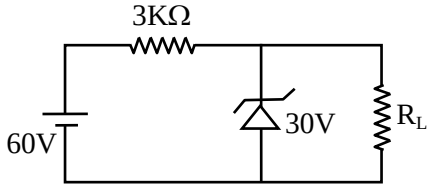
1. a) A series LCR circuit is connected to a source of sinusoidal emf of angular frequency ω and peak amplitude value V_0. Find the relation between Q-factor and voltage magnification factor of this circuit. [2]

   b) Explain the principal of operation of a generalized ac bridge. Why do we require two conditions of balance? [3+2]

   c) Prove that for a transformer with perfect coupling and an open circuited secondary the transformation ratio $\frac{V_2}{V_1} = \frac{N_2}{N_1}$, the ratio of the number of turns in the secondary coil to that in the primary. [3]

2. a) Draw the circuit diagram of a bridge rectifier with a resistive load using P-N junction diodes. Calculate the ripple factor of the output. [1+3]

   b) Consider the circuit given below. Using ideal Zener diode find the current through the diode when the load resistance R_L is $30K\Omega$ and $3K\Omega$. Explain whether can R_L be $2K\Omega$. [2+1]

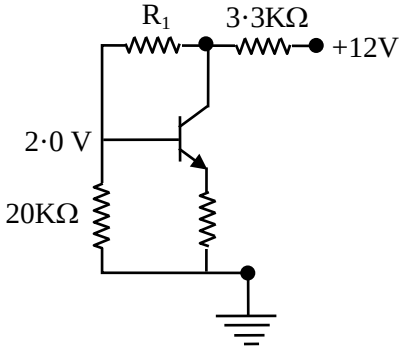


   c) How does the reverse biasing affect the depletion region and the movement of holes and electrons in a p-n junction? [3]

3. a) What are the factors that affect the bias stability of a transistor/ Draw the circuit diagram of a self biased n-p-n transistor. [2+1]

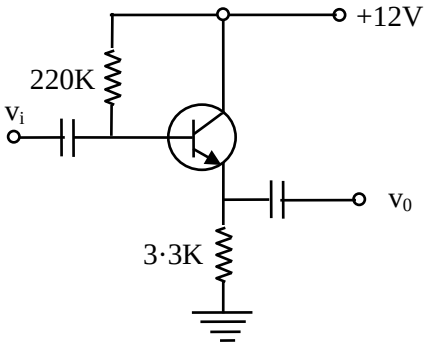
   b) Show that in a transistor circuit a self bias is superior to fixed bias. [4]

   c) The transistor in the following circuit has the following parameters $\alpha = 0{\cdot}98$, $V_{BE} = 0{\cdot}7\,V$ and negligible I_{CO}. For an emitter current $I_E = 2mA$, calculate I_C, I_B and R_1. [3]



4. a) Draw the a-c hybrid parameter equivalent circuit of a bipolar junction transistor (small signal). Obtain the expressions for voltage and current gain. [2+4]

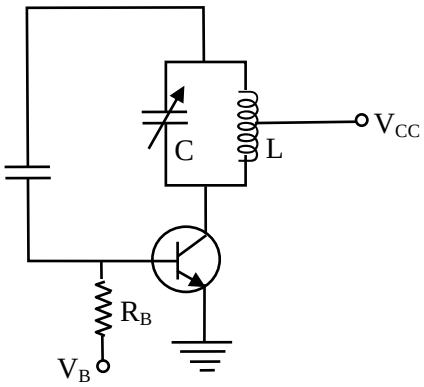
   b) Determine the voltage gain and output resistance of the given circuit. Given $h_{fe} = 100$, $h_{ie} = 1260\Omega$, $h_{re} = h_{oe} = 0$, $R_S = 0$. [4]



5. a) Obtain an expression for voltage gain of a common source JFET amplifier at low frequency. [3]
   b) Define pinch-off voltage of a JFET. Sketch the depletion region before and after pinch off. [1+1+1]
   c) What is the difference between the depletion and enhancement type MOSFET? Draw the drain characteristics curves of a n-channel depletion MOSFET. Show how can it be used in enhancement mode. [1+2+1]

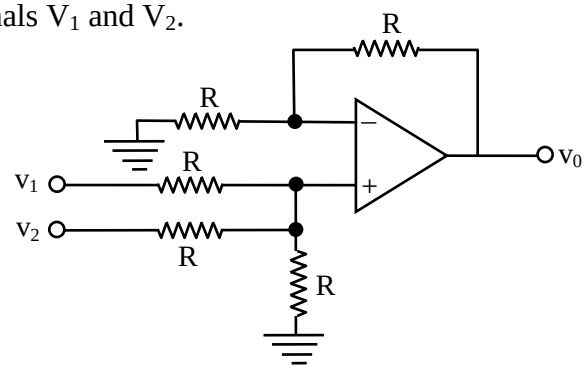
6. a) Obtain an expression for amplitude modulated wave. Show that an AM wave consists of a Carrier and two side band components for each modulation frequency. [3+2]
   b) Define frequency modulation. State Carson's rule related with bandwidth of an FM wave. [1+2]
   c) The total power content of an AM wave is 5·90 KW and the modulation index is 0·6. Find out the power of the carrier and sideband. [2]

7. a) Draw the circuit diagram of a Hartley oscillator and find the condition for oscillation and frequency of oscillation of the oscillator. [1+5]
   b) The capacitor in the following circuit ranges from 50 pF to 479 pF and is used to vary the frequency from 50 KHz to 150 KHz. Calculate the required inductance of the coil (L). [4]



8. a) Give a Truth Table of full adder. Using this table, draw the circuit diagram of this. Give some advantages of full-adder over half adder. [2+4+2]
   b) How half adder can be used as a subtractor. [2]

9. a) What is virtual ground? [2]
   b) Show circuit diagram of a summing amplifier input given in inverting input of Op Amp. Prove that it is acting as a summing amplifier. [1+3]
   c) Circuit diagram of an amplifier using Op Amp is shown. Find an expression for the output signal V_0 with the input signals V_1 and V_2. [4]



10. a) What is class B push pull power amplifier. Give circuit diagram and explain it. [1+1+2]
    b) Find an expression of its power efficiency. In this amplifier how crossover distortion is removed? [4+2]

11. a) Draw the block diagram of a feed back amplifier. [2]
    b) Obtain an expression for the closed loop voltage gain of the amplifier. [4]
    c) In an amplifier with bandwidth 200KHz and voltage gain 100, 5% negative feedback is introduced, what will be the new bandwidth and gain? What should be the amount of feedback if the bandwidth of the amplifier has to be 1MHz? [2+2]

Group - B

Answer <u>any three</u> questions from question nos. <u>12 to 16</u> : [3×10]

12. a) Give the Kelvin-Planck and Clausius statements of the second law of thermodynamics. [2]
    b) Show that the two statements, though Seemingly different, one in fact equivalent in so far as the consequences are concerned. [4]
    c) A mass m of a liquid at temperature T_1 is mixed with an equal mass of same liquid at temperature T_2. The system is thermally insulated. Show that the entropy change of the universe is $2mC_p \log_e \frac{(T_1+T_2)}{2\sqrt{T_1T_2}}$. [4]

13. a) What is Legendre transformation? Use it to obtain the expression of Helmhottz free energy F(T, V) starting from enthalpy H(S, p). [3]
    b) Define Gibb's potential function and show that for simultaneous isobonic and isothermal process, Gibb's free energy remains constant. [1+3]
    c) Show that for one mole of van-der Wall's gas $C_p - C_V = \frac{R\left(P + a/V^2\right)}{p - \frac{a}{V^2} + \frac{2ab}{V^3}}$.

    [symbols have usual meaning] [3]

14. a) Distinguish between first order and second order phase transition. [4]
    b) Deduce the Clausius-Clapeyron's equation $\frac{dp}{dT} = \frac{L}{T(v_2 - v_1)}$ (where symbols have their usual meaning). [3]
    c) Calculate the boiling point of benzene under a pressure of 80 cm of mercury. The normal boiling point is 80°C. Latent heat of vaporisation is 380 joule/gm, density of vapour at boiling point is 4gm/litre and that of the liquid is 0·9 gm/cm^3. [3]

15. a) Show that J-T effect is an isenthalpic process. [2]
    b) Show that the expression for J-T co-efficient in the isenthalpic process can be
    $$\mu = \frac{T^2}{C_p}\left\{\frac{\partial}{\partial T}\left(\frac{V}{T}\right)_p\right\}_H .$$ [3]
    c) A real gas satisfies the equation $\left(P + \frac{a}{v^2}\right)(V - b) = RT$ where a and b constants and other symbols have usual meaning. Find the expression of temperature of inversion in terms of the constants of the equation. Also show that Joule-Thomson co-efficient for a perfect gas is zero. [3+2]

16. a) What do you mean by a black body? Show that the energy density of a black-body radiation is $u = aT^4$. Assume the expression of pressure due to diffuse radiation. [1+4]
    b) An aluminium foil of relative emittance 0·1 is placed in between two concentric spheres at temperatures 300K and 200K respectively. Calculate the temperature of the foil after the steady

state is reached. Assume that the spheres are perfect black body radiators. Also calculate the rate of energy transfer between one of the spheres and the foil. [$\sigma = 5 \cdot 672 \times 10^{-8}$ M.K.S unit] [3]

c) A certain system is found to have a Gibb's free energy given by $G(p,T) = RT \ln\left[\frac{ap}{(RT)^{5/2}}\right]$ where a and R are constants. Find the specific heat at constant pressure (C_p). [2]

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