RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2017

SECOND YEAR [BATCH 2015-18]

Date : 18/05/2017 **PHYSICS (Honours)**

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

[Use a separate Answer Book for each group]

Group – A

Answer **any seven** questions from **Question Nos. 1 to 11**: [7 X 10]

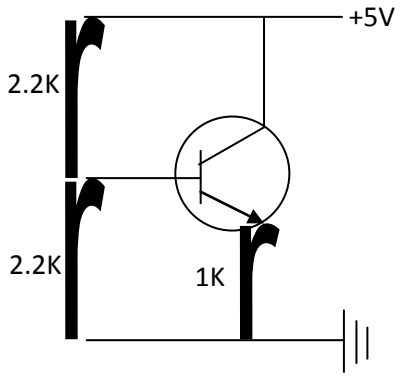
1. a) What is a parallel resonant circuit? State its characteristics and uses. 1+2
   b) Define Q-factor. How does the selectivity depend on the Q-factor? 1+2
   c) An ac supply of emf 50V (rms) at a frequency 1 KHz is connected across an inductance of 100 mH and a resistance of 2 KΩ in series. Find the potential difference across the inductance and the resistance. Is sum of them equal to 50 V? If not, explain why? 2+2

2. a) A box, containing an inductor of negligible resistance, a capacitor and a resistor connected in a definite fashion, is provided with two terminals. When a potential of 100V (dc) is applied between the terminals, a current of 0.1 amp flows. When a source of ac voltage of 100V (rms), 50 Hz is connected, 1.0 amp (rms) flows. Maintaining the ac voltage constant, if the frequency is increased, the current rises to a maximum at 1 KHz. How are the three components connected inside the box and what are the values of the components? 6
   b) Why a filter is used with a rectifier? Explain the operation of a capacitor filter briefly. 2
   c) Estimate the maximum 'no load' voltage of a full wave ideal diode rectifier without and with a capacitor filter (having high capacitance value). The ac input rms voltage is V_0 volt. 2

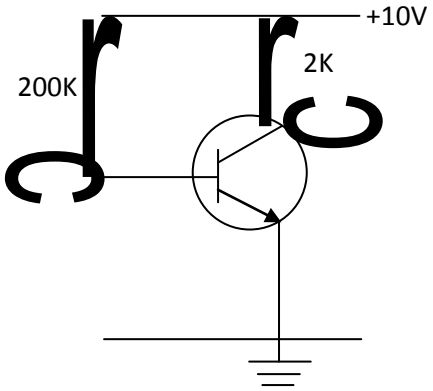
3. a) What are the basic requirements for getting steady oscillation at a fixed frequency from an oscillator? 2
   b) Explain the operation of a Wien-Bridge oscillator with the help of its circuit diagram. 3
   c) In the oscillator the source of oscillation is the noise in the circuit with wide frequency range. Then explain how do you get an output ac of specific frequency? 2
   d) Mention two advantages of crystal oscillator. 1
   e) A Colpitt oscillator uses a tank circuit with L = 10 mH, C_1 = 300 pF and C_2 = 200 pF. What is the frequency of oscillation? 2

4. a) Derive an expression for an FM wave with sinusoidal modulating signal. Obtain the frequency modulation index for the above case. 3+1
   b) Distinguish between AM and FM signals. 2
   c) Draw the circuit diagram of an AM envelope detector with input and output waveforms. 2
   d) Determine the audio power necessary to amplitude modulate a 10 KW carrier to a depth of modulation of 60%. 2

5. a) Show that a self bias circuit is superior to a fixed bias circuit. 6
   b) In the circuit shown the transistor is made of Si. Will the biasing circuit shown place it in active region? If no, explain the situation and find the base current. Assume β = 100. 4



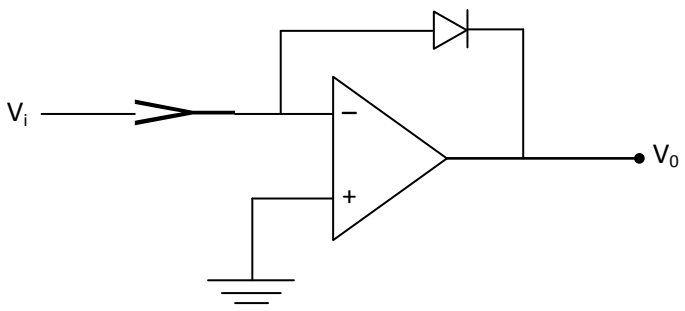
6. a) Define the four h-parameters in an h-parameter equivalent circuit of a transistor. Which of them can be neglected in a simplified model and why? 4+2
   b) Using simplified h-parameter model determine input impedance, output impedance, voltage gain and current gain of the following circuit. 4



Given $h_{fe} = 100$, $h_{ie} = 1.1\ \text{K}\Omega$

7. a) Define the pinch off voltage of a JFET. BJT is a current controlled device but JFET is a voltage controlled device — explain the statement. 1+2
   b) Obtain an expression for the voltage gain of a common source JFET amplifier. 4
   c) What is the difference between the depletion and enhancement type MSOFET? Explain how a depletion type MOSFET can be used as both enhancement and depletion mode. Also draw the output characteristics for both cases. 3

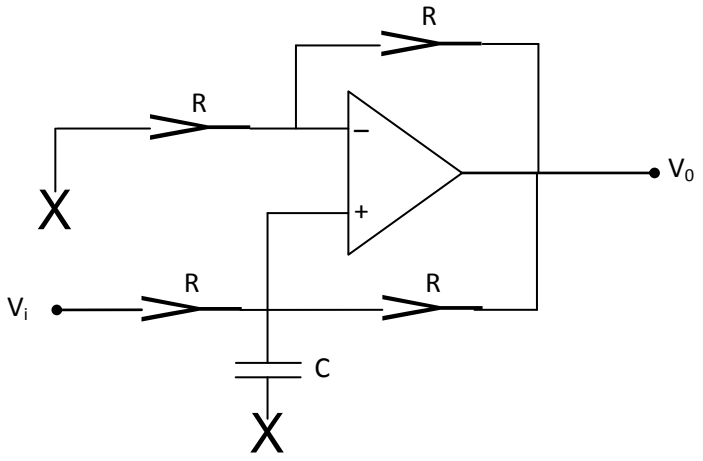
8. a) Distinguish between combinational and sequential logic circuit. 2
   b) Explain how the phase difference between two sinusoidal a.c. signals of same frequency can be measured by a CRO using Lissajous figure. 3
   c) Determine the output voltage of the following circuit: 2



d) A ramp voltage of 2 volt/ms (pure ac signal of frequency 1 KHz) is applied to an OP-Amp differentiator with R = 2 KΩ and C = 0.01 μF. Find the output voltage and waveform with timing diagram. 3

9. a) How NOR gates can be used to construct RS Flip-Flop, give its truth table. Give circuit diagram of Master-Slave Flip-Flip using NOR gates. 2+1+2
   b) Give a block diagram of binary ripple counter. Draw the output waveform after 5^{th} and 9^{th} pulse. Mention some of its uses. 2+2+1

10. a) What is a digital full adder? Design and draw its circuit diagram. Can it be used as subtractor? 1+3+1+2
    b) Can the following circuit be used as a non-inverting integrator? Explain. 3



11. a) Distinguish between class A, B, AB and C power amplifiers. Mention uses of different classes in practical applications. 2+2
    b) Draw the circuit diagram of a transformer coupled class-A power amplifier using transistor. Explain the role of transformer. Derive efficiency for such an amplifier. 1+1+2
    c) How does a transformerless class-B amplifier can be designed? 2

Group – B

Answer **any three** questions from **Question Nos. 12 to 16** : [3×10]

12. a) What is meant by 'thermodynamic process'? How is it represented on an indicator diagram? 3
    b) Calculate the work required to blow a spherical soap bubble of radius *r* in an isothermal, quasi-static process in the atmosphere. 2
    c) Show that the entropy is a state function. 3
    d) 20 gm of hydrogen gas at 27^oC are compressed isothermally to one-fourth of the original volume. Find the amount of work done. 2

13. a) State Clausius theorem and discuss briefly the concept of entropy. 3
    b) 1 Kg of water is heated in two ways, from 273 K to 373 K. (i) Firstly by bringing it in contact with a heat reservoir at temperature 373 K. (ii) Secondly into two steps firstly by bringing it in contact with a heat reservoir at temperature 323K and then by bringing it in content with a reservoir at temperature 373K. Calculate the change in entropy of the universe in two cases. Assume that the specific heat of water is 4200J/Kg and temperature of reservoir does not change due to flow of heat.

Suggest a method from the above result that there is a no change of entropy of the universe while heating the water from 273K to 373K. 2+2+1

c) Establish the 'principle of increase in entropy' for a non-static irreversible process. 2

14. a) Distinguish between first order and second order phase transition. 3

b) Derive an equation for the phase boundary of the liquid and gas phases under the assumptions that the latent heat L is temperature independent, that the vapour can be treated as an ideal gas, and $V_{vapour} = V \gg V_{liquid}$. 3

c) Show that $\frac{dL}{dT} = \frac{L}{T} + C_2 - C_1$ where C_1 and C_2 are specific heat of first and second phase under saturated condition and L is the latent heat at the temperature T. 4

15. a) What are the basic differences between adiabatic expansion and Joule Thomson (J.T) expansion? 3

b) Obtain an expression for Joule Thomson coefficient. What do you mean by the inversion temperature of a gas undergoing Joule-Thomson expansion? Why some gases are cooled down on J-T expansion while other gets warm on same expansion? 3+1+1

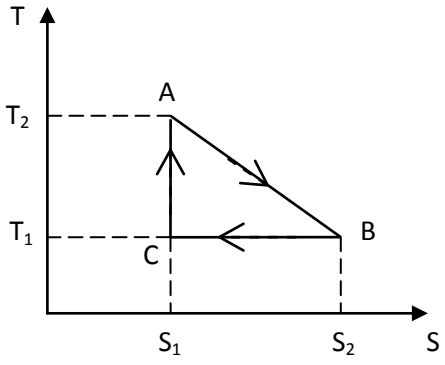
c) Find out the inversion temperature for a gas obeying the following equation of state: 2

$p(v-b) = RT\exp(-\frac{a}{RTV})$, where a and b are constants.

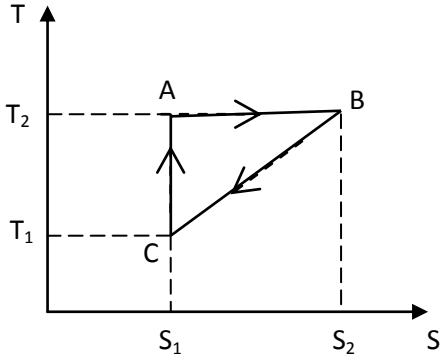
16. a) Define emissive power and absorptive power of a substance in connection with thermal radiation. 2

b) Show that for a system undergoing processes at constant pressure and temperature the Gibb's free energy will be minimum. 4

c) Compare the efficiencies of the cycles ABCA as shown in the figures below: 4



(a)



(b)

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