RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2019

SECOND YEAR (BATCH 2017-20)

Date : 16/05/2019 **PHYSICS (Honours)**

Time : 11.00 am – 3.00 pm Paper : IV Full Marks : 100

[Use a separate Answer Book for each Group]

Group – A

Answer <u>any four</u> questions from <u>Question Nos. 1 to 7</u>: [4×10]

1. a) What do you mean by cascading of amplifier? [2]
   b) What are the factors which make a CE amplifier suitable for cascade connection? [3]
   c) Obtain expressions for the voltage gain of an RC-coupled amplifier in the mid and low frequency ranges. Also define lower cut-off frequency. [2+2+1]

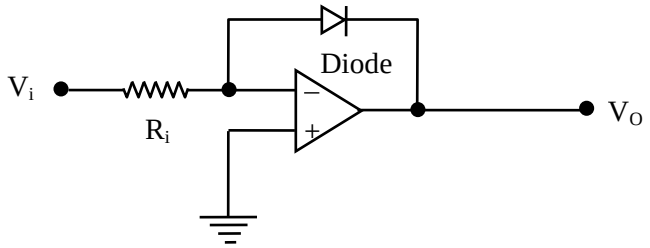
2. a) Draw the circuit diagram of a tuned amplifier circuit and explain its principle of operation. [5]
   b) What are the advantage of tuned voltage amplifier? [2]
   c) A CE class A power amplifier is coupled to a load resistance of 10Ω by a transformer of primary-to-secondary turns ratio 10:1. The signal has a peak-to-peak swing of 300 mA. Calculate the output power. [3]

3. a) What do you mean by sampling and mixing in a feedback amplifier. [2]
   b) Mention some advantages of positive and negative feedback. [2]
   c) Discuss how negative feedback modifies the input and output resistance of an amplifier. [4]
   d) An amplifier having a voltage gain of -80, uses a negative feedback circuit with a loop gain of -2. What are the overall voltage amplification and the reverse transfer ratio? [2]

4. a) What is monolithic voltage regulator? Discuss how IC 7805 can be used to output +12V DC. [1+3]
   b) Draw and explain the working of RTL based NOR and NAND gates. [4]
   c) In a DL based OR gate with two input terminals A and B having voltage levels (0, 5.0) and (5.0, 0) for two states respectively, the output (y) assumes 4.8 V and 4.9 V. If both A and B are kept at 5.0 V, estimate the voltage at y. [2]

5. a) State the basic conditions for oscillations in a feedback amplifier. [1]
   b) Derive the frequency of oscillation and the oscillation condition for a Crystal oscillator. [4]
   c) Describe the working of an bistable multivibrator using transistors. [4]
   d) Mention the modifications needed to convert an astable multivibrator to a monostable multivibrator. [1]

6. a) What should be the expression for output voltage: [3]



   b) Draw and explain the working of a 4 bit weighted-resistor DAC designed using OPAMP. [4]
   c) What do you mean by full adder? Describe how half adder blocks can be used to design a full adder. [3]

7. a) Explain with a circuit diagram how AM waves can be produced. [5]
   b) Compare AM and FM. [2]
   c) An AM transmitter radiates a power of 100 KW. If the modulation factor is 0.84, calculate the carrier power and power of side frequencies. [3]

Group - B

Answer <u>any six</u> questions from <u>Question Nos. 8 to 16</u> : [6×10]

8. a) i) Explain the concept of temperature form kinetic theory.
   ii) Using kinetic energy concept show that the number of molecule striking per unit area per sec is $\frac{1}{4}n\bar{c}$, where n is the molecular density and $\bar{c}$ is the mean velocity of the gas molecules.
   iii) Hence find the expression for pressure from this relation. [2+3+2]
   b) For a mono-atomic gas in a gravitational potential (mgZ), does the average velocity in Z-direction depend on height Z? Explain. [3]

9. a) Write down the expression of mean free path. Comment on its dependence on pressure and temperature. [2]
   b) Define molecular effusion. Explain why effusion preferentially selects faster molecules. [1+2]
   c) Using kinetic theory of gas, find an expression of thermal conductivity 'K'. Comment on the dependence of 'K' on pressure and temperature. [3+2]

10. a) If λdt be the probability of a gas molecule making a collision in the time interval dt. find i) the probability of a molecule experiencing no collisions during the time interval t. (ii) the mean time interval between successive collision. [3+2]
   b) Deduce an expression for rate of flow of heat under steady state in the radial direction per unit length of an infinite annular conducting cylinder heated uniformly along the axis. [3]
   c) A cylindrical tube of radii 1 cm and 4 cm has temperatures T_1 and T_2 at the inner and outer surfaces respectively. Find at what distance from the axis, the temperature will be $\frac{T_1+T_2}{2}$. [2]

11. a) Express the Van der Waal's equation of state in terms of a virial expansion and hence find the Boyle temperature in terms of the critical temperature. [3]
   b) i) Show that at the critical temperature, the departure of the Van der Waal's gas from the ideal gas law $\frac{p_cV_c}{RT_c}$ measures 62.5 %.
   ii) Should a and b in Van der Waal's equation be really constants? Give reasons for your answer. [2+2]
   c) The critical temperature and pressure of argon are -122^oC and 48 atoms respectively. Calculate the radius of an argon atom. [3]

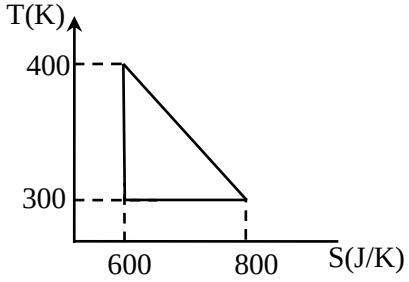
12. a) Show that Kelvin Plank statement and Clausius statement are equivalent in second law of thermodynamics. [4]
   b) Using Kelvin Plank statement show that
   i) One isothermal curve and one adiabatic curve cannot intersect twice. [1]
   ii) Two adiabatic curves cannot intersect each other. [1]

   c) An ideal gas undergoes a process in which its internal energy U is related to its volume V as $U = aV^b$, where a,b are constants. Show that the work done by the gas and the quantity of heat transferred to it to increase its internal energy by ΔU are respectively. [2+2]

i) $\frac{\Delta U}{b}(\gamma-1)$ ii) $\Delta U\{1+(\gamma-1)/b\}$; $\gamma=\frac{C_p}{C_V}$

13. a) State and proof the Clausius theorem. [1+3]
    b) "The entropy of an isolated system tends towards a maximum while it approaches equilibrium"— Justify the statement. [3]
    c) Two identical bodies of constant heat capacity of temperature T_1 and T_2 are used as the source and sink respectively of a heat engine. If the bodies remain at constant pressure and there is no change in phase, show that the maximum possible work by the heat engine is $W_{max} = C_P\left(\sqrt{T_1}-\sqrt{T_2}\right)^2$, where the symbols have usual meaning. [3]

14. a) Define entropy. Show that the entropy is a state function. [1+2]
    b) The T-S diagram of a reversible heat engine is shown in the adjoining figure. Find its efficiency. [3]



    c) 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 323 K and then by bringing it in contact with a heat reservoir at temperature 373K. Calculate the change in entropy of the universe in two cases. Assume that the specific heat of water is 4200 J/Kg and temperature of reservoirs does not change due to flow of heat. [2+2]

15. a) What do you understand by thermodynamic potentials? What is the importance of these potentials? [2+2]
    b) A system of mass m undergoes a phase transition at a constant temperature T and pressure p. If it suffers a change Δv in its volume per unit mass, show that the change in its internal energy Δu is given by $\Delta u = mT^2\frac{\partial}{\partial T}\left(\frac{p}{T}\right)_V \Delta v$ [3]
    c) Show that if $\alpha=\frac{1}{T}$, the specific heat Cp is independent of temperature. Where $\alpha=\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$. [3]

16. a) Find an expression for Joule Thompson coefficient for Vander Waal's gas and also find an expression for inversion temperature. [2+1]
    Show that Joule Thompson effect (JT effect) deviates from Joule's law as well as from Boyle's law. [2]
    b) Write down the Poisson's distribution. Find the mean value and variance of a variable n using Poisson's distribution. [1+1+1]
    c) A book contains 600 pages with 600 typographical mistakes. Using prison's distribution find (y) a page contains no error. [2]

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