RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2018

SECOND YEAR (BATCH 2016-19)

Date : 19/05/2018 **PHYSICS (Honours)**

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

[Use a separate Answer Book for each Unit of Group A and another Answer Book for Group B]

Group – A

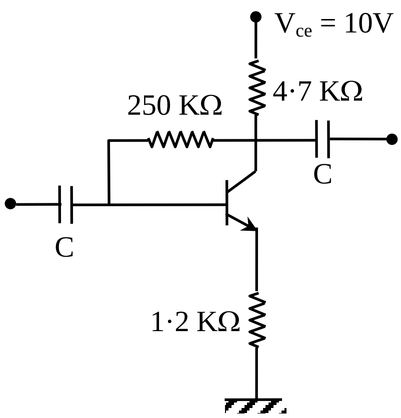
***Answer any seven questions from Question No. 1 to 11*:** [7×10]

Unit - I

1. a) Explain that at a frequency ω below the resonant frequency, the reactance of a series resonant circuit is capacitive, but that of a parallel resonant circuit is inductive. [3]
   b) Explain the resonance in a series RLC circuit in terms of phase diagram. [3]
   c) Write down the differential equations of primary and secondary of a ideal transformer involving current, voltage and other required circuit parameters. [2]
   d) Explain why in balance condition, the detector current in a ac bridge is minimum but not zero in contrast to a dc bridge. [2]

2. a) Consider a circuit consisting of a series combination of a battery with e.m.f E, a forward biased p-n junction diode and a resistor R. Explain with the circuit diagram how you can find the value of the current flowing in the circuit as well as the voltage drop across the diode. [4]
   b) Draw the circuit diagram of a full wave bridge rectifier with a π filter. [2]
   c) A full wave rectifier uses two semi-conductor diodes with forward resistance R_f. Find the rectification efficiency when a load R_L is driven by the rectifier. [4]

3. a) Explain why a transistor should be biased. [2]
   b) What is self-bias? Draw the circuit diagram showing the self-bias of an n-p-n transistor in the CE mode. Explain physically how the self biasing resistor improves the stability. [1+1+2]
   c) In the figure below, find the value of I_E & V_{CE}. Given $\beta = 90$ and $V_{BE} = 0{\cdot}7$ V. If β is increased by 50% what will be the effect on I_C & V_{CE}? [4]



4. a) What do you mean by small signal amplifier? Draw the circuit diagram of a two-stage RC coupled CE transistor amplifier. [2]
   b) Obtain the expressions for the voltage gain of an RC coupled amplifier in the mid, low and high frequency regions. Then draw the gain-frequency curve from your expressions. [8]

Unit - II

5. a) Draw a family of common source drain characteristic curve of an n-channel JFET. Explain the shape of the curve qualitatively and name various regions. Compare it with the output characteristic curve of a transistor in CE mode. [1+3+2]

   b) Define pinch-off voltage in case of an n-channel JFET and draw the depletion regions before and after pinch-off. [2]

   c) In a experiment using JFET following data are obtained :

V_{GS} in Volt	0	0	–0·2
V_{DS} in Volt	7	15	15
I_D in mA	10	10·25	9·65

   Calculate r_d and g_m. [2]

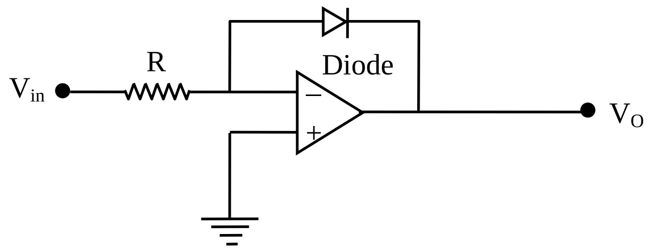
6. a) Show that a transistor may be considered as two port network and hence define hybrid parameters. [3]

   b) Compare positive and negative feedback. Give practical examples for both types of feedback. [3]

   c) Explain how negative feedback decreases the phase distortion of an amplifier. [4]

7. a) Draw the circuit diagram of an astable multivibrator using transistors. Design it to produce a train of pulses $10\,\mu s$ wide at a repetition rate of $10\,khz$. (Use $1K\Omega$ as baising resistances). [2+3]

   b) Determine the output voltage of the given circuit : [3]

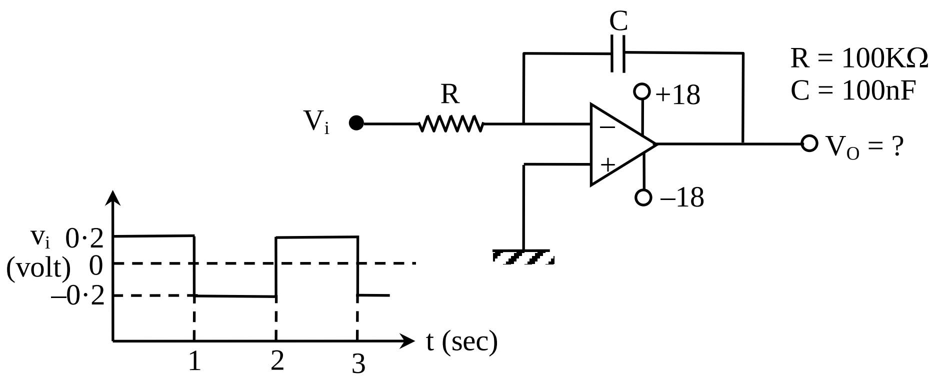


   c) How the internal impedance of a voltmeter can be increased with the help of any active device. Draw the relevant circuit. [2]

8. a) What should be the value of CMRR of an ideal OPAMP? Explain. [2]

   b) State the working principle of a R-2R Ladder converter with suitable circuit diagram. [6]

   c) What should be the output of the given circuit for given input signal? [2]



9. a) State why modulation is needed. [2]

   b) Compare amplitude modulation and angle modulation. [2]

   c) How many side frequencies should be there if a carrier is amplitude modulated and frequency modulated respectively and independently with the help of a single tone modulating signal? [2]

   d) Consider an AM wave with 80% modulation. Calculate the percentage of power saved when a SSB-SC is transmitted instead of the total AM wave. [4]

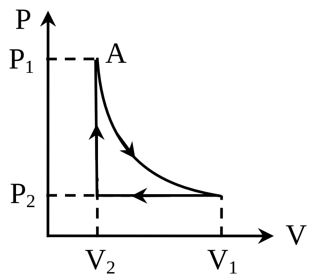
10. a) Compare class A, B and C amplifiers with suitable output characteristics. [3]
b) Design and draw a half adder (circuit) using basic gates. [3]
c) What is multiplexer? Design an draw the circuit diagram of a 4-to-1 line data selector multiplexer system. [4]

11. a) Convert the following numbers :
$(BAD)_{16} \rightarrow (?)_8$, $(976\cdot52)_{10} \rightarrow (?)_7$ [2]
b) Perform the following using r's complement method :
$(+725\cdot62)_8 - (+661\cdot33)_8, (-9234)_{10} + (-1877)_{10}$ [3]
c) Design NOR gate using basic analog components for Diode-Transistor Logic (DTL) system. [5]

Group - B

Answer any three questions from Question No. 12 to 16 : [3×10]

12. a) An inventor claims to design a device operating between two reservoirs maintained at temperatures 800K and 400K respectively with efficiency 52%. Justify his claim. [2]
b) Using Clausius statements prove that no engine can be more efficient than a reversible engine working between the same two reservoirs. [4]
c) Figure represents an imaginary ideal-gas cycle. Assuming constant heat capacities, show that the thermal efficiency is $\eta = 1 - \gamma \frac{\left(\frac{v_1}{v_2} - 1\right)}{\left(\frac{p_1}{p_2} - 1\right)}$; where γ is the ratio of specific heats. [4]



13. a) Show that the second law of thermodynamics leads to a scale of temperature which is independent of the nature of the working substance. [4]
b) Give a mathematical formulation of second law of thermodynamics in terms of entropy. [2]
c) A body of constant heat capacity C_P and at a temperature T_i is put in contact with a reservoir at a higher temperature T_f. The pressure remains constant while the body comes to equilibrium with the reservoir. Show that the entropy change of the universe is equal to $\Delta S = C_P[x - \ln(1+x)]$ where $x = -\frac{(T_f - T_i)}{T_f}$. Also prove that the entropy change is positive. [4]

14. a) Establish that for a system with constant volume and in contact with a heat bath of a given temperature, the equilibrium corresponds to the minimum of Helmholtz free energy 'F'. [3]
b) Establish the equation $TdS = C_v \left(\frac{\partial T}{\partial p}\right)_V dp + C_p \left(\frac{\partial T}{\partial v}\right)_p dv$. (where symbols have their usual meaning). [3]
c) Calculate the variation of C_P with pressure at constant temperature for a substance whose equation of state is $V = \frac{RT}{p} - \frac{c}{T^3}$, where c is a constant. [4]

15. a) What are the characteristic features of a first order phase transition? How the order of the phase transition is determined? [2+2]

b) Derive the Clausius-Clapeyron's equation $\frac{dp}{dT} = \frac{L}{T(V_2 - V_1)}$ (where symbols have their usual meaning) [3]

c) Determine the phase diagram of water using Clausius-Clapeyron's equation. Mention its nontrivial part. [2+1]

16. a) Distinguish between free expansion and Joule Thomson expansion. Show that the Joule Thomson expansion is the result of deviation from Joule's law and as well as Boyle's law. [1+2]

b) Define inversion temperature in the context of Joule-Thompson expansion experiment. Show that the van der Waal's equation gives rise to two inversion temperature. [1+3]

c) Show that $U = -T^2 \left[\frac{\partial}{\partial T} \left(\frac{F}{T} \right) \right]$ (Symbols have their usual meaning) [3]

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