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25.10.25

The figures in the margin indicate full marks.

The corresponding Course Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the Course are mentioned at the end of the question paper.

USE SEPARATE SCRIPTS FOR EACH SECTION

**SECTION - A**

There are **FOUR** questions in this section. Answer to **Question NO. 1** is **compulsory**.

Answer any **TWO** questions from **Questions 2-4**.

1. (a) For the voltage regulator circuit shown in Fig. for Q. 1(a), the faulty supply voltage can vary in the shown range, and the diodes have **piecewise linear** I-V characteristics, so that for each diode,  $V_D = 1.11V$  when  $I_D = 1 mA$ , and  $V_D = 1.12V$  when  $I_D = 2 mA$ . (26 2/3) (CO3)
- (i) Find the cut-off voltage ( $V_c$ ) and the forward resistance ( $R_{on}$ ) for each diode.
- (ii) At no load condition ( $I_L = 0$ ), find the line regulation ( $\Delta V_o / \Delta V_s$ ) of the circuit.
- (iii) At the nominal value of  $V_s = 5V$ , find the load regulation ( $\Delta V_o / \Delta I_L$ ) of the circuit.
- (b) For the circuit shown in Fig. for Q. 1(b), both BJTs have  $\beta = 100$ . Find the output voltage  $v_o$  for (i)  $v_i = 2V$ , (ii)  $v_i = 0.5V$ , (iii)  $v_i = -1V$ . You must justify any assumptions you make. (20) (CO3)

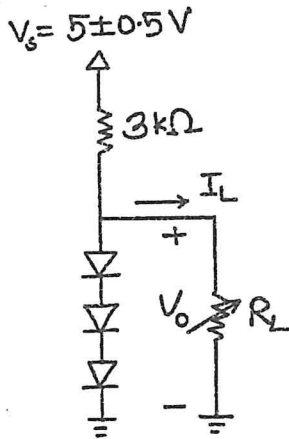


Fig for Q.1(a)

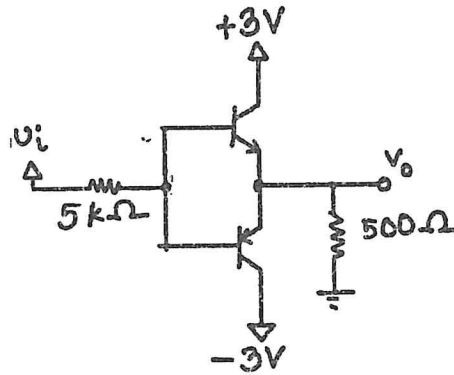


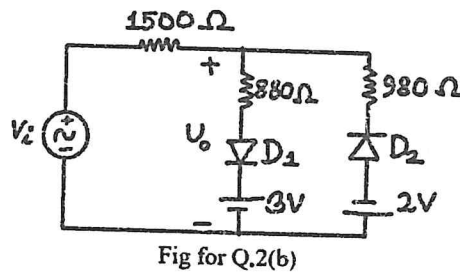
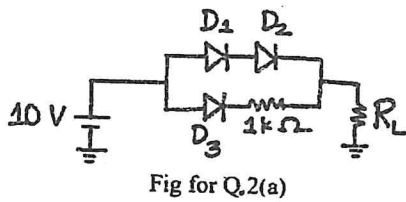
Fig for Q.1(b)

2. (a) In the circuit shown in Fig. for Q. 2(a), the diodes have piecewise linear I-V characteristics, with cut-off voltage  $V_c = 0.7V$  and forward resistance  $R_{on} = 20 \Omega$ . 23 2/3 (26 2/3)
- (i) If only one diode turns on, which one will it be? Justify your answer with a clear explanation.
- (ii) Find the range of values for  $R_L$  for which only one diode will turn on.

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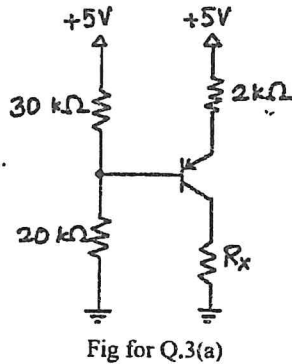
**Contd ... Q. No. 2**

(b) For the circuit shown in Fig. for Q. 2(b), the diodes have piecewise linear I-V characteristics, with cut-off voltage  $V_c = 0.7V$  and forward resistance  $R_{on} = 20 \Omega$ . The input voltage  $v_i = 10 \cos(\omega t) V$ . Find the mathematical relation between the output voltage  $v_o$  and the input  $v_i$  for all ranges of  $v_i$ , and also draw the  $v_o$  versus  $v_i$  transfer curve. (23)

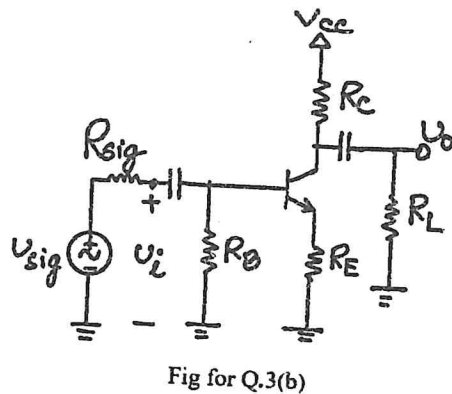


3. (a) In the circuit shown in Fig. for Q. 3(a), it is given that  $\beta = 100$  for the BJT. (23 <sup>2</sup>/<sub>3</sub>)

- (i) Find the node voltage at the base terminal, and currents at all the three terminals of the BJT. You **cannot assume** that the base current is negligible.
- (ii) Find the range of values of  $R_x$  for which the BJT will operate in the saturation region.



(b) For the BJT amplifier circuit shown in Fig. for Q. 3(b), find the **input resistance ( $R_{in}$ )** and output resistance ( $R_o$ ) in terms of  $g_m$ ,  $\beta$ ,  $\alpha$ , and other resistance values. (23)



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4. (a) Both of boxes in Fig. for Q. 4(a) contain the same linear AC circuit with two terminals *a* and *b*. (13)

- (i) If a complex load  $Z_L$  is connected between terminals *a* and *b* in the left figure, find the maximum average power deliverable to the load, and find the values of the resistive and the reactive elements (inductance/capacitance) in the load for that condition.
- (ii) If a purely resistive load  $R_L$  is connected between terminals *a* and *b* in the left figure, find the maximum average power deliverable to the load.

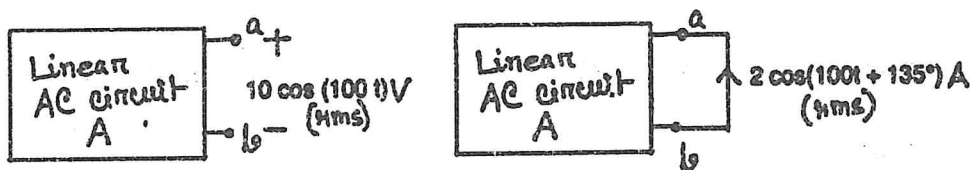


Fig for Q.4(a)

(b) Fig. for Q. 4(b) shows a balanced three-phase system. The frequency is 50 Hz, and the line impedance on the left of supply terminals a-b-c is  $0.1 - 0.2j \Omega$  on each line. (33 2/3)

- (i) Find the line loss (total average power lost in the lines) and calculate the overall power factor seen by the supply.
- (ii) Improve the overall power factor to 0.95 (lagging) by connecting a Y-connected capacitor bank to the lines. Find the necessary capacitance in each phase. Also, find the line loss after this power factor improvement.

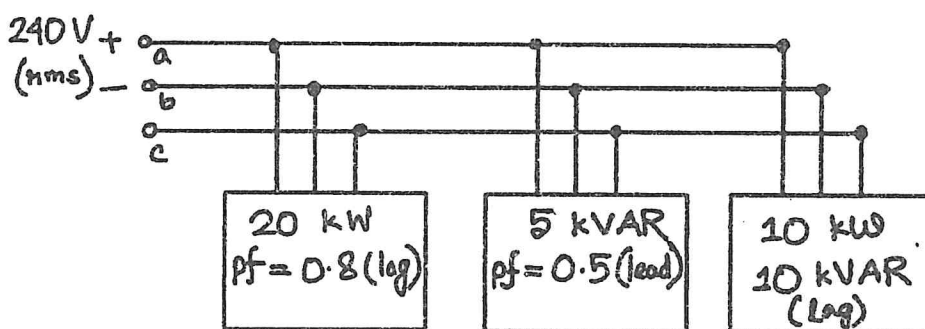


Fig for Q.4(b)

**SECTION – B**

There are FOUR questions in this section. Answer to Question NO. 5 is compulsory.  
Answer any TWO questions from Questions 6-8.

5. (a) Find the values if  $R_1$  and  $R_2$  in the circuit shown in Fig. for Q. 5(a) if the voltmeter and ammeter read 6V and 0.6A, respectively. (20)

(CO1)

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Contd ... Q. No. 5(a)

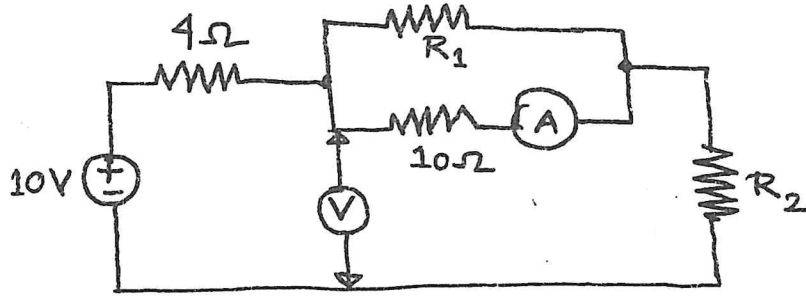


Fig for Q.5(a)

- (b) Using mesh analysis, find the branch currents  $I_1, I_2, I_3, I_4$  and  $I_5$  for the circuit shown in Fig. for Q. 5(b). (26<sup>2</sup>/<sub>3</sub>)  
(CO2)

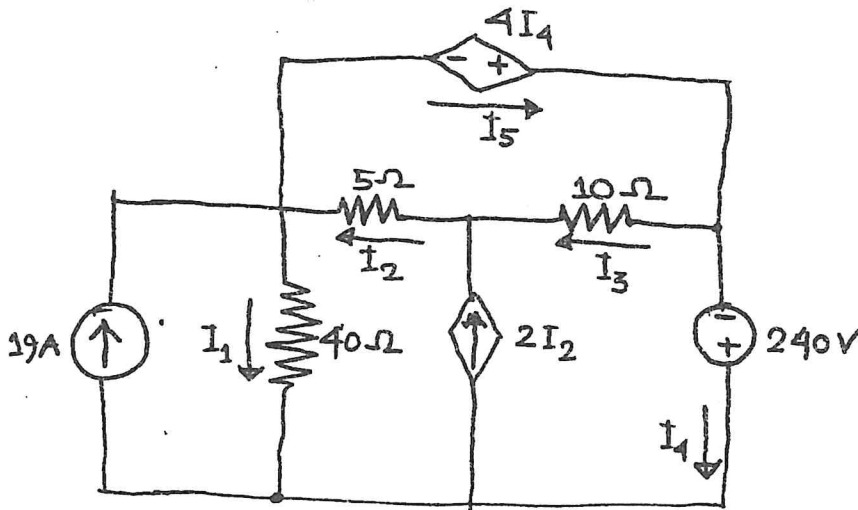


Fig for Q.5(b)

6. (a) Find the value of  $R$  in the circuit shown in Fig. for Q. 6(a). (26<sup>2</sup>/<sub>3</sub>)

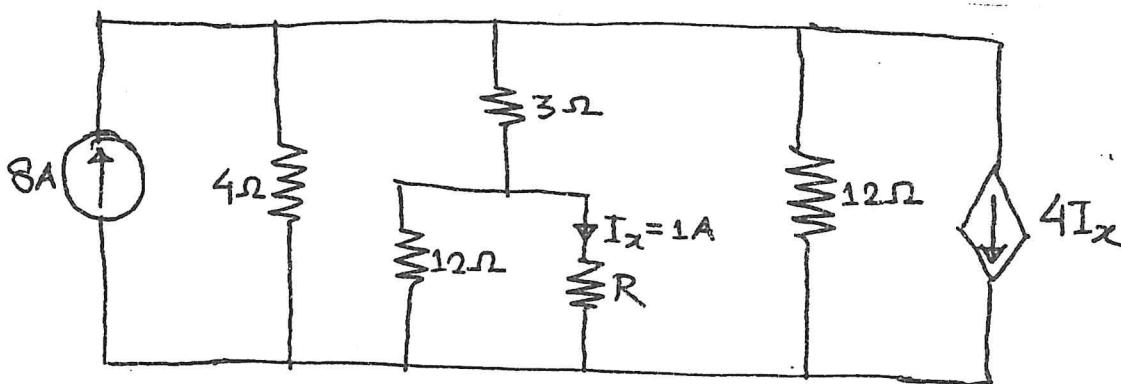


Fig for Q. 6(a)

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**Contd ... Q. No. 6**

(b) Find the equivalent resistances,  $R_{xy}$  and  $R_{yz}$  in the circuit shown in Fig. for Q. 6(b). (20)

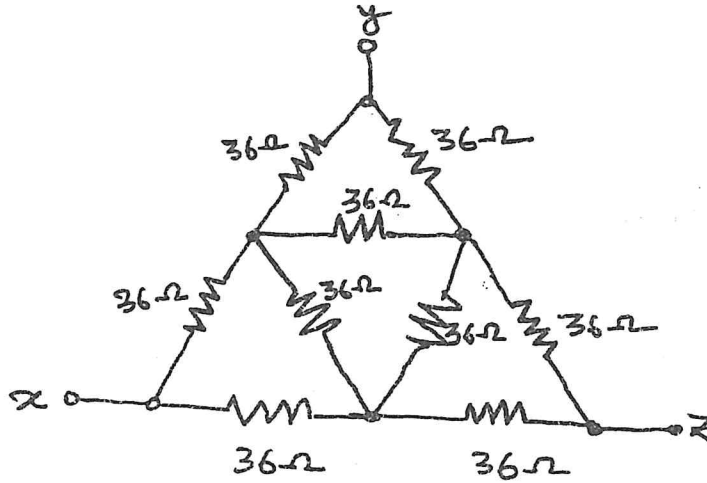


Fig for Q. 6(b)

7. (a) Find  $V_o$  and  $I_o$  in the circuit shown in Fig. for Q. 7(a) using source transformation. (20)

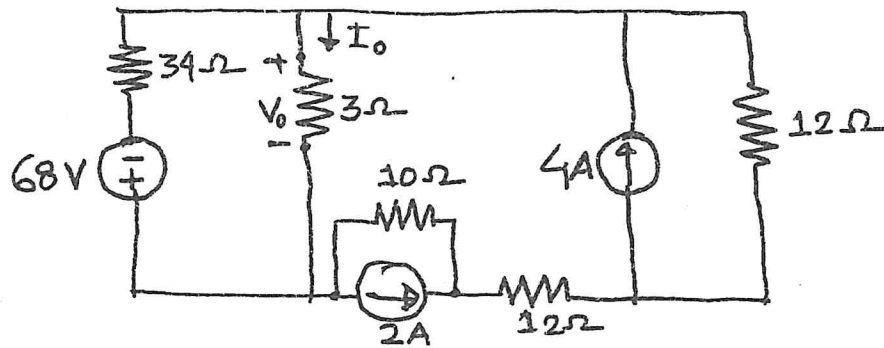


Fig for Q. 7(a)

(b) The variable resistor,  $R$  in the circuit shown in Fig. for Q. 7(b) is adjusted until the power dissipated in it is 250 W. Find the values of  $R$  that satisfy this condition. (26<sup>2</sup>/3)

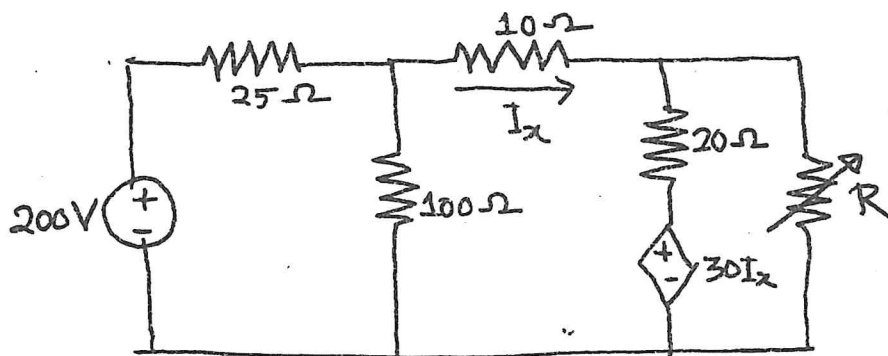


Fig for Q. 7(b)

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8. (a) Use nodal analysis technique to find  $V$  in the circuit shown in Fig. for Q. 8(a). (20)

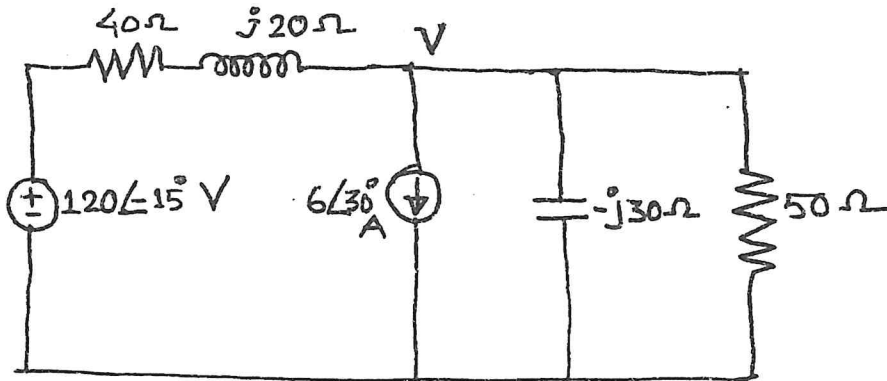


Fig. for Q. 8(a)

(b) Use the superposition principle to obtain  $v_x$  in the circuit of Fig. for Q. 8(b). Here,  $v_s = 50 \sin 2t$  V and  $i_s = 12 \cos(6t + 10^\circ)$  A.

(26<sup>2</sup>/<sub>3</sub>)

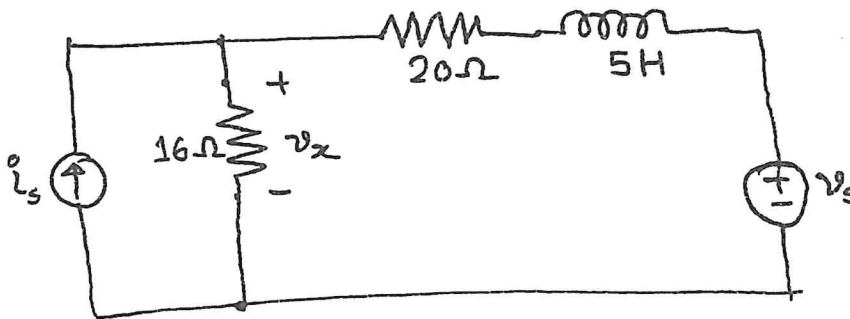


Fig. for Q. 8(b)

**Course Outcomes of EEE 167 (for IPE)**

CO No.	CO Statement
CO1	Explain the behavior of circuit operation based on the understanding of circuit elements, laws, analysis methods and theorems
CO2	Apply the fundamental laws and theorems of circuit analysis to solve electrical circuits.
CO3	Analyze the operation of electronic circuits based on the understanding of their operation principles