

**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE** questions.

Symbols and notations have their usual meanings.

1. (a) What is surveying? Briefly explain the difference between plane surveying and geodetic surveying. Mention the importance of surveying. (10)
- (b) Describe the method of calculating area of a land according to Simpson's one third rule. (10)
- (c) A survey has been conducted and the following readings are recorded: (15)

Chainage (m)	0	15	30	45	60	70	80	100	120	140
Offsets (m)	7.6	8.5	10.7	12.8	10.6	9.5	8.3	7.9	6.4	4.4

Determine the area applying any suitable method.

2. (a) Explain the permanent adjustment of a dumpy level. (10)
- (b) Define: (i) MSL, (ii) Datum, (iii) BM, (iv) Back sight (10)
- (c) The following consecutive staff readings were taken using a dumpy level: (15)
- 0.895, 1.555, 2.810, 3.015, 0.605, 0.625, 0.955, 0.255, 1.635, 0.860, 3.375
- The instrument was shifted after the fourth and the eighth readings. The first reading was taken on a bench mark whose RL is 105.505 m. Rule out a page of a level book and enter the above readings. Calculate the reduced levels of the stations by the rise and fall method and apply arithmetic checks.
3. (a) Briefly explain how the height of a transmission tower can be determined when the foot of the tower is inaccessible. (10)
- (b) Mention the important characteristics of contours. (10)
- (c) The areas within the contour line at the site of a reservoir and the face of the proposed dam are as follows: (15)

Contour (m)	101	102	103	104	105	106	107	108	109
Area (m <sup>2</sup> )	1000	12800	95200	147600	872500	1350000	1985000	2286000	2512000

Taking 101 as the bottom level and 109 as the top level, calculate the capacity of the reservoir.

**WRE 103**

4. (a) How the constants of a tacheometer can be determined? Explain. (10)
- (b) Mention different types of curves with sketches. (10)
- (c) Two straight alignments of road intersect at a chainage (300+15), the angle of intersection being 130°. If the radius of a simple circular curve introduced is 600 m, find: (15)
- (i) the tangent distance, (ii) the length of the curve, (iii) the chainages at the tangent points, (iv) the long chord, (v) the apex distance and (vi) the verse sine. Assume that the length of the chain is 30 m.

**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume any reasonable value where necessary.

5. (a) Describe with appropriate diagrams what are solstices and equinoxes. And how are they related to changes in season in northern and southern hemispheres? (10)
- (b) Explain the following terms (i) nadir (ii) zenith (iii) Polaris (iv) horizon (v) celestial sphere and (vi) Tropic of Cancer: (15)
- (c) What are the different astronomical co-ordinate systems in use? Explain with appropriate diagrams. (10)
6. (a) Briefly explain, what are (i) stereo photogrammetry (ii) eccentric camera station (iii) terrestrial photogrammetry (iv) triangulation, and (v) crabbing. (15)
- (b) An area is 30 miles long in the north-south direction and 18 miles wide in the east-west direction is to be photographed with a lens having a 15-in focal length for the purpose of compiling a topographic map. The photograph size is 10 inch by 10 inch. The average scale is to be 1:10,000 effective at an average elevation of 700 ft above sea level. Overlap is to be at least 70% and side lap is to be at 30%. The ground speed of the aircraft will be maintained at 180 mph. The flight lines are to be laid out in a north-south direction on an existing map having a scale of 1:50,000. Determine the data for the flight plan. (20)

**WRE 103**

7. (a) Briefly describe two modern survey equipments with neat diagrams. (10)

(b) A closed traverse ABCDEA was conducted around an obstacle. The lengths of the lines AB and CD are to be calculated. The lengths and bearing of the traverse are shown below: (15)

Side	Length (m)	Bearing
AB	—	N 30° 45' E
BC	280	N 86° 23' E
CD	—	S 15° 37' E
DE	400	234° 54'
EA	250	N 42° 30' W

Assume that there is no closing error. Calculate the followings:

- (i) Length of AB and CD
- (ii) Latitude and Departure of each of the 5 lines of the traverse

(c) Compare and contrast between corresponding bearing and meridians: (10)

- (i) true
- (ii) magnetic, and
- (iii) arbitrary.

8. (a) What are the objectives of sounding? (10)

(b) The following streamflow data have been collected from a river at a certain cross section. Compute the discharge and mean velocity for entire section.  $V_{0.2}$  and  $V_{0.8}$  are the point velocities measured at 0.2 and 0.8 depth of the vertical in a strip using a propeller type current meter. The velocity is measured at the middle of each strip. (25)

Distance from Left Bank (m)	Total Depth of Flow (m)	Velocity (m/s)
10	18	$V_{0.2}=0.50$
		$V_{0.8}=0.90$
36	10	$V_{0.2}=1.60$
		$V_{0.8}=1.30$
39	38	$V_{0.2}=1.60$
		$V_{0.8}=1.30$
44	36	$V_{0.2}=1.80$
		$V_{0.8}=1.50$
48	34	$V_{0.2}=1.70$
		$V_{0.8}=1.16$

-----

**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) What do you know about the Cardinalist approach and the Ordinalist (Indifference Curve) approach to utility analysis? Illustrate consumer equilibrium in these two approaches separately. (13 1/3)
- (b) Define different types of economic systems. What do you know about the main challenges that every economy struggles to overcome? (10)
  
2. (a) Define substitution effect and income effect of a price change. Graphically show the amount of substitution effect and income effect of a price rise for a normal commodity. (13 1/3)
- (b) What do you know about market demand and market equilibrium? What factors would you consider constructing a comprehensive demand function for diesel in Bangladesh? Justify your answer. (10)
  
3. (a) How would you derive the formula for measuring cross price elasticity of demand? Discuss the applications of cross price elasticity of demand in business. What are the implications of Engel's law? (13 1/3)
- (b) Given the demand function of a commodity X (10)

$$Q_{dx} = 1080 - 23P_x + 0.008 M + 8.4 P_y - 10.5 P_z$$

Where, price of X,  $P_x = \text{Tk. } 35$ , price of Y,  $P_y = \text{Tk. } 55$ , price of Z,  $P_z = \text{Tk. } 20$  and income,  $M = \text{Tk. } 60000$ . Find the cross-price elasticities and income elasticity of X. State the implications of the results you have obtained.
  
4. Write short notes on any **THREE** of the following (23 1/3)
  - (i) Marginal utility (MU) and Marginal rate of substitution (MRS)
  - (ii) Movements along and shifts in the supply curve
  - (iii) Range of values and determinants of elasticity of demand
  - (iv) Consumer surplus

**HUM 113/WRE**

**SECTION – B**

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What do you understand by MRTS? Explain increasing returns to scale, decreasing returns to scale and constant returns to scale. (10)
- (b) Complete the following table and plot the total product (TP), average product (AP) and marginal product (MP) of labour. (13 1/3)

Number of workers	Total Product (TP)	Average Product (AP)	Marginal Product (MP)
1	8		
2	24		
3	54		
4	82		
5	95		
6	100		
7	100		
8	96		

6. (a) How would you derive the short run supply curve of a firm under perfect competition? (10)
- (b) Graphically explain the long run equilibrium of a firm under perfect competition. (13 1/3)
7. (a) Define fixed cost and variable cost. From the following cost function find the AC, AVC, AFC and MC functions. Calculate the amount of output when MC and AVC will be minimum, (10)

$$C = \frac{1}{3}Q^3 - 8Q^2 + 122Q + 100$$

- (b) How would you derive the long run average cost (LAC) curve of a firm from its short run average cost curves? Explain graphically. (13 1/3)
8. (a) What are the methods of measuring national income? Explain any two methods. (10)
- (b) Explain the difficulties of measuring national income in a developing country like Bangladesh. (13 1/3)
-

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2020-2021

Sub: **MATH 133** (Matrix and Co-ordinate Geometry)

Full Marks: 210

Time: 3 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

**SECTION – A**There are **FOUR** questions in this section. Answer any **THREE** questions.

1. (a) Define Nilpotent and Idempotent matrices with proper examples. Find inverse of

$$\text{the matrix } A = \begin{pmatrix} 6 & 2 & -2 \\ 2 & 5 & 0 \\ -2 & 0 & 7 \end{pmatrix} \text{ using adjoint method.} \quad (20)$$

- (b) Two factory outlets
- $F_1$
- and
- $F_2$
- in Dhaka and Chittagong sell sofas (S), chairs (C), and tables (T) with a profit of 35 tk, 62 tk and 30 tk, respectively. Let the sales in a certain week be given by the matrix:
- (15)

$$A = \begin{matrix} & \begin{matrix} S & C & T \end{matrix} \\ \begin{pmatrix} 400 & 60 & 240 \\ 100 & 120 & 500 \end{pmatrix} & \begin{matrix} F_1 \\ F_2 \end{matrix} \end{matrix}$$

Introduce a "profit vector"  $\mathbf{P}$  such that the components of  $\mathbf{V} = \mathbf{AP}$  give the total profits of  $F_1$  and  $F_2$ .

2. (a) Write the conditions at which a system of linear equations has no solution, unique solution, and infinite number of solutions. Solve the following system of linear equations:
- (18)

$$\begin{aligned} x_1 + x_2 - x_3 &= h+1 \\ 3x_1 + x_2 - 2x_3 &= 2h+1 \\ 4x_1 + 4x_2 - 3x_3 &= 5h+8 \\ 2x_1 - x_2 + 3x_3 &= 4h+13 \end{aligned}$$

where,  $h$  is last digit of your student ID.

- (b) Define linearly independence and dependence of vectors. Find a basis for the

$$\text{column space of the matrix } \begin{bmatrix} 1 & 0 & -1 & 2 \\ 2 & 1 & 2 & 3 \\ -1 & 0 & 1 & -2 \end{bmatrix}. \quad (17)$$

MATH 133/WRESECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) Find the direction cosines and angle between two straight lines whose direction cosines  $l, m, n$  are connected by the relations  $l - 5m + 3n = 0$  and  $7l^2 + 5m^2 - 3n^2 = 0$ . (20)

- (b) If the edges of a rectangular parallelepiped are  $a, b, c$ , show that the angle between four diagonals are given by  $\cos^{-1}\left(\frac{a^2 \pm b^2 \pm c^2}{a^2 + b^2 + c^2}\right)$ . (15)

6. (a) A plane meets the coordinates axes in A, B, C such that the centroid of the triangle ABC is the point  $(p, q, r)$ ; show that the equation of the plane is  $\frac{x}{p} + \frac{y}{q} + \frac{z}{r} = 3$ . (17)

- (b) Find the equation of the plane passing through the line of intersection of the planes  $2x - y = 0$ ,  $3z - y = 0$  and perpendicular to the plane  $4x + 5y - 3z = 8$ . (18)

7. (a) Determine whether the lines  $\frac{x+1}{2} = \frac{y-2}{2} = \frac{z}{1}$  and  $\frac{x-1}{6} = \frac{y+1}{1} = \frac{z-3}{5}$  are coplanar or not. If the lines are coplanar, then find the equation of the plane in which they lie. (17)

- (b) Find the length and the equations of the shortest distance between the lines  $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$  and  $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$ . (18)

8. (a) Find the equation of the sphere which touches the sphere (18)

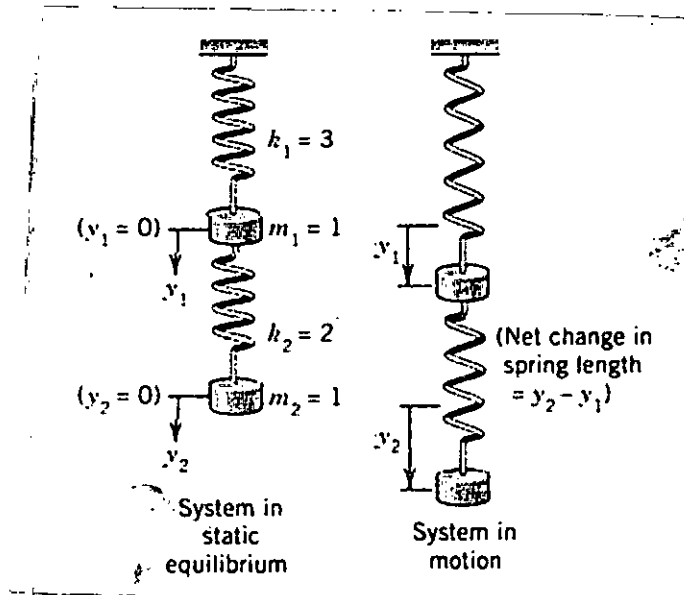
- $4(x^2 + y^2 + z^2) + 10x - 25y - 2z = 0$  at the point  $(1, 2, -2)$  and passes through the point  $(-1, 0, 0)$ . (18)

- (b) Find the equations of the tangent planes to the surface  $\frac{x^2}{4} + y^2 - 2z^2 = 1$  which are perpendicular to the line  $\frac{x}{2} = \frac{y}{3} = \frac{z}{-4}$ . (17)

**MATH 133/WRE**

3. (a) The mechanical system given below is governed by the system of ODEs, where  $y_1$  and  $y_2$  are the displacements of the masses from rest, and primes denote derivatives with respect to time  $t$ . (20)

$$\begin{aligned} y_1'' &= -3y_1 - 2(y_1 - y_2) \\ y_2'' &= -2(y_2 - y_1) \end{aligned}$$



Find the component of  $y$  i.e.  $y_1$  and  $y_2$  and describe the motion of vibration of the two masses.

- (b) State Cayley Hamilton theorem and verify it for  $A = \begin{pmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{pmatrix}$ . Also find  $A^{-2}$ . (15)

4. (a) Reduce the quadratic form  $q = x_1^2 + 2x_2^2 + 3x_3^2 + 4x_1x_2 + 10x_2x_3 + 6x_3x_1$  into the form of  $w_1^2 + w_2^2 + \dots + w_p^2 - w_{p+1}^2 - w_{p+2}^2 - \dots - w_r^2$ . Find the rank, index, and signature. Also write down the corresponding equations of linear transformation. (20)

- (b) Check whether the matrix  $A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}$  is derogatory or not. Also find the relation between the characteristic polynomial and minimal polynomial. (15)



The figures in the margin indicate full marks.

The symbols have their usual meanings.

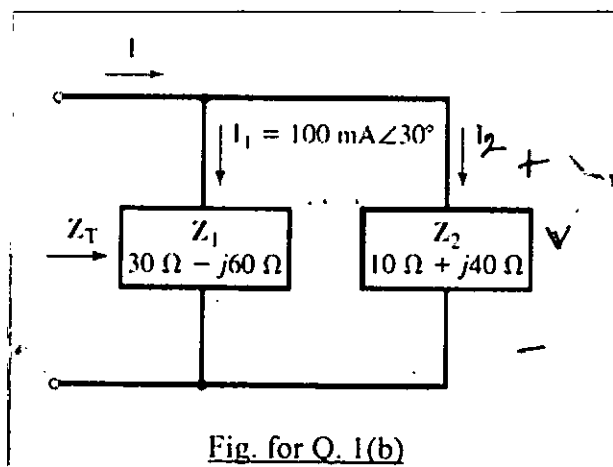
USE SEPARATE SCRIPTS FOR EACH SECTION

**SECTION – A**

There are **FOUR** questions in this section. Answer any **THREE**.

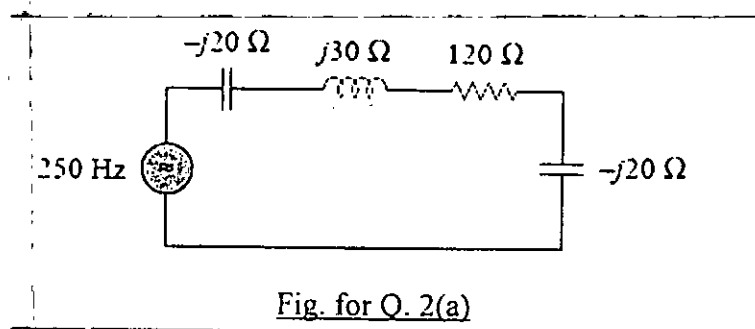
1. (a) A RL branch is connected in series with a current source,  $i(t) = I_m \sin(\omega t)$ . Derive the equation of instantaneous voltage across the source and instantaneous power supplied by the source. Also, draw the waveshapes of the instantaneous voltage and the instantaneous power. Find the average real power consumed in this circuit. (20)

- (b) Find  $Z_T$ ,  $I$ ,  $I_2$ , and  $V$  in the circuit shown in Fig. for Q. 1(b). Draw the phasor diagram of  $I$ ,  $I_1$ , and  $V$  taking  $I_2$  as reference. (15)



2. (a) A series audio circuit is shown in Fig. for Q. 2(a). (10)

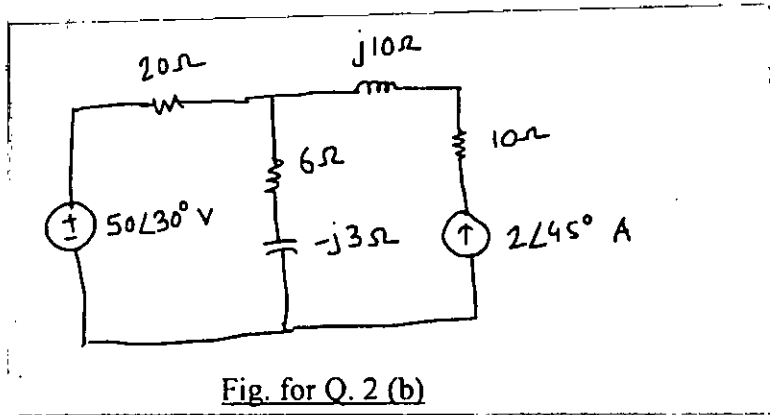
- (i) What is the impedance of the circuit?  
 (ii) If the frequency were halved, what should be the impedance of the circuit?



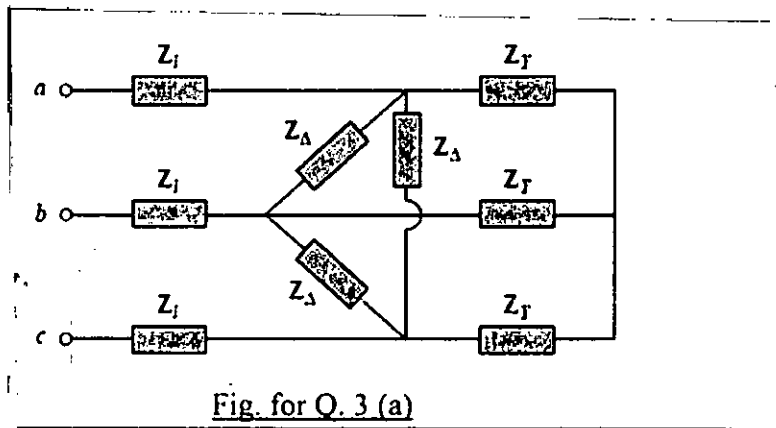
**EEE 165/WRE**

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

(b) For the circuit shown in Fig. for Q. 2(a), find (i) the real power of each component of the circuit, (ii) apparent power of the current and voltage sources, (iii) equations of instantaneous voltage across and instantaneous current through the capacitor, and (iv) rms voltage across the inductor and capacitor. (25)



3. (a) The circuit in Fig. for Q. 3(a) is excited by a balanced three-phase source with a-b-c sequence, line-to-line voltage of 120 V (rms), and line impedance,  $Z_l = 0.5 \Omega$ . Given, the loads are  $Z_\Delta = 6 - j8 \Omega$ , and  $Z_Y = 5 + j2 \Omega$ . Determine the line currents. Also, find the total power loss in the line impedances. What is the power factor of the total load? (22)



(b) A 475-V, 50-Hz, 50-hp, three-phase induction motor is drawing 60 A at 0.8 pf lagging. The stator copper losses are 2 kW, and the rotor copper losses are 600 W. The friction and windage losses are 400 W, the core losses are 2000 W, and the stray losses are negligible. Find the following quantities: (13)

- (i) Air-gap power
- (ii) Converted power
- (iii) Output power
- (iv) Efficiency of the motor

**EEE 165/WRE**

4. (a) Show the relationships (i) between primary and secondary side currents, and (ii) between primary and secondary side voltages for an ideal transformer. Draw the exact equivalent circuit of a real single-phase transformer. Describe each component in this equivalent circuit. (12)

(b) A single-phase power system consists of a 220-V 50-Hz generator supplying a load  $Z_{load} = 12 + j9 \Omega$  through a transmission line of impedance  $Z_{line} = 0.1 + j0.3 \Omega$ . (23)

- (i) If the power system is exactly as described above (and shown in Fig. for Q. 4(b)(i)), what will be the load voltage, load current; and transmission line losses?
- (ii) Suppose a 1:30 step-up transformer is placed at the generator end of the transmission line and a 30:1 step-down transformer is placed at the load end of the line (and shown in Fig. for Q. 4(b)(ii)). What will be the load voltage; load current; and transmission line losses?

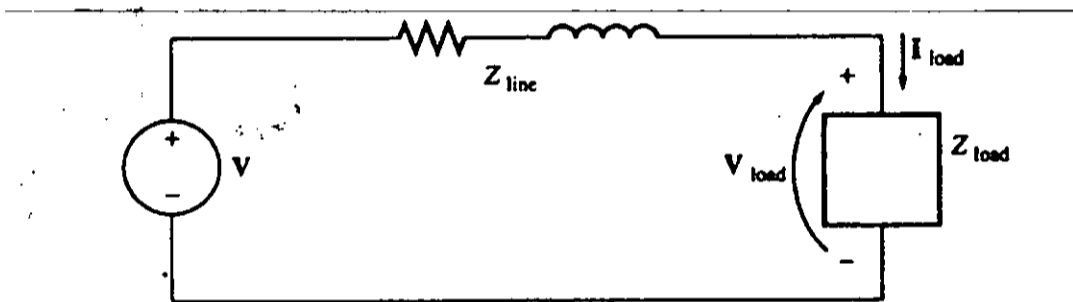


Fig. for Q. 4(b)(i)

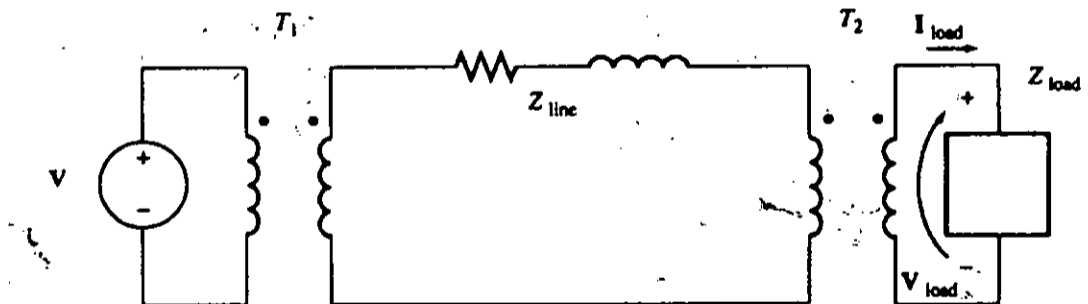


Fig. for Q. 4(b)(ii)

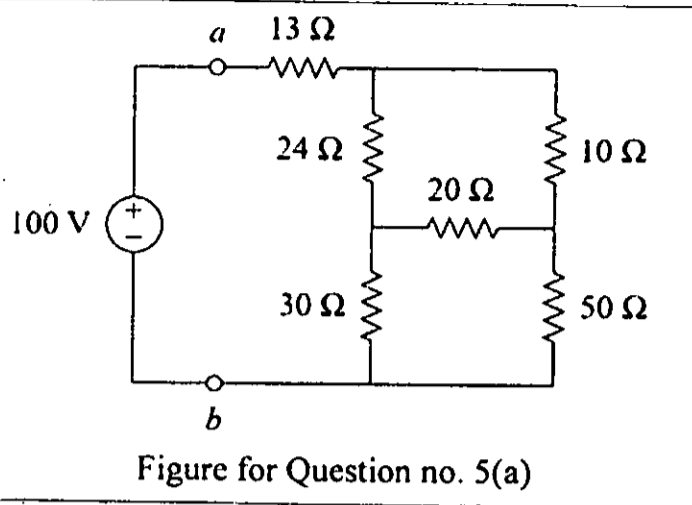
**SECTION - B**

There are **FOUR** questions in this section. Answer any **THREE**.

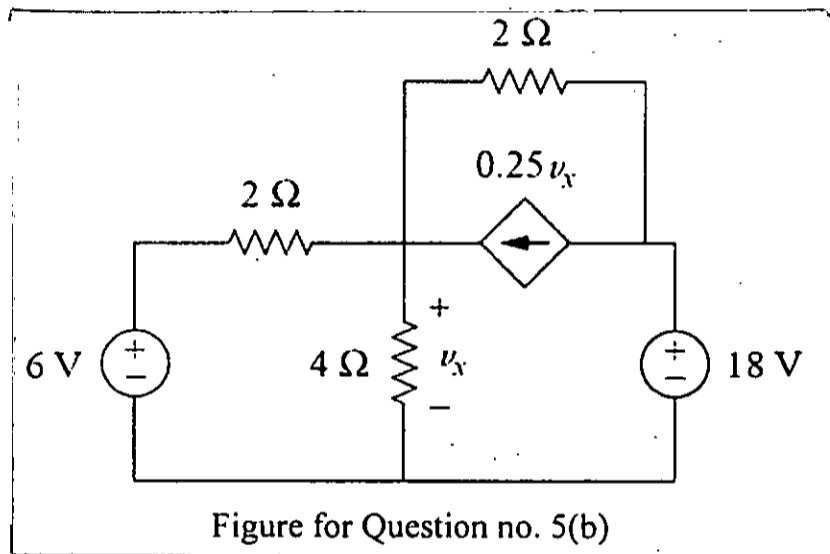
5. (a) For a circuit shown in the Fig. for Q. 5(a) below, calculate the equivalent resistance between terminals *a* and *b*. Also calculate the voltage appearing across the 13  $\Omega$  resistor in this circuit. (18)

**EEE 165/WRE**

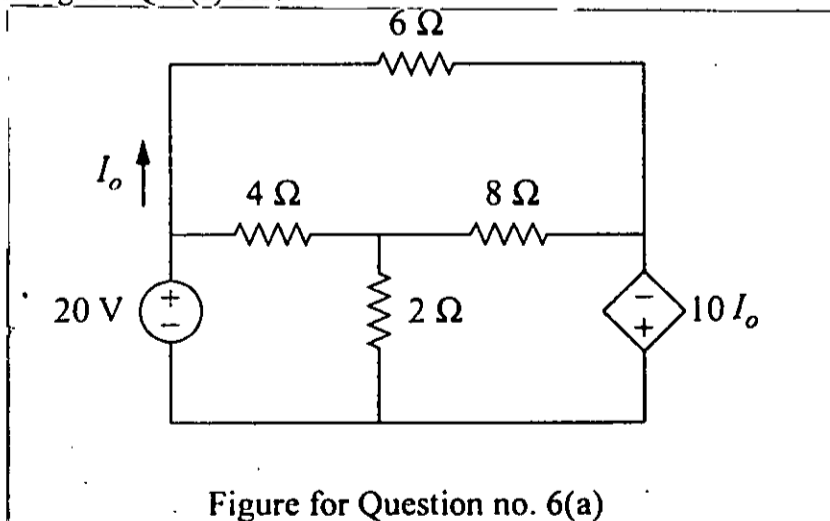
**Contd ... Q. No. 5(a)**



(b) Applying source transformation, calculate the power being consumed by the 4 Ω resistor in the following circuit of Fig. for Q. 5(b). (17)



6. (a) Using mesh analysis, calculate the power being supplied by each circuit element shown in the Fig. for Q. 6(a) below. (18)



(b) Consider the circuit shown in the Fig. for Q. 6(b) below. Based on superposition theory, calculate the power being consumed by the 8 Ω resistor. What fraction of the power consumed by this resistor is being supplied by the current source? (17)

**EEE 165/WRE**

**Contd ... Q. No. 6(b)**

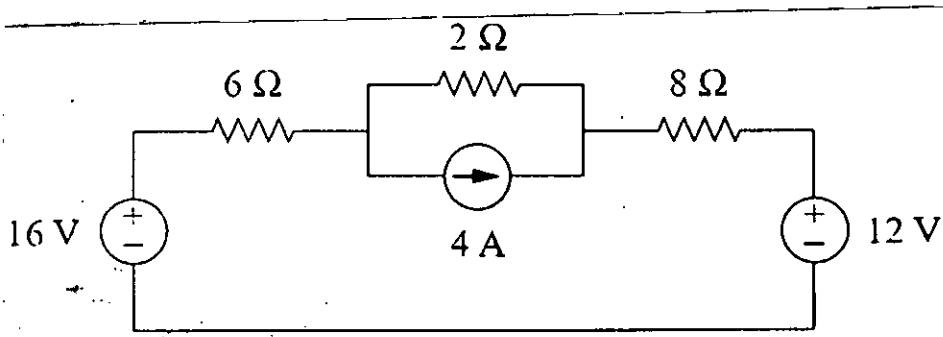


Figure for Question no. 6(b)

7. (a) Using node analysis, calculate the current  $i$  shown in the figure below. Also calculate the current flowing through the dependent current source and according to passive sign convention, comment whether this dependent source is actually supplying or consuming power.

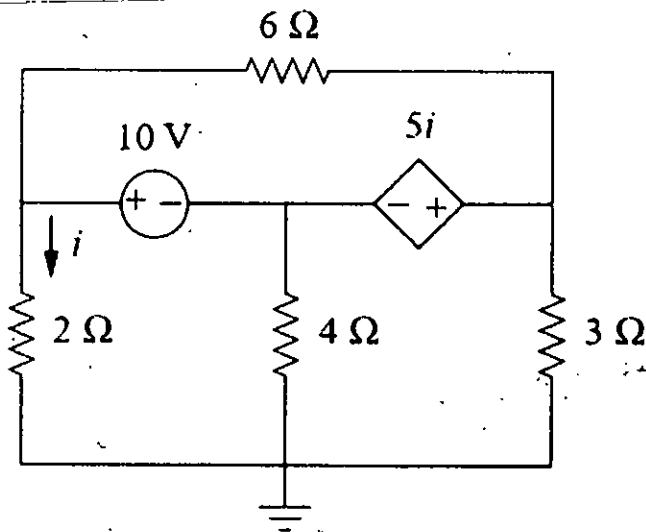


Figure for Question no. 7(a)

(18)

- (b) Calculate the Thevenin equivalent circuit between terminals  $a$  and  $b$  of the following circuit. Based on your derived circuit, calculate the power consumed by a load connected between terminals  $a$  and  $b$  when the load resistance is  $10\ \Omega$ . What will be the power consumed by the load if the load resistance is increased to  $100\ \Omega$ ?

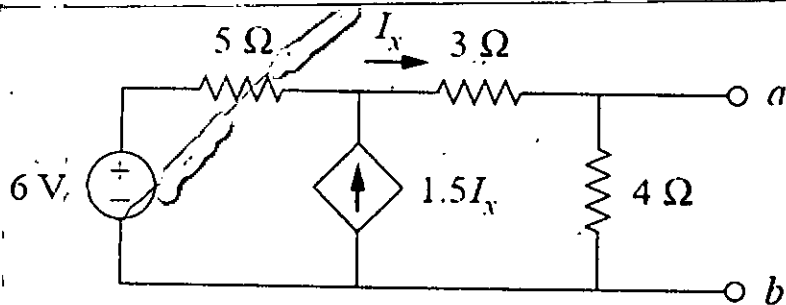
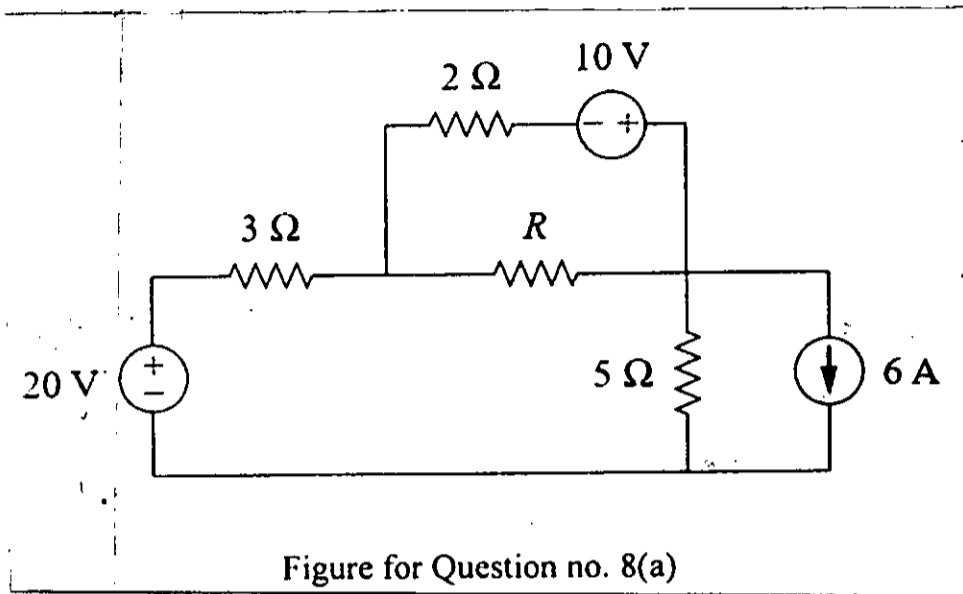


Figure for Question no. 7(b)

(17)

**EEE 165/WRE**

8. (a) Derive the expression of maximum power transfer for a DC circuit. Based on your derived expression, calculate the maximum power that can be delivered to the resistor  $R$  shown in the circuit below. What should be the value of  $R$  to receive this power? (20)



- (b) For the circuit shown in the Fig. for Q. 8(b), show that the total power being supplied by the sources is equal to the total power being consumed by the resistors. (15)

