

SECTION – A

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

1. (a) A manufacturer has a fixed cost of \$160,000 and a variable cost of \$160 per unit made and sold. Selling price is \$500 per unit. (10)
- (i) Find the revenue, cost and profit functions using q for the number of units.
- (ii) Compute profit if 150000 units are made and sold.
- (iii) Find the break-even quantity.
- (iv) Construct the break-even chart. Label the cost and revenue lines, the fixed cost line, and the break-even point.
- (b) Complete the following table and sketch the graph explaining the relations among the various short run cost curves. (13 1/3)

Quantity of output	Total fixed cost	Total variable cost	Total cost	Average fixed cost	Average variable cost	Average Total cost	Marginal cost
1	90	30					
2	90	40					
3	90	45					
4	90	55					
5	90	75					
6	90	120					

2. (a) From the following revenue and cost functions calculate the profit maximizing level of output and maximum profit. (10)

$$R = 111Q - 2Q^2$$

$$C = \frac{1}{3}Q^3 - 8Q^2 + 122Q + 50$$

- (b) Graphically explain the short run equilibrium of a firm under perfect competition. (13 1/3)

3. (a) Explain producer's equilibrium with the help of iso-cost and isoquant curves. (13 1/3)

- (b) From the following functions calculate the amount of labour and capital that maximize output. What is the maximum amount of output? (10)

$$Q = 300 L^{0.5} K^{0.05}$$

$$4000 = 30 L + 50 k$$

HUM 113(WRE)

4. (a) What do you understand by localization of industries? What are the causes of localization of industries? (10)
- (b) Explain the advantages and disadvantages of localization of industries. (13 1/3)

SECTION – B

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

5. (a) Explain the concept of demand function. (3)
- (b) Discuss the various factors that affect the demand for a commodity in general. (7 1/3)
- (c) What is meant by market demand for a commodity? Explain graphically. (8)
- (d) What are the exceptions to the downward sloping demand curve? Discuss. (5)
6. (a) How is price determined in an economy under competition? Explain graphically. (5)
- (b) Calculate the equilibrium price and quantity from the following demand and supply functions and graphically show the results.
- $$QD_x = 50 - 3P_x$$
- $$QS_x = -30 + 5P_x$$
- What will happen to the equilibrium price and quantity if Government imposes a tax of Tk. 2 per unit? Graphically show the results. (10)
- (c) Explain in detail the concept of price elasticity of demand. (5)
- (d) Discuss how the state of technology affects the supply of a commodity. (3 1/3)
7. (a) Distinguish between the concepts of total utility and marginal utility. Explain graphically. (5)
- (b) Starting with a utility function $U = f(A, B)$, where A and B refer, respectively, to the quantities of commodities A and B and assuming a budget constraint derive the expressions for consumer equilibrium using calculus. (10)
- (c) Discuss the various properties of indifference curve. (8 1/3)
8. (a) How does production Possibility Frontier of a country indicate efficient resource allocation? Explain. (13 1/3)
- (b) Explain three applications of production possibility frontier. (10)
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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

Sub : **PHY 153** (Structure of Matter, Electricity and Magnetism and Modern Physics)

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) What is an electric dipole? Find an expression of electric field in terms of electric dipole moment at a point on the perpendicular bisector of an electric dipole. (15)
- (b) Show that the electric field at a point between two similarly but oppositely charged plates is constant but zero outside the plates. (10)
- (c) The length of an electric dipole is 16 cm and strength of charge is $15 \mu\text{C}$. Calculate the electric dipole moment and find the electric field intensity at a point on the axis of dipole at a distance of 16 cm from centre. (10)
2. (a) State and explain Ampere's law. (7)
- (b) Find magnetic field due to a long current carrying conductor using both the Biot-Savart law and Ampere's law. (18)
- (c) A solenoid has a mean diameter of 0.03 m and length 2 m. It has four layers of 1000 turns each. Calculate the magnetic flux density at its centre when a current of 2.5 A flows through it. Also calculate the flux at the centre. (10)
3. (a) Explain the terms self-inductance and mutual inductance. (6)
- (b) A circuit containing an inductance L and a resistance R placed in series with a cell of emf E. Derive an expression for current in the circuit. What will be the expression of current if L is replaced by a capacitance C. (19)
- (c) The current in a circuit changes from 15 A to zero in 2 ms. If the average induced emf is 150 V, what is the coefficient of self-inductance of the circuit? How much energy was initially stored in the magnetic field of the inductor? (10)
4. (a) Establish a relation between Miller indices and interplanar spacing for a crystal system in which the crystallographic axes (X, Y and Z) are mutually perpendicular to each other. Modify the established relation for a cubic crystal. (15)
- (b) Find the interplanar distances for the crystal planes of Miller indices (113) and (012) of a cubic lattice with the lattice constant 4.89 \AA . (6)
- (c) Write short note on covalent bond in solid. Why covalent solids show directional behaviour during the formation of bonds? What is the effect of such a directional behaviour? (14)

PHY 153(WRE)

SECTION – B

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

5. (a) Define atomic packing factor of a crystal and write down its physical significance. Compare the atomic packing factors of a simple cubic, a body centered cubic and a face centered cubic crystals. (15)
- (b) Describe cesium chloride (CsCl) structure with necessary diagram. Why CsCl structure is defined to be simple cubic structure? (10)
- (c) Calculate the ionic packing factor of CsCl structure considering the ionic radii of Cs^+ and Cl^- ions as 0.167 nm and 0.181 nm, respectively. Why does it differ from that of a standard simple cubic crystal? (10)
6. (a) What are the properties of X-rays that make it useful for analyzing the structure of a solid? Can visible light be used for analyzing a crystal structure? -Justify your answer. Write down Bragg's law of X-ray diffraction and identify each term. (15)
- (b) Determine the angle through which an X-ray beam of wavelength 1.35 Å undergone 3rd order reflection from the (311) plane of a crystal. Consider the interplanar spacing between two (311) parallel planes is 3.71 Å. (5)
- (c) What does crystal defect mean? Give an example of increase of electrical conductivity of a crystalline material by creating defect. Discuss point defects in crystal. (15)
7. (a) Briefly describe the nature of the nuclear force. (10)
- (b) Describe the various components of a nuclear reactor with schematic diagram. (16)
- (c) Suppose you need 200 kWh electric power per month for your house. How long you can use the energy produced in fission process from 100 gm of uranium ${}^{235}_{92}\text{U}$. Given, one uranium atom releases 200 MeV energy during nuclear fission. (9)
8. (a) What are the differences between inertial and non-inertial frame of references? (6)
- (b) Describe Michelson-Morley experiment and explain the physical significance of the negative result. (20)
- (c) Show that the momentum of a particle at rest mass m_0 and kinetic energy k_E is given by the expression (9)

$$P = \sqrt{\frac{k_E^2}{c^2} + 2m_0k_E}$$

where, c is the velocity of light.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2 B. Sc. Engineering Examinations 2015-2016

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

Full Marks : 210

Time : 3 Hours

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Find the adjoint of the matrix $A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 2 & -3 \\ 2 & -1 & 3 \end{bmatrix}$ and show that $A(\text{adj.}A) = |A|I_3$. (13)

(b) Prove that the matrix $A = \frac{1}{6} \begin{bmatrix} 3 & 3 & 3 & 3 \\ 3 & -5 & 1 & 1 \\ 3 & 1 & 1 & -5 \\ 3 & 1 & -5 & 1 \end{bmatrix}$ is orthogonal. (12)

(c) If A, B, and C are matrices such that the product AC and BC obey the commutative law, prove that $(AB + BA)C = C(AB + BA)$. (10)

2. (a) Find the inverse of the matrix A to reduce to I (using only elementary row transformation): (20)

$$A = \begin{bmatrix} 1 & 2 & -2 & -1 \\ -1 & -4 & 4 & 0 \\ 2 & -7 & 4 & -7 \\ 1 & 6 & -5 & 1 \end{bmatrix}$$

(b) Find the rank and nullity of the matrix A when (15)

$$A = \begin{bmatrix} 2 & 2 & 0 & 4 & 0 & 4 \\ 0 & 2 & 4 & 4 & 0 & 2 \\ 1 & 1 & 6 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 1 & -2 & 3 & 0 & 2 \end{bmatrix}$$

3. (a) Test whether the following equations are consistent. If found consistent, find the solution: (17)

$$\begin{aligned} x + y + z + t &= 4 \\ 2x - y - z + 3t &= 6 \\ 3x + 4y - 5z + 6t &= -11 \\ 7x - 5y + 7z + t &= 46 \end{aligned}$$

= 2 =

MATH 133(WRE)

Contd ... Q. No. 3

(b) State Cayley-Hamilton theorem. Verify Cayley-Hamilton theorem for the matrix A and using this theorem find A^{-1} :

(18)

$$A = \begin{bmatrix} 1 & 2 & 2 \\ 3 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

4. (a) Reduce the quadratic form q to canonical form and hence find rank, index and signature of q . Also write down the corresponding equations of transformation:

(17)

$$q = x_1^2 + 5x_3^2 + 8x_2x_3 + 6x_3x_1 + 4x_1x_2.$$

(b) Find all eigen values, eigen vectors and corresponding eigen spaces of the matrix A where:

(18)

$$A = \begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -4 & -3 \end{bmatrix}$$

SECTION - B

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

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

(18)

(b) If $l_1, m_1, n_1; l_2, m_2, n_2$ are the direction cosines of two mutually perpendicular lines, show that the cosines of the line perpendicular to them both are

$$m_1n_2 - m_2n_1, n_1l_2 - n_2l_1, l_1m_2 - l_2m_1.$$

(17)

6. (a) Through the point P(-1, 1, 2) a line is drawn parallel to the line of intersection of the planes $x - 2y + z = 3$ and $x + 6y - 5z = 0$. This line cuts the plane $x - 3y + 2z = 3$ in Q.

Find the equation of the line PQ and their coordinates.

(18)

(b) A variable plane is at a constant distance p from the origin O and meets the axes in A, B and C. Show that the locus of the centroid of the tetrahedron OABC.

(17)

$$x^{-2} + y^{-2} + z^{-2} = 16p^{-2}$$

7. (a) Show that 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. Also find

their point of intersection and the equation of the plane containing them.

(18)

Contd P/3

MATH 133(WRE)

Contd ... Q. No. 7

(b) Find the magnitude and the equation of the line of shortest distance between the two

lines $\frac{x-3}{2} = \frac{y+15}{-7} = \frac{z-9}{5}$, $\frac{x+1}{2} = \frac{y-1}{1} = \frac{z-9}{-3}$. Also find the points of intersection. (17)

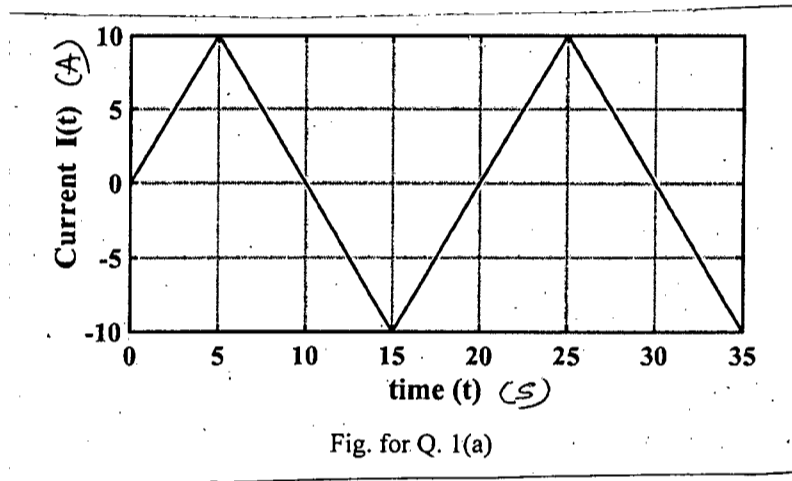
8. (a) Show that the plane $3x+12y-6z=17$ touches the conicoid $3x^2+6y^2+9z^2+17=0$ and hence find the point of contact. (18)

(b) Find the equation of the sphere which passes through the circle $x^2+y^2+z^2-2x+2y+4z-3=0$, $2x+y+z-4=0$ and touches the plane $3x+4y-14=0$. (17)

SECTION - A

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

1. (a) For the graph shown in Fig. for Q. 1(a), calculate the effective value of the current waveform and the average power delivered to a 12Ω resistor when this current run through the resistor. (10)

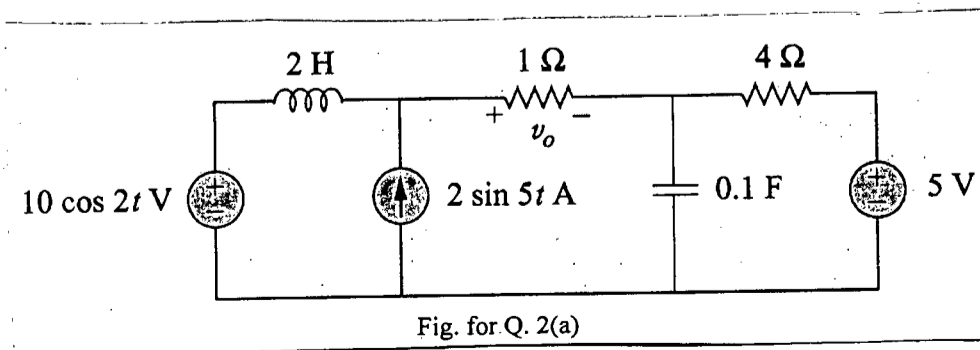


- (b) A Y-connected balanced three-phase generator with an impedance of $0.4 + j0.3 \Omega$ per phase is connected to a Y-connected load with an impedance of $24 + j19 \Omega$ per phase. The line joining the generator and the load has an impedance of $0.6 + j0.7 \Omega$ per phase. Assume that, $V_{an} = 120 \angle 30^\circ$ and source voltages are in positive sequence. Find (i) the line voltages (ii) line currents and also draw the corresponding phasor diagram. (iii) Determine the total real power delivered to the load. (15)

- (c) Using the phasor approach, find the voltage $v(t)$ in a circuit describe by the following equation: (10)

$$2 \frac{dv}{dt} + 5v + 10 \int v dt = 20 \cos(5t - 30^\circ)$$

2. (a) For the circuit shown in Fig. for Q. 2(a), find v_0 . (20)



EEE 165(WRE)

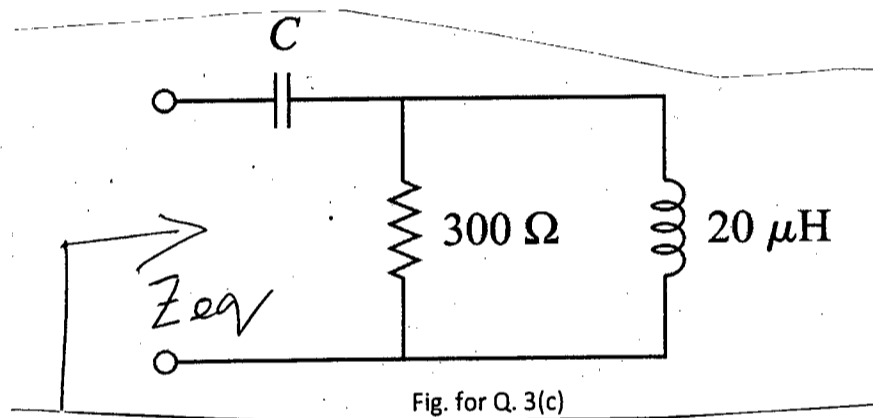
Contd ... Q. No. 2

(b) Stating the differences between an ideal transformer and a real transformer, derive the approximate equivalent of a real transformer. (15)

3. (a) Find the value of parallel capacitance needed to correct a load of 140 KVR at 0.85 lagging power factor to unity power factor. Assume that the load is supplied by a 220 V (rms), 50-Hz line. Also, draw a power triangle illustrating the corresponding power factor correction. (12)

(b) Find the phase angle between $v_1 = -4 \sin(377t + 25^\circ)$ and $v_2 = \cos(377t - 40^\circ)$ and determine which voltage waveform leads. (8)

(c) Consider the circuit shown in Fig. for Q. 3(c). Find the value of the capacitor C (for operating the circuit at 10 MHz) so that equivalent impedance (z_{eq}) is resistive. (15)



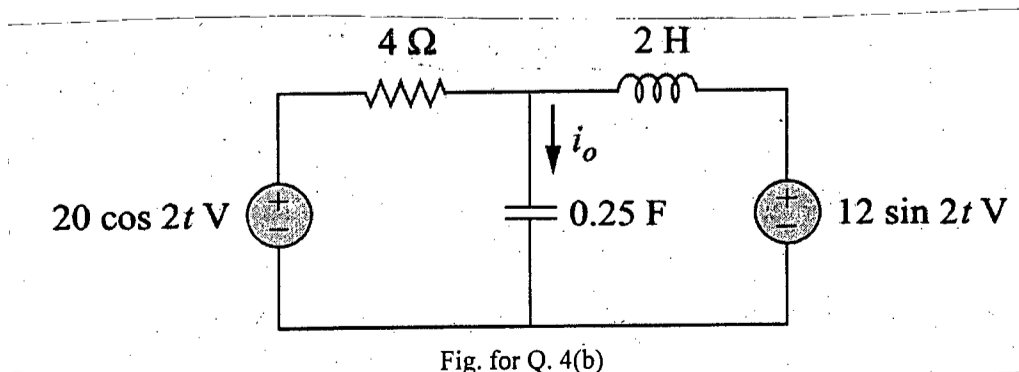
4. (a) Open circuit test and short circuit test data for a 15 KVA, 2300/230-V transformer are given in Table for Q. 4(a). (20)

Open Circuit Test	Short Circuit Test
$V_{oc} = 2300 V$	$V_{sc} = 47 V$
$I_{oc} = 0.21 A$	$I_{sc} = 6 A$
$P_{oc} = 50 W$	$P_{sc} = 160 W$

(i) Calculate the full load voltage regulation at 0.8 leading power factor.

(ii) Find the efficiency of the transformer at full load with a power factor of 0.8 lagging.

(b) Find i_0 for the circuit shown in Fig. for Q. 4(b). (15)



EEE 165(WRE)

SECTION - B

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

Symbols have their usual meaning. Assume values if required.

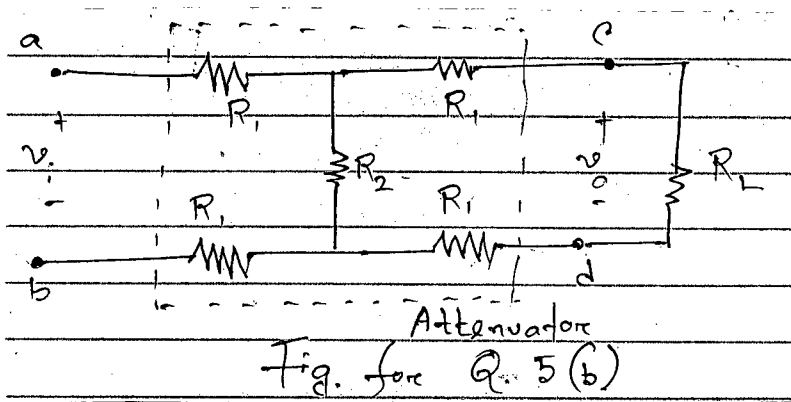
5. (a) Starting from basic principles, show that the expressions for Δ conductances as functions of three Y conductance are-

(20)

$$G_a = \frac{G_2 G_3}{G_1 + G_2 + G_3}, G_b = \frac{G_1 G_3}{G_1 + G_2 + G_3}, G_c = \frac{G_1 G_2}{G_1 + G_2 + G_3}$$

- (b) A typical fixed resistance attenuator pad is shown in Fig. for Q. 5(b).

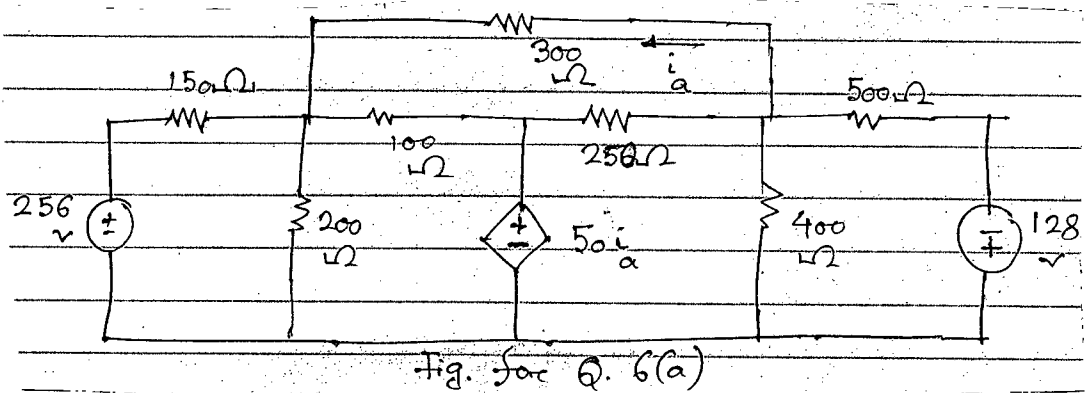
(15)



Find R_1 and R_2 so that $R_{ab} = R_L = 600 \Omega$

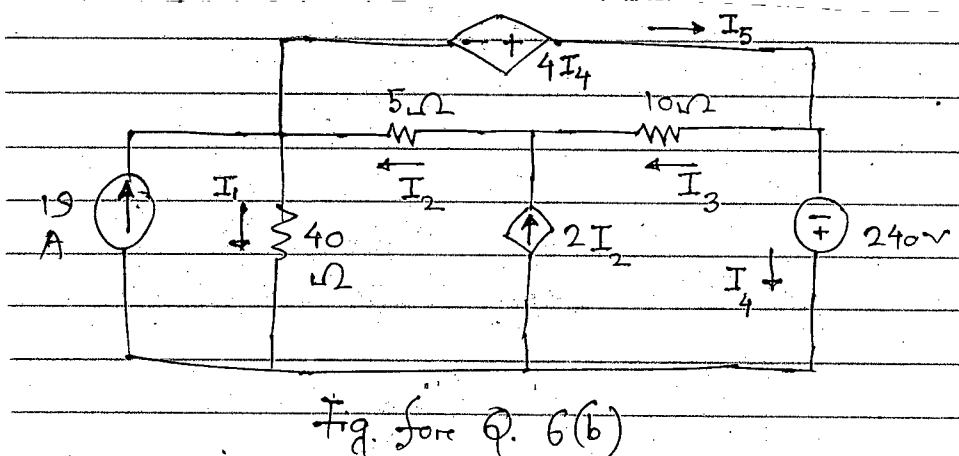
6. (a) Find the power dissipated in the 300Ω resistor in the circuit of Fig. for Q. 6(a) using nodal analysis:

(18)



- (b) Using mesh analysis calculate branch currents I_1 to I_5 in the circuit of Fig. for Q 6(b).

(17)

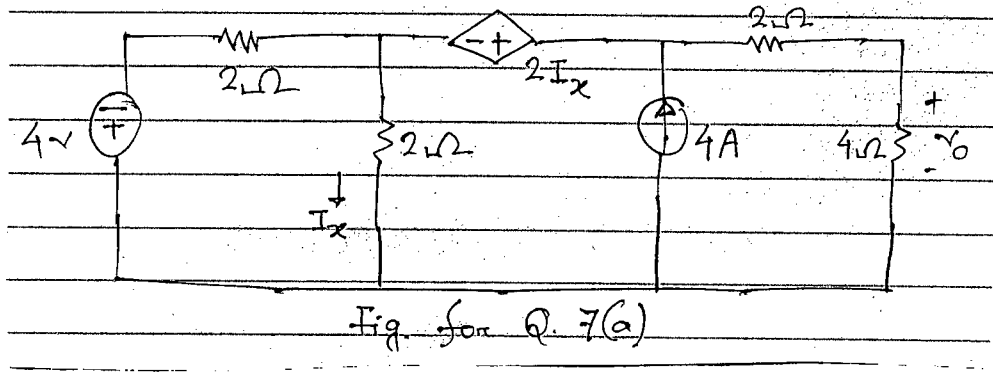


EEE 165(WRE)

7. (a) Find the value of v_0 using Thevenin's theorem for the circuit shown in Fig. for Q.

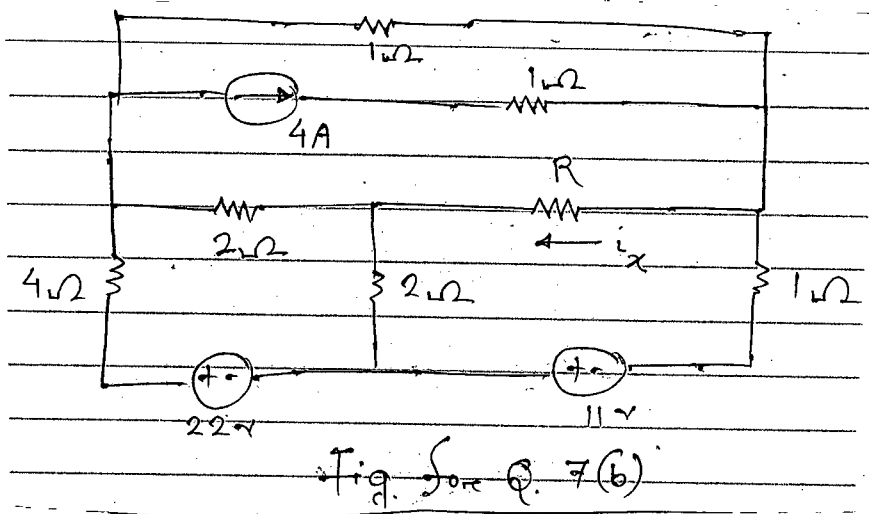
7(a).

(17)



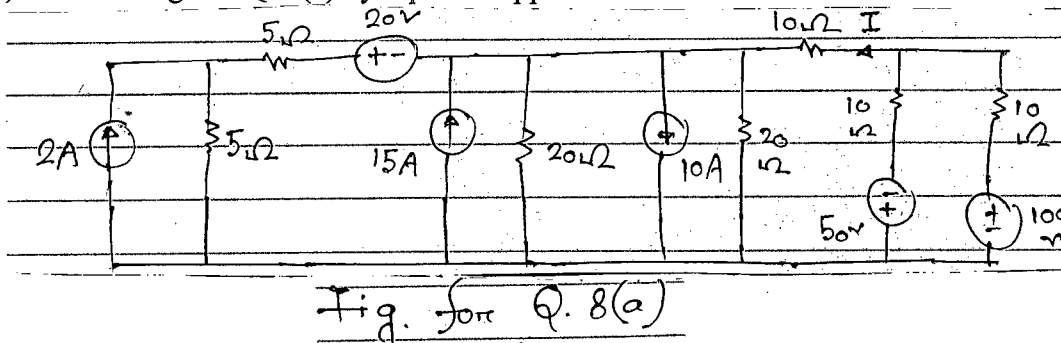
(b) For the circuit shown in Fig. for Q. 7(b), use Norton's theorem to find the value of R which will result in $i_x = 1A$.

(18)



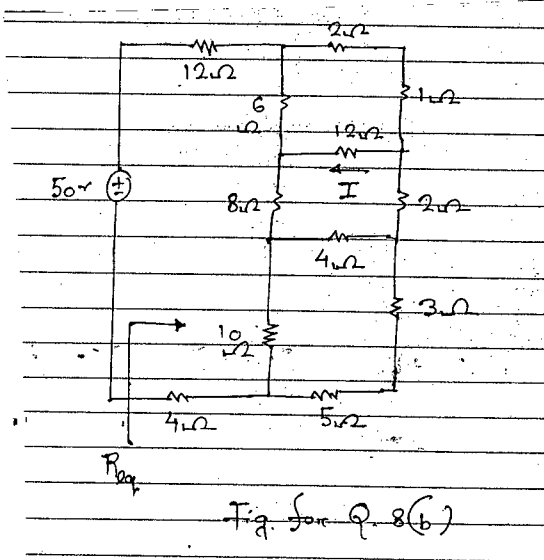
8. (a) Find I in Fig. for Q. 8(a) by repeated application of the source transformation.

(15)



(b) Find R_{eq} and I in Fig. for Q. 8(b).

(20)



SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Differentiate between “Plane Table” and “Geodetic” surveying. (5)
- (b) With the help of a figure, show that for an optical square to perform its function, two internal mirrors are to be placed at an angle of 45° . (12)
- (c) It is proposed to widen a highway by increasing the gradient of the side slope to 1 in 1.5. The difference in level between the bottom and top of the embankment at a critical section was measured as 15.0 m. The length of the embankment along the side slope was measured as 29.872 m using a steel tape under a pull of 151 N at a temperature of 27°C . Determine the additional road width which will be available with the new slope. The tape was standardized on the flat at 18°C under a pull of 47 N. The cross-sectional area of the tape is 6.5 mm^2 . $E = 20.8 \times 10^4 \text{ MN/m}^2$ and $\alpha = 1.1 \times 10^{-5} \text{ per } ^\circ\text{C}$. (17 $\frac{2}{3}$)
- (d) The contour diagram of the bottom of a circular pond is given in figure 1. All contours are circular in shape. Determine the volume of water the pond can hold. (12)

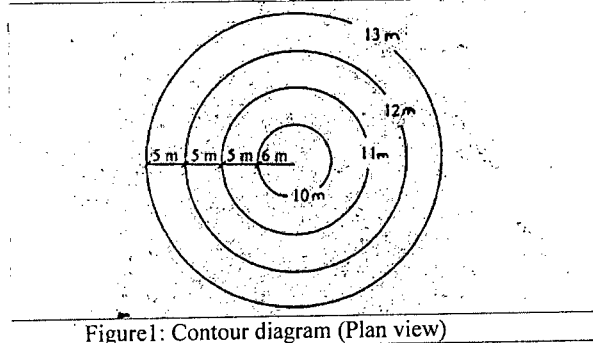


Figure 1: Contour diagram (Plan view)

2. (a) Make a list of various methods of plotting a traverse. Define closing error and how this error can be adjusted? (2+10)
- (b) The bearings of two inaccessible stations A and B, taken from station C, were 220° and $148^\circ 30'$ respectively. The coordinates of A and B were as below: (18 $\frac{2}{3}$)

Station	Easting	Northing
A	180	120
B	240	90

Calculate the independent coordinates of C.

- (c) A Dumpy Level was placed at the mid point C of A and B which were 200 ft apart. The staff readings at A and B are 2.5 ft. and 4.6 ft. The instrument was then shifted and placed midway between A and C. The reading at A and B were 3.2 ft and 5.6 ft respectively. (i) Is the line of collimation adjusted? (ii) If not is it inclined upward/downward? (iii) What should be the staff reading at A and B when the level is adjusted? (16)

WRE 103

3. (a) For the following natural features, what would be the contour map? (i) Overhanging Cliff (ii) Ridge line (iii) river (iv) vertical cliff (8)
- (b) Derive the distance and elevation formula for inclined sights with staff remain vertical, provided that the ground point has a vertical depression angle. (15)
- (c) A tachometer is set up at an intermediate point on a traverse course PQ and the following observations are made on a vertically held staff: (16²/₃)

Staff station	Vertical angle	Staff intercept	Axial hair readings
P	+8°36'	2.350	2.105
Q	+6°6'	2.055	1.895

The instrument is fitted with an anallatic lens and the constant is 100. Compute the length of PQ and reduced level of Q, that of P being 321.50 m.

- (d) Define "DISTOMAT". How can you calculate area of a closed traverse by total station? (2+5=7)
4. (a) What are the requirements in Remote Sensing process? Briefly explain the working procedure of GPS System. (4+6=10)
- (b) Define the following terms: (2×5=10)
- (i) Change point
 - (ii) Quadrantal Bearing
 - (iii) Independent Coordinate
 - (iv) Horizontal equivalent
 - (v) Target staff

(c) P, Q and R stations are on a straight level line of bearing 160°15'48". The distance PQ and QR are measured as 516.2 m and 358.68 m respectively. For taking these measurement, height of instrument was constant having a value of 1.4 m and the vertical angles to an inaccessible station, A, were measured successively as: (16²/₃)

At P : 6°15'45"

At Q : 15°10'7"

At R : 16°13'25"

Calculate : (i) The higher of station A above the line PQR (ii) The bearing of the line PA (iii) The horizontal distance between P and A.

- (d) A surveyor aims to survey BUET campus (Figure 2). While continuing a survey line BA, he came across 'Civil Engineering Building', so prolonging the line beyond the obstacle is impossible. Find the length of civil building (MN). Given: DC = CB; DF = FE, FG = CA and DB = DE (10)

WRE 103

SECTION – B

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

5. (a) Write down five major purposes of hydrographic surveying. (4)
- (b) Write short note on (i) Shoreline survey (ii) Sounding machine (iii) Sounding lead and lead line (iv) Measurement and calibration of velocity. (4×4=16)
- (c) Briefly discuss the principle of Eco-sounding. Differentiate the operational principle of float gauge and bubble gauge recorder. (5+6=11)
- (d) The followings are data obtained in a stream gauging operation in which current meter with a calibration equation, $v = 0.32N + 0.032$ m/s where N = number of revolutions per seconds. Using the area-velocity method calculate the mean discharge, mean velocity and the total cross sectional area. (15 $\frac{2}{3}$)

Distance from right bank (m)	0	4	9	15	20	23	25
Depth (m)	0	1.1	2.25	1.75	1.5	0.75	0
No. of revolutions	0	83	139	114	92	70	0
Time (sec)	0	120	120	120	120	150	0

6. (a) Differentiate the summit curve and sag curve with sketches. Discuss the characteristics of an easement curve. Explain the field operation of Two Theodolite Method. (4+4+5=13)
- (b) Two roadways meet at an angle of 110°. It is proposed to insert a circular curve of 6 chains radius with transition curve at the ends. The super elevation is 14 cm, the rate of attainment of super elevation by the vehicle is 2 cm/s and the vehicle speed is 50 km/hr. Calculate the data to set out the combined curve (full of one transition curve and half of the circular curve) by deflection angle method. Chainage at the point of intersection is 10+25 and length of the chain is 30 m. Take the interval, x as equal to half of a chain length for the transition curve. (18)
- (c) Calculate the offsets to set out a vertical curve which connects an upgrade of 1% and downgrade of 0.5%. Chainage at the point of intersection is 600 m and the R.L at the point of intersection is 65 m. Take the rate of change of grade as 0.1% per chain of 30 m length. Take the interval as 30 m for calculation of offsets. (15 $\frac{2}{3}$)
7. (a) List down the factors to be considered in selecting the camera stations and the base lines. (6)
- (b) Discuss the operations involved in aerial photogrammetry. (9)
- (c) An area 100 km long in the north-south direction and 50 km in the east-west direction is to be photographed with a lens having 21 cm focal length for the purpose of compiling a topographic map. The size of photograph is 18 cm × 18 cm.

WRE 103

Contd ... Q. No. 7(c)

The average scale is to be 1 : 20000 at an average ground surface elevation of 500 m above mean sea level. Overlap is to be at least 60% and sidelap is to be 20%. The ground speed of the aircraft will be maintained as 300 km/hr. Determine (i) Flight height (ii) No. of flights required (iii) Actual ground distance between flight lines (iv) Exposure interval (v) Total number of photographs.

(18)

(d) Calculate the time at New York (Longitude 74°10' W) when it is 8.00 P.M. at Dublin (Longitude 6°20' W). Differentiate between the following with figures:

(7 2/3 + 6)

(i) Celestial and Terrestrial equator (ii) Zenith and Nadir (iii) Latitude and Longitude

8. (a) Discuss the methods of calculation of area from map measurements. Derive the expression of two level section for the measurement of volume.

(6+10=16)

(b) The following perpendicular offsets were taken from a chain line to a hedge:

(14 2/3)

Chainage (m)	0	15	30	60	90	100	120
Offset (m)	7.6	8.0	10.1	12.0	7.5	7.9	6.4

Calculate the area between the survey line, the hedge and the end offsets using trapezoidal rule and Simpson's rule. Comment on the difference of the results obtained from these two methods.

(c) A plane of a pit excavated for roadwork is shown in Figure 3. Length AB = 25 m, BC = 30 m and DE = 28 m. Calculate the volume of excavation in cubic meter from the following data.

(16)

Point	A	B	C	D	E
Original Level (m)	45.2	49	52	47.7	51.8
Final level (m)	38.4	40.3	43.6	42.3	44.1

