ELECTRICAL SCIENCE ASSIGNMENT 01

DC CIRCUITS

Q1) Find the resistance at 20 °C of the following annealed standard copper wires:-

a) 1 mm^2 cross section and 10 m long.
b) 25 mm^2 cross section, 200 mm long. [(a) 0.173 Ω; (b) 0.138 Ω]

Q2) Determine the resistance of a metal tube in terms of the external diameter D, the internal diameter d, the length l and the resistivity ρ. Calculate the resistance of a copper tube 0.5 cm thick and 2m long. The external diameter is 10 cm.

[23.14 μΩ]

Q3) Calculate the loss in watts per kg of a current carrying conductor in terms of the resistivity ρ μ-cm, the current density σ A per mm^2 and specific gravity S.

[10 σ^2 ρ/S]

Q4) Determine the length l and diameter d of a cylinder of copper in terms of the volume, x; resistivity, ρ; and the resistance between opposite ends r.

[l= (rx/ρ) ^ (1/2); d= (16xρ/πr^2)^(1/4)]

Q5) The insulation resistance of a single core cable is connected in series with a voltmeter across a 480 V supply. The voltmeter reads 5V. When connected in series with a 50,000 Ω resistor across 240 mains, the voltmeter reading is 90V. Calculate the value of the insulation resistance. [2.85 MΩ]

Q6) The resistance temperature coefficient of phosphor bronze is 39.4*(10^(-4)) per 1°C at 0°C. Find the coefficient for a temperature of a) 20°C ; b)100°C [(a) 36.5*(10^(-4)) ; (b) 28.2*(10^(-4))]

Q7) Calculate the capacitance of an air insulated capacitor with 13 plates each 10 cm^2, the distance between plates being 2 mm. [530 pF]

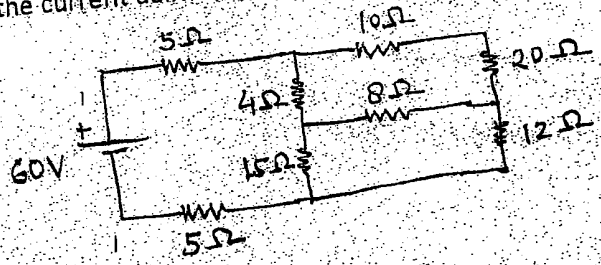
Q8)Find the equation to the voltage to be applied to a 50μF capacitor initially uncharged to produce a steady current of 10 mA. If the charging ceases after 10 s, calculate : a) the capacitor voltage b) the charge, c) stored energy. [(a) 2000 V, (b)0.1 C, (c)100 J]

Q9) Calculate for approximate resistance and inductance of a solenoid of mean diameter 1 cm, 1 m long, wound with thousand turns of a copper wire 0.5 mm in diameter. What potential difference exists at the terminals of the solenoid at the instant when the current is 1 A and increasing at the rate of 10,000 A/sec. [2.76 Ω ; 0.0987 mH, 3.75 V]

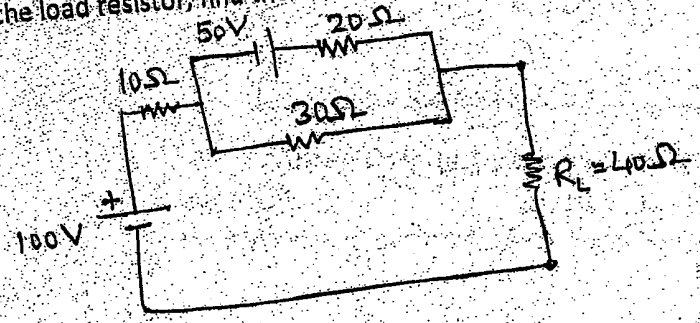
Q10) A circuit has thousand turns enclosing a magnetic circuit 20 m^2 in section. With 4 A the flux density is one Wb/m^2 and with 9 A it is 1.4 Wb/m^2. Find the mean value of the inductance between these current limits and the induced electromotive force if the current fell uniformly form 9 A to 4 A in 0.05 sec. [0.16H; 16 V]

ASSIGNMENT 2

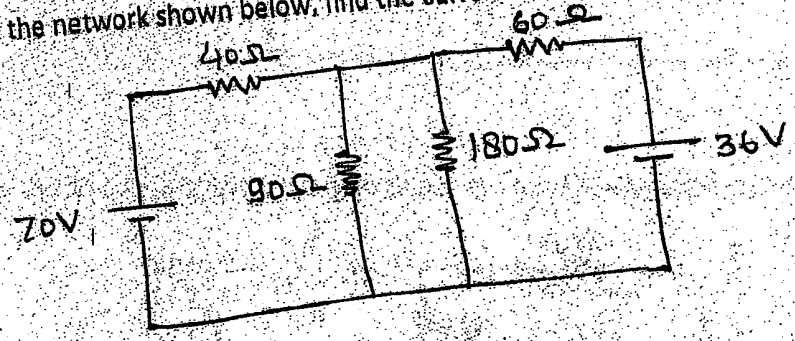
1) Find the current delivered by the battery



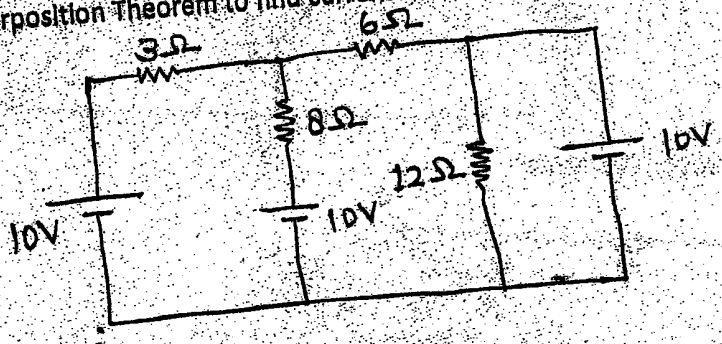
2) Assuming R_L is the load resistor, find the Thevenin equivalent circuit



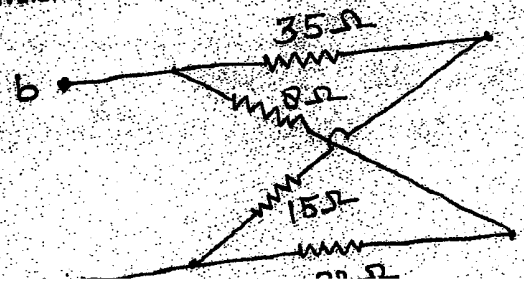
3) In the network shown below, find the current through 90Ω resistor



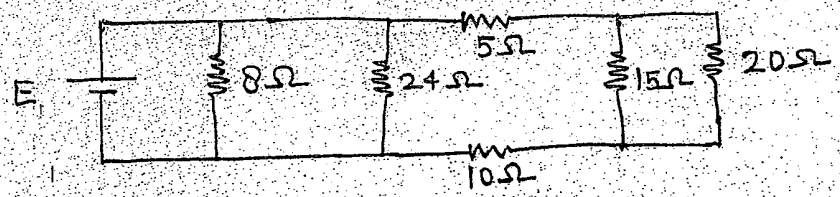
4) Using Superposition Theorem to find current which flows in each resistor of the circuit



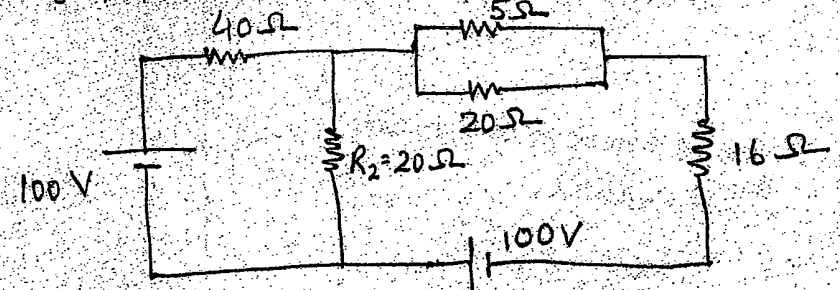
5) Find the equivalent resistor between the terminals ab, where all the resistor values are given in Ω.



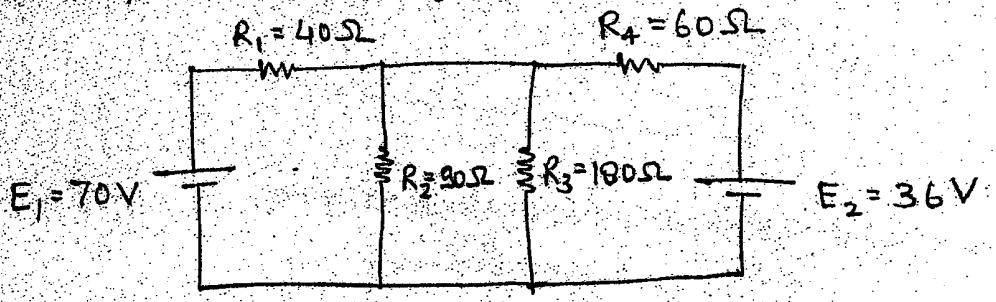
6) Find the value of E which permits a dissipation of 180W in the 20Ω resistor.



7) Using Superposition theorem, find the current flowing in R_2 = 20Ω.



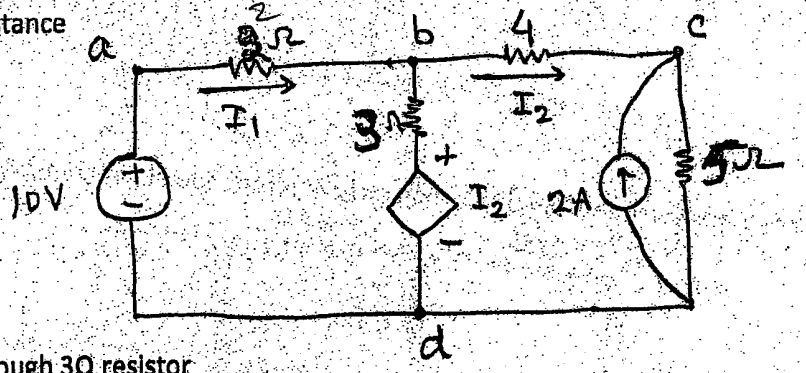
8) Using Nodal analysis find the current through 90 Ω resistor.



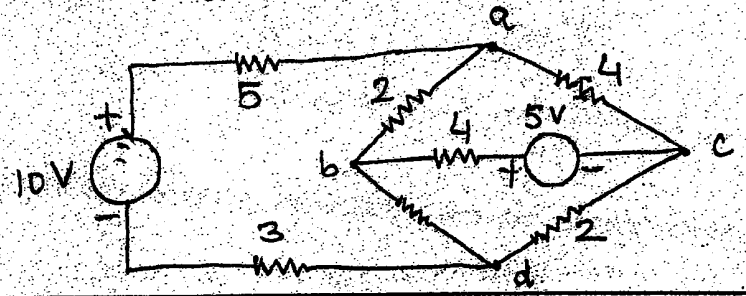
9) Find the

(a) value of I_1

(b) Thevenin's equivalent between c & d removing the current source of 2A, 5Ω resistance



10) Find the current through 3Ω resistor



Answers: 1. 2.86A; 2. V_{oc}= 130V, R_{th}= 22Ω; 3. 0.448A; 4. I_3=0, I_6=0, I_8=0, I_{12}=0.835A;
5. 18.75 Ω; 6. 165V; 7. 1A; 8. 0.448A; 9. a) $\frac{90}{49}$A, b) 6V, $\frac{24}{5}$Ω; 10. 0.855A.

Assignment 3

1. In a particular circuit a voltage of 10 V at 25 Hz produces 100 mA, while the same voltage at 75 Hz produces 60 mA. Draw the circuit diagram and insert values of the constants. At what frequency will the value of the impedance be twice of that at 25 Hz?

   [R = 88.1 Ω and L = 0.3 H in series ; 95 Hz]

2. A resistor R in series with a capacitance C is connected to a 50 Hz, 240 V supply. Find the value of C so that R absorbs 300 W at 100 V. Also find the maximum charge and the maximum energy stored in C.

   [44 μF ; 0.0135C ; 2.1 J]

3. An alternating voltage 80 + j60 V is applied to a circuit and the current flowing is – 4 + j10 A. Find (a) the impedance of the circuit (b) the power consumed and (c) the phase angle.

   [(a) 9.28 Ω (b) 280 W (c) 75^0 leading]

4. Calculate (a) the admittance Y, (b) the conducatnce G and (c) the susceptance B of a circuit consisting of a resistor of 10 Ω in series with an inductor of 0.1 H, when the frequency is 50 Hz.

   [(a)0.0303 mho (b) 0.0092 mho (c) – 0.029 mho]

5. Find the impedance , current , power and power factor of the following series circuits and draw the corresponding vector diagrams (a) R only (b) L only (c) C only (d) R and L (e) R and C (f) R,L and C (g) L and C. In each case the applied voltage is 200 V , the frequncy is 50 Hz , R = 10 Ω , L = 50 mH , C = 100 μF.

   [(a) 10 Ω, 20 A, 4 KW, 10 ; (b) 15.7 Ω, 12.72 A, 0, 0 lag ; (c) 81.8 Ω, 6.29 A, 0, 0 lead ; (d) 18.6 Ω, 10.75 A, 1.155 KW, 0.537 lag ; (e)33.3 Ω, 6 A, 360 W, 0.31 lead ; (f) 18.9 Ω, 10.58 A, 1.12 KW, 0.53 lead ; (g) 16.1 Ω, 12.4 A, 0, 0 lead]

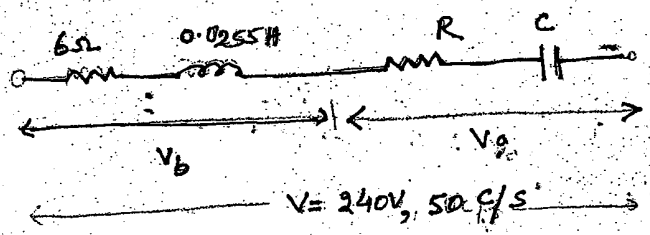
6. When a resistor and inductor in series are connected to a 240 V supply, a current of 3 A flowing lagging 37^0 behind the supply voltage, while the voltage across the inductor is 171 V. Find the resistance of the resistor and the resistance and reactance of the inductor.

   [33.26, 30.74, 48 Ω]

7. A coil having resistance R ohms and inductance L henry is connected acroos a variable frequency alternating-current supply of 110 V. An ammeter in the circuit showed 15.6 A when the frequency was 80 Hz and 19.7 A when the frequency was 40 Hz. Find the values of R and L and the time constant of the coil.

   [4.95 Ω, 0.01 H, 2.02 ms]

8. Find the values of R and C so that $V_b = 3V_a$ and V_b and V_a are in quadrature. Also find the phase relation between V and V_b; V_a and I.



   [R = 2.66 Ω, C = 1590 μF]

9. A circuit comprises of a conductance G in parallel with a susceptance B. Calculate the admittance G + jB if the impedance is 10 + j5 Ω. [0.08 – j0.04]

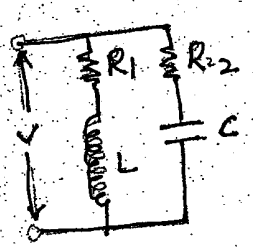
10. Find the impedances, the current in each branch, the total current and power factor of the following circuits.
    (a) Resistance R in parallel with inductance L.
    (b) Resistance R in parallel with capacitance C.
    (c) Inductance L in parallel with capacitance C.
    (d) R and L in series with C

In each case the applied voltage is 200 V at 50 Hz : R = 10 Ω, L = 70 mH, C = 127.2 μF. Draw in each case the circuit dagram and the vector diagram of the voltages and currents.

[(a) 9.1 Ω, 20 A, 9.1 A, 22 A, 0.91 lag ; (b) 9.3 Ω, 20 A, 8 A, 21.51 A, 0.93 lead ; (c) 182 Ω, 9.1 A, 8 A, 1.1 A, 0 lag ; (d) 57.9 A, 8.28 A, 8 A, 3.45 A, 0.99 lead.]

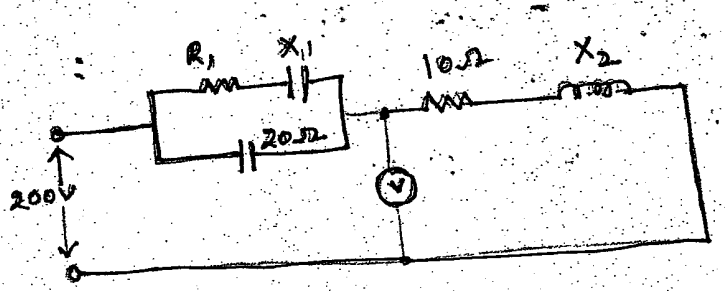
11. A small single phase 240 V induction motor is tested in parallel with a 160 Ω resistor; the motor takes 2 A and the total current is 3 A. Find the power and power factor of (a) the whole circuit and (b) the motor. [(a) 580 W, 0.807 (b) 220 W, 0.46]

12. Find the condition that the currents in the two branches of the alternating current circuit shown shall remain in quadrature when R_1 and R_2 are varied simultaneously. Determine (a) the frequency at which the total current remains constant in magnitude under this condition, (b) the magnitude of this current.



[$R_1R_2 = L/C$ (a) $1/(2\pi\sqrt{LC})$ (b) $V\sqrt{(C/L)}$]

13. The circuit shown takes 12 A at a lagging P.F, and dissipates 1.8 KW when the voltmeter reading is 200 V. Calculate the values of R_1, X_1 and X_2. [3.14, 2.17 and 13.32 Ω]



Assignment 4

1. Calculate the active and reactive current components in each phase of a star connected, 10,000 V, 3 phase alternator supplying 5000 KW at a power factor of 0.8. If the total current remains the same when the load power factor is raised to 0.9, find the new output.
[289 A, 266 A, 5625 KW]

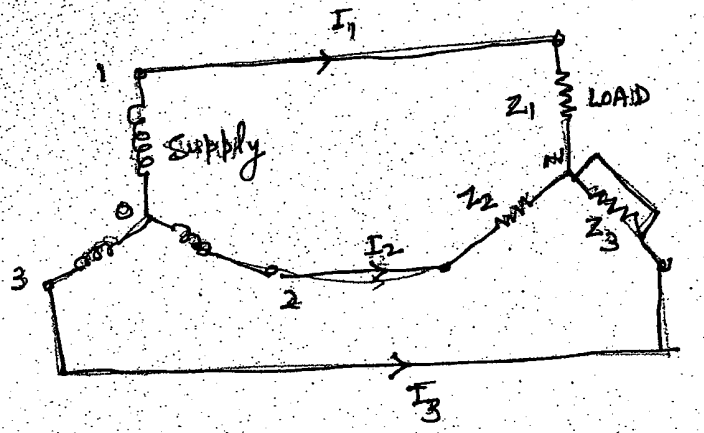
2. A 3-phase star-connected alternator feeds a 2000 hp delta-connected induction motorhaving a P.F. of 0.85 and an efficiency of 0.93. Calculate the current and the active and reactive components in (a) each alternator phase (b) each motor phase. The line voltage is 2200 V.
[(a) 496, 421, 262 A ; (b) 286, 243, 151 A]

3. A balanced star connected load of 8 + j6 Ω per phase is connected to a 3 phase, 230 V supply. Find the line current power factor, power, reactive volt amperes and total volt-amperes.
[13.3 A, 0.8, 4250 W, 3130 VA, 5280 VA]

4. A balanced 3-phase star connected load of 150 KW takes a leading current of 100 A with a line voltage of 1100 V, 50 Hz. Find the circuit consatnts of the load per phase.
[R = 5 Ω, C = 810 μF]

5. A balanced star-connected load is supplied from a symmetric 3 phase, 400 V system. The current in each phase is 30 A and lags 30^0 behind the phase voltage. Find (a) the phase voltage and (b) the total power. Draw the vector diagram showing the currents and voltages.
[(a) 231 V (b) 18 KW]

6. Three equal star connected inductors take 8 KW at power factor 0.8 when connected to 460 V, 3 phase, 3 wire supply. Find the line currentsif one inductor is short circuited.



[21.7, 21.7, 37.6 A]

7. In the two wattmeter method of power measurement in a 3-phase circuit, the readings of the wattmeters are 1,200 W and 300 W. What is the pf of the load : Prove the formula used.
[0.6934 (lag)]

8. A 3-phase balanced load power was measured by two wattmeter method. If the readings of the two wattmeters so connected are 5 and 0.5 KW, the latter reading being obtained after reversal of current coil connections, calculate the power factor of the load.

[0.427 (lag)]

9. Two wattmeters are used for measuring the power input and the power factor of an over-excited synchronous motor. If the readings of the meters are -2 and +7 KW respectively, calculate the input and power factor of the motor.

[5 KW, 0.3054 (lead)]

10. A 3-phase delta-connected balanced load consists of a resistance of 10 Ω in series with an inductive reactance of 17.32 Ω. If the circuit is connected to a 440 V, 50 Hz supply and the total power consumed is 14,520 W, what is the reading read by each wattmeter if the power is measured by 2 wattmeter method?

[14,520 W and zero]

11. The power input to a 2,000 V, 50 Hz, 3-phase motor running on full load at an effeiciency of 90% is measured by two wattmeters which indicate 300 KW and 100 KW respectively. Calculate (i) input (ii) power factor (iii) line current and (iv) hp output.

[(i) 400 KW (ii) 0.756 (lag) (iii) 152 A (iv) 490 (metric)]

12. A 3-phase motor draws a line current of 50 A from 220 V source while starting. The pf is 0.4. Find the readings of the two wattmeters connected to measure power.

[8.85 KW ; -1.23 KW]

Assignment 5

1. Two identical 1000 turns coils X and Y lie in parallel planes such that 60% of the magnetic flux produced by one coil links the other. A current of 5 A in X produces in it a flux of 0.05 mWb. If the current in X changes from +6 A to -6 Ain 0.01 s, what will be the magnitude of the emf induced in Y? Calculate the self inductance of each coil and the mutual inductance.

[7.2 V, each coil 10 mH, 6 mH]

2. A solenoid consists of 1500 turns of wire wound in a length of 60 cm. A search coil of 500 turns enclosing a mean area of 20 cm^2 is placed centrally in the solenoid. Find (a) the mutual inductance of the arrangement, and (b) the emf induced in the search coil when the current in the solenoid is changing uniformly at the rate of 250 A per sec.

[3.14 mH, 0.786 V]

3. A search coil having 50 turns enclosing a cross-sectional area of 2 cm^2 is placed at the middle of a solenoid having 505 turns of wire wound uniformly on a length of 12 cm and carrying an alternating current of 0.2 A at a frequency of 5 KHz. Calculate the mutual inductance between the coils and the emf induced in the search coil.

[52.4 μH, 0.329 V]

4. A solenoid consisting of 1000 turns of wire wound on a former of length 100 cm and diameter 3 cm is placed co-axially within another solenoid of the same length and number of turns, but of diameter 6 cm. Find approximately the mutual inductance and the coupling coefficient of the arrangement.

[0.887 mH, 0.5]

5. Two coils, X of 12000 turns and Y of 15000 turns, lie in parallel planes so that 45% of the flux produced by coil X links with coil Y. a current of 5 A in X produces 0.05 mWb while the same current in Y produces 0.075 mWb. Calculate (a) the mutual inductance and (b) the coupling coefficient.

[67.5 mH, 0.41]

6. Two coils of 30 and 600 turns respectively are wound side by side on a closed iron circuit of section 100 cm^2 and mean length 150 cm. (a) Estimate the mutual inductance between the coils if relative permeability of the iron is 2000 (b) a current in the first coil grows steadily from 0 to 10 A in 0.01 s ; find the emf induced in the other coil.

[0.302 H, 302 V]

7. An 11500/2300 V transformer is rated at 100 KVA as a two winding transformer. If the two windings are connected in series to form an auto-transformer what will be the voltage ratio and output?

[13.8/11.5, 600 KVA ; 13.8/2.3 KV, 120 KVA]

8. A 1-phase tranformer has 180 and 90 turns respectively in its secondary and primary windings. The respective resistances are 0.233 Ω and 0.067 Ω. Calculate the equivalent resistance of (a)

the primary in terms of the secondary winding, (b) the secondary in terms of the primary winding and (c) the total resistance of the tranformer in terms of the primary.
[0.268 Ω, 0.058 Ω, 0.125 Ω]

9. Calculate in terms of the primary, the effective (equivalent) resistance and leakage reactance of a transformer which gave the following data on test with the secondary terminals short circuited : Applied voltage 60 V ; current 100 A ; power input 1.2 KW.
[0.12 Ω, 0.59 Ω]

10. A 40 KVA transformer with a ratio of 2000/250 V has a primary resistance of 1.15 Ω and a secondary resistance of 0.155 Ω. Calculate (a) totale resistance in terms of the secondary winding (b) the total resistance drop on full load and (c) the total copper loss on full load.
[0.0334 Ω, 5.35 V, 856 W]

11. A 50 Hz single phase transformer has a turn ratio of 6. The resistances are 0.9 and 0.3 Ω and the reactances 5 and 0.13 Ω for high voltage and low voltage respectively. Find (a) the voltage to be applied to the high voltage side to obtain full load current of 200 A on the low voltage winding on short-circuit (b) the power factor on short circuit.
[330 V, 0.2]

12. Calculate the regulation of tranformer in which the ohmic loss is 1% of the output and the reactance drop 5% of the voltage, when the P.F. is (a) 0.8 lagging (b) unity (c) 0.8 leading.
[3.8 %, 1 %, - 2.2 %]

13. A 100 KVA , 6600/330 V, 50 Hz, single phase tranformer took 10 A and 436 W at 100 V in a short circuit test, the figures referring to the high voltage side. Calculate the voltage to be applied to the high voltage side on full load at P.F. 0.8 lagging when the secondary terminal voltage is 330 V.
[6734 V]

14. A 4 KVA, 200/400 V, 50 Hz, single phase transformer gave the following test figures :
No-load : low voltage data : 200 V, 0.7 A, 60 W
Short-circuit : high voltage data : 9 V, 6 A, 21.6 W
Calculate (a) the magnetising current and the component corresponding to iron loss at normal voltage and frequency (b) the efficiency on full load at unity power factor (c) the secondary terminal voltage on full load at power factors of unity, 0.8 laggind and 0.8 leading.
[(a) 0.63 A, 0.3 A (b) 97.1% (c) 394V, 387V, 403.4V]

15. Find the efficiency of a 150 KVA transformer at 25%, 33% and 100% full-load (a) at unity P.F. (b) at P.F. 0.8 lagging, if the copper loss is 1600 W at full-load and the iron loss is 1400 W. Ignore the effect of temperature use and magnetizing current.
[(a) 96.15, 96.94, 98.04% (b) 95.23, 96.21, 97.56%]

16. In a 25 KVA, 2000/200 V transformer, the iron and copper losses are 350 and 400 W rsepectively. Calculate the efficiency on unity P.F. at (a) full-load (b) half-load (c) determine the load for maximum efficiency and the iron and copper losses in this case.
[(a) 97.1% (b) 96.5% (c)23.4 KVA, 350 W each]

17. A transformer has its maximum efficiency of 0.98 at 15 KVA at unity P.F. During the day it is loaded as follows :
12 hours : 2 KW at P.F. 0.5

6 hours : 12 KW at P.F. 0.8

6 hours : 18 KW at P.F. 0.9

Find the "all day" efficiency (output in KWh/input in KWh)

[0.97]

18. Calculate the efficiencies at half, full and 1.5 loaf of a 100 KVA transformer for P.F. of (a) unity (b) 0.8. The copper loss is 1000 W at full load and the iron loss is 1000 W.

[(a) 97.56, 98.04, 97.98% (b) 96.96, 97.56, 97.5%]