MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

ELE 1051: BASIC ELECTRICAL TECHNOLOGY

End Semester Examination: Scheme of Evaluation

1 A. Resistance between the terminals A & B in the circuit shown in **Fig. 1 A** is 3M

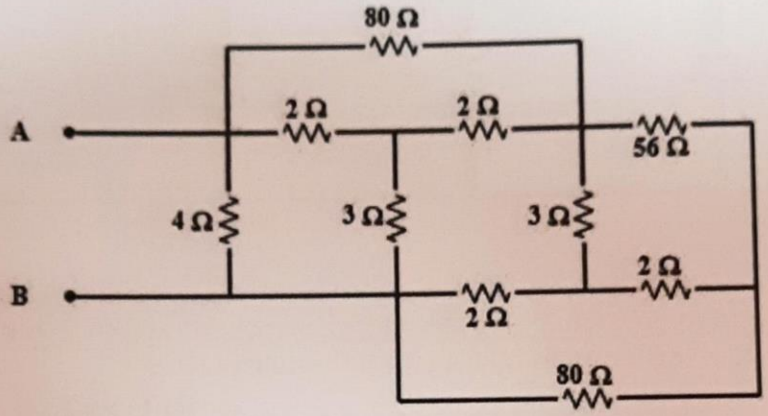
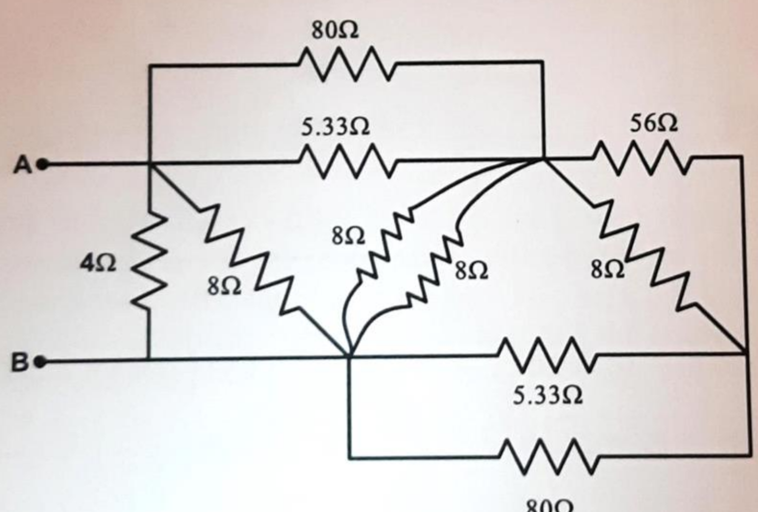
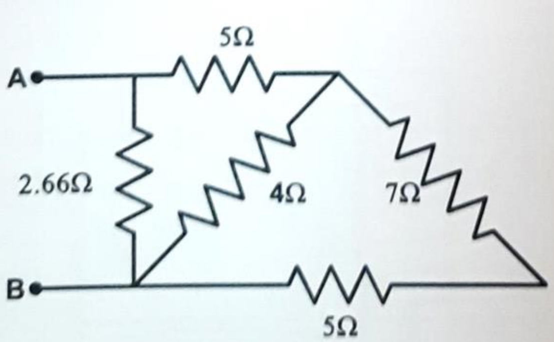


Fig. 1 A



---------------------1M

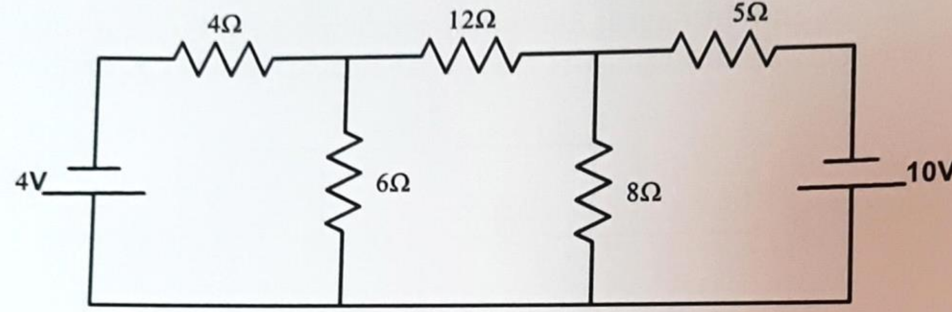


---------------------1M

$R_{AB} = 2\Omega$ ---------------------1M

1 B. Realize the network defined by mesh current equations given below. 3 M

$$\begin{bmatrix} 10 & -6 & 0 \\ -6 & 26 & -8 \\ 0 & -8 & 13 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} -4 \\ 0 \\ 10 \end{bmatrix}$$



----------3M

1 C. In the circuit shown **Fig. 1C**, the switch is initially in position 1 for 120 μs and then it is moved to position 2. Find the voltage across the capacitor and the charging current in the intervals (a) 0 ≤ t ≤ 120 μs (b) t >120 μs 4 M

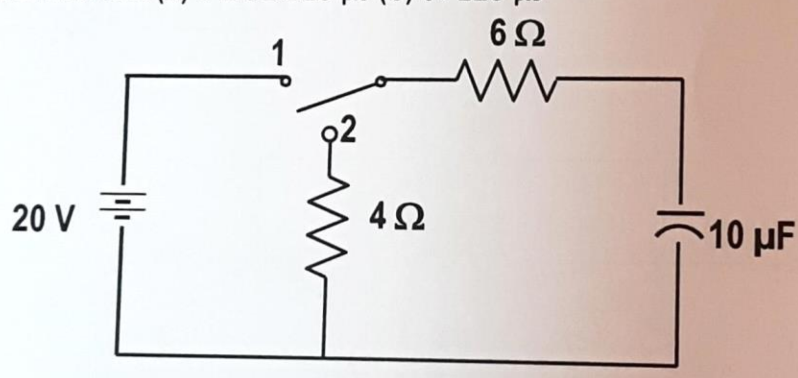
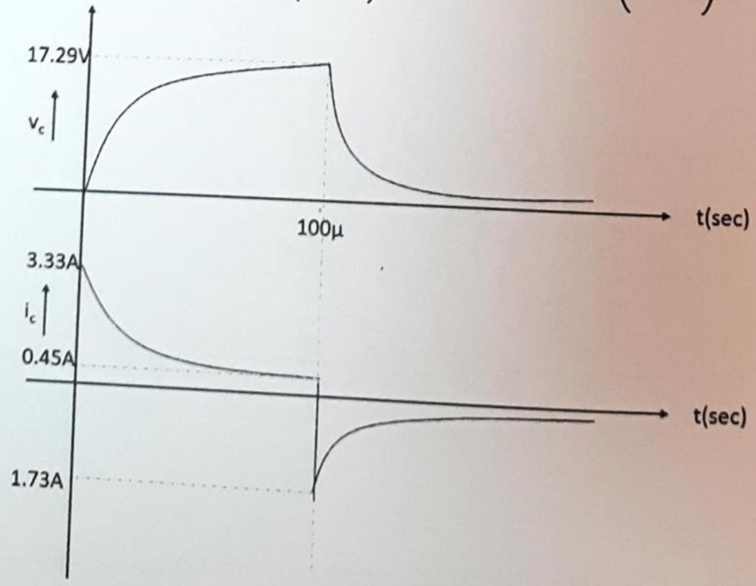


Fig. 1C

For time 0 ≤ t ≤ 120 μs; $v_c = 20\left(1 - e^{\frac{-t}{60\mu}}\right)V \quad i_c = 3.33\left(e^{\frac{-t}{60\mu}}\right)A$---------------**2M**

For time t >120 μs; $v_c = 17.29\left(e^{\frac{-t'}{0.1m}}\right)V \quad i_c = -1.729\left(e^{\frac{-t'}{0.1m}}\right)A$--------------**2M**



2 A. Find the flux density in the central limb of the magnetic core shown in the Fig. 2 A, given the current i = 20 A and μ_r of the core material = 2000. 6 M

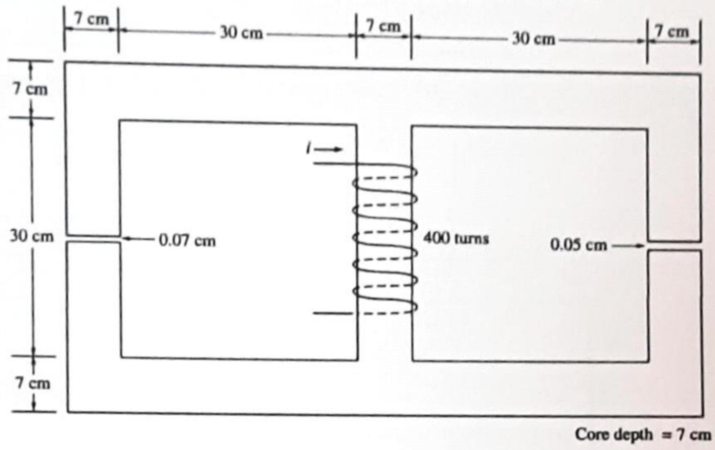


Fig. 2 A

$S_{LEFT} = 90076.83\ AT/Wb$
$S_{L\ AIRGAP} = 113682.102\ AT/Wb$ ---------- 1M

$S_{RIGHT} = 90093.066\ AT/Wb$
$S_{R\ AIRGAP} = 81201.50\ AT/Wb$ ---------- 1M

$S_{CENTRAL} = 30044.56\ AT/Wb$ ---------- 1M

$NI = \phi_{CENTRAL} * S_{CENTRAL} + \phi_{RIGHT}(S_{RIGHT} + S_{R\ AIRGAP})$
$\phi_{LEFT}(S_{LEFT} + S_{L\ AIRGAP}) = \phi_{RIGHT}(S_{RIGHT} + S_{R\ AIRGAP})$ ---------- 2M

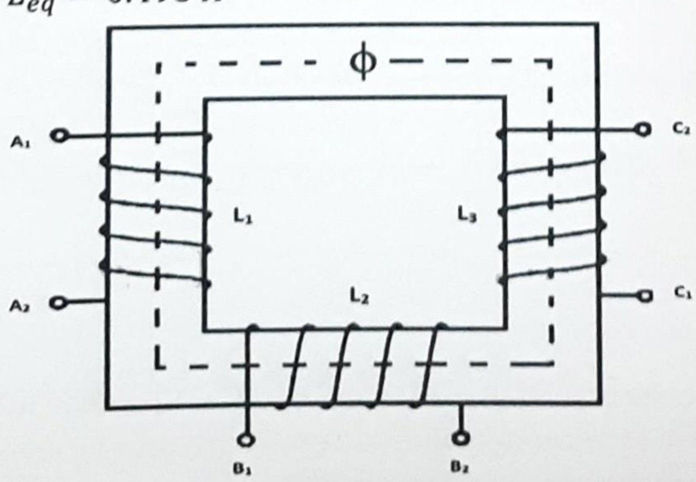
$\phi_{CENTRAL} = \phi_{RIGHT} + \phi_{LEFT}$
$\phi_{CENTRAL} = 64.98m\ Wb$
$B_{CENTRAL} = 13.26 Wb/m^2$ ---------- 1M

2 B. Three coupled coils L_1 = 0.4 H, L_2 = 0.5 H and L_3 = 0.8 H wounded on the same core as shown in the **Fig. 2 B** are connected in series by joining the terminals A_2 to B_1 and B_2 to C_1 and the coefficient of coupling $k_{12} = k_{13} = k_{23} = 0.8$. Sketch the dotted equivalent circuit of the coils connected in series and find the equivalent inductance measured across terminals A_1 and C_2. 4 M

$L_{eq} = L_1 + L_2 + L_3 + 2M_{12} - 2M_{23} - 2M_{13}$ ---------- 2M

$M_{12} = 0.358\ H$
$M_{23} = 0.506\ H$
$M_{31} = 0.453\ H$ ---------- 1M

$L_{eq} = 0.498\ H$ ---------- 1M



3 A. For network shown in Fig. 3 A, calculate the value of current I and the voltage across the parallel branch. 3 M

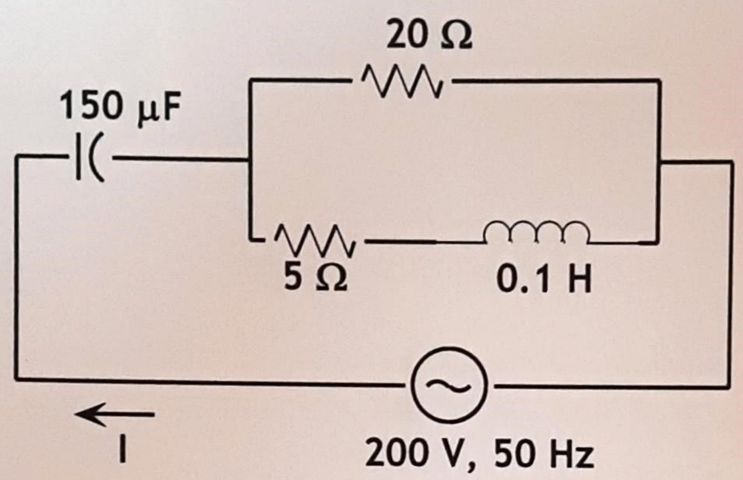


Fig. 3A

$Z_{eq} = 19.25\angle -44.22° \ \Omega = 13.79 - \mathrm{j}13.42 \ \Omega$--**1M**

$I_T = 10.39\angle + 44.22° \ \mathrm{A} = 7.45 + \mathrm{j}7.25 \ \mathrm{A}$--**1M**

$V_{parallel} = 164.64\angle 73.68 \ \mathrm{V} = 46.26 + \mathrm{j}158.01 \ \mathrm{V}$------------------------------------**1M**

3 B. For the network shown in Fig. 3 B, determine the impedance of the load which will dissipate maximum power, and determine the maximum power 4 M

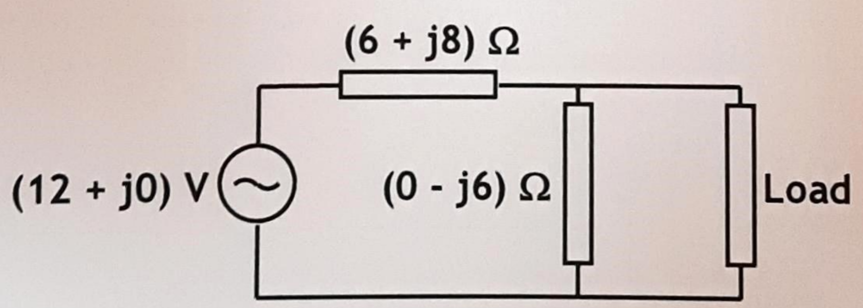


Fig. 3B

$Z_L = Z^*_{TH} = 5.4 + j7.8 \ \Omega = 9.48\angle 55.31\Omega$--**2M**

$V_{TH} = 11.38\angle - 108.44 \ \mathrm{V} = -3.6 + \mathrm{j}10.8 \ \mathrm{V}$ --**1M**

$P_{max} = 6 \ W$--**1M**

3 C. A parallel circuit with an RL series branch (R = 20 Ω and L = 50 mH) and an RC series branch (R = 10 Ω and C = 100 µF) are connected to a variable frequency voltage source. Find at what frequency the circuit will resonate? 3 M

$\omega_c = \frac{1}{LC}\sqrt{\frac{R_L^2C-L}{R_C^2C-L}} = 100000rad/sec = 15.915kHz$--**3M**

4A. Three identical impedances of 12 + j5 Ω are connected in delta to a 3 phase, 3 wire, 415 V, RYB system. Taking V_{RY} as reference, find the line currents I_R, I_Y, I_B and the total power. 5 M

$$\left.\begin{aligned} V_{RY} &= 415\angle 0°V \\ V_{YB} &= 415\angle -120°V \\ V_{BR} &= 415\angle -240°V \end{aligned}\right\}$$ ---1M

$$\left.\begin{aligned} I_{RY} &= 31.92\angle -22.62°A \\ I_{YB} &= 31.92\angle -142.62°A \\ I_{BR} &= 31.92\angle 97.38°A \end{aligned}\right\}$$ ---1M

$$\left.\begin{aligned} I_R &= 55.29\angle -52.62°A \\ I_Y &= 55.29\angle -172.62°A \\ I_B &= 55.29\angle 67.38°A \end{aligned}\right\}$$ ---2M

$P_T = 36.685\ kW$---1M

4B. A three phase, 4 wire, 400 V, ABC system supplies a star connected load in which $Z_A = 10\angle 0°\ \Omega$, $Z_B = 15\angle 30°\ \Omega$ and $Z_C = 10\angle -30°\ \Omega$. Taking V_{AN} as reference, find the line currents & the neutral current. 5 M

$$\left.\begin{aligned} V_{AN} &= 230.94\angle 0°V \\ V_{BN} &= 230.94\angle -120°V \\ V_{CN} &= 230.94\angle -240°V \end{aligned}\right\}$$ ---1M

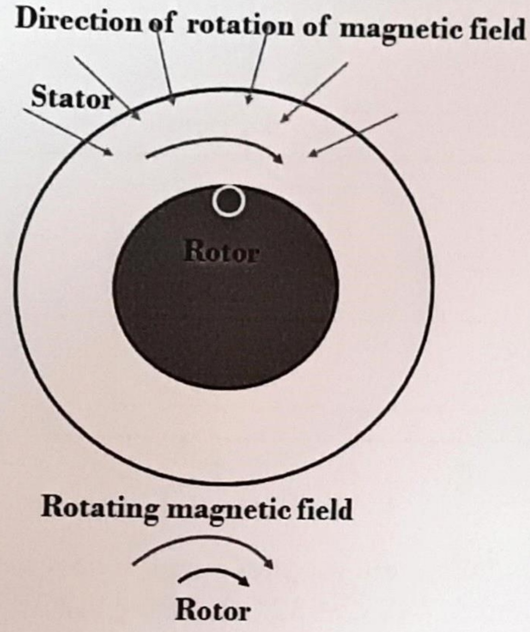
$$\left.\begin{aligned} I_A &= 23.094\angle 0°A \\ I_B &= 15.396\angle -150°A \\ I_C &= 23.094\angle 150°A \end{aligned}\right\}$$ ---3M

$I_N = 10.94\angle 159.4°A$ ---1M

5 A. Discuss the role of the transformer in an electric transmission and distribution network. 4 M

Role & rating of Step up transformers at generating stations
11kv to 765 kV/400 kV/ 220 kV
Role & rating Step down transformers at subtransmission & distribution network
132 kV/ 110kV/ 66 kV/ 33 kV to 11kV
Distribution transformer 11kV to 415 V (3ph)

5 B. Explain the working principle of a three phase Induction Motor. 3 M



- Rotating magnetic field is cut by the rotor conductor
- EMF is induced in rotor conductor
- Current in the rotor conductor sets up a magnetic field which opposes the rotation of main field
- Main field is independent and hence rotor field tries to catch up the speed of main field to reduce the relative speed
- Rotor rotates in the same direction as that of rotating magnetic field

5 C. Sketch and explain the block diagram of a single phase digital energy meter. 3 M