KSU CET

S1 & S2 Notes

2019 Scheme

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester B.Tech Degree Examination December 2021 (2019 scheme)

Course Code: EST130

Course Name: BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

PART I: BASIC ELECTRICAL ENGINEERING

(2019 Scheme)

Max. Marks:50 Duration: 90 min

PART A

Answer all questions, each carries 4 marks.

1 A coil of 180 turns is linked with a flux of 0.03 Wb when carrying a current of 10A. Calculate the inductance of the coil. If the current is uniformly reversed in 0.04 sec, calculate the emf induced in the coil.

2 An alternating current is represented by i(t)=14.14 sin (377t). Find (i)rms value (ii) frequency (iii)time period and (iv)instantaneous value of the current at t=3ms.

3 Derive an expression for the energy stored in an inductor.

4 Derive the expression for the current in an ac series RLC circuit.

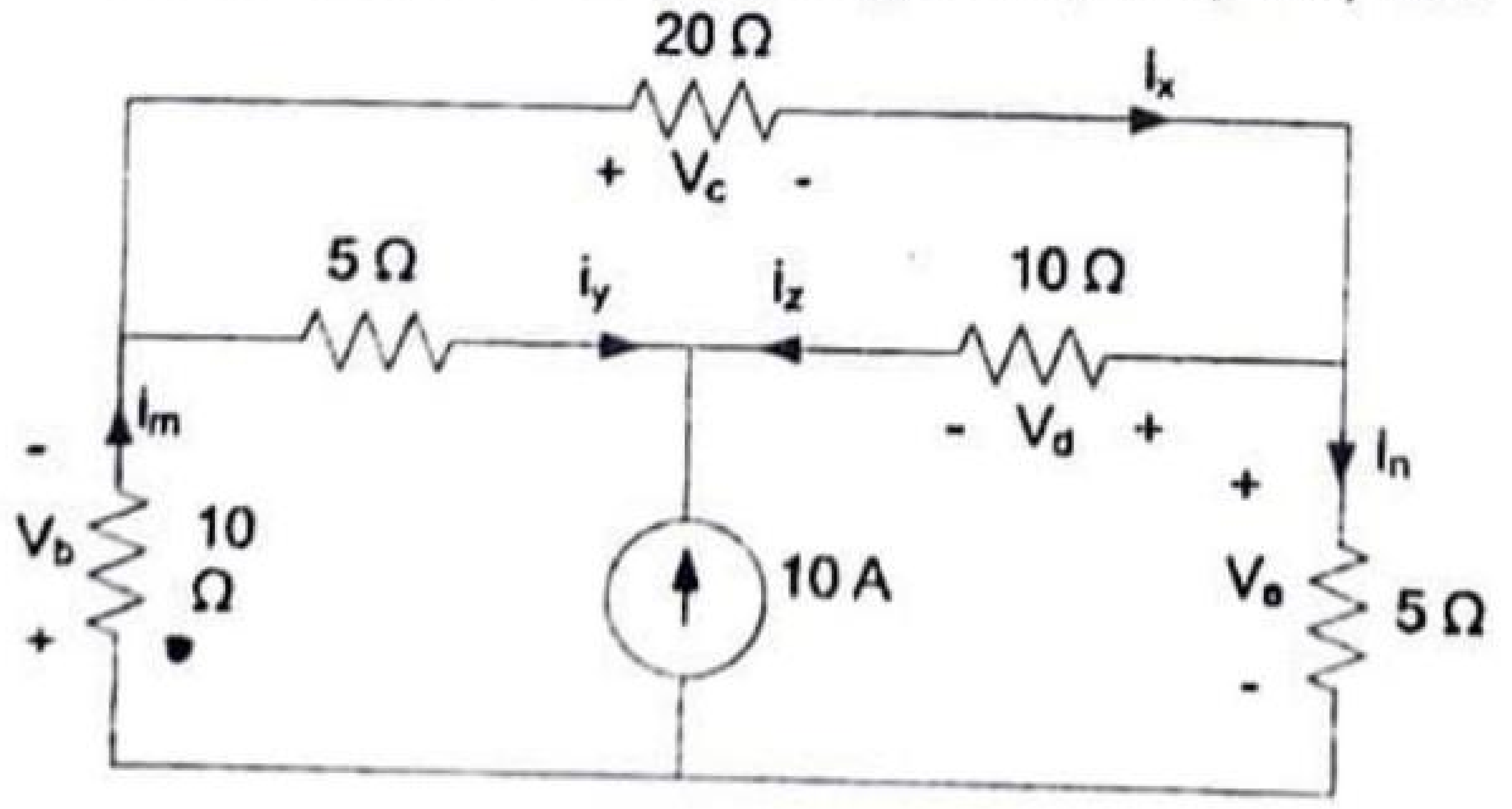
5 A resistance of 10Ω, an inductance of 0.3 H, and a capacitance of 100μF are connected in series across 230V, 50 Hz single phase power supply. Calculate the impedance, current through and power factor of the circuit. (5x4=20)

PART B

Answer one full question from each module, each question carries 10 marks

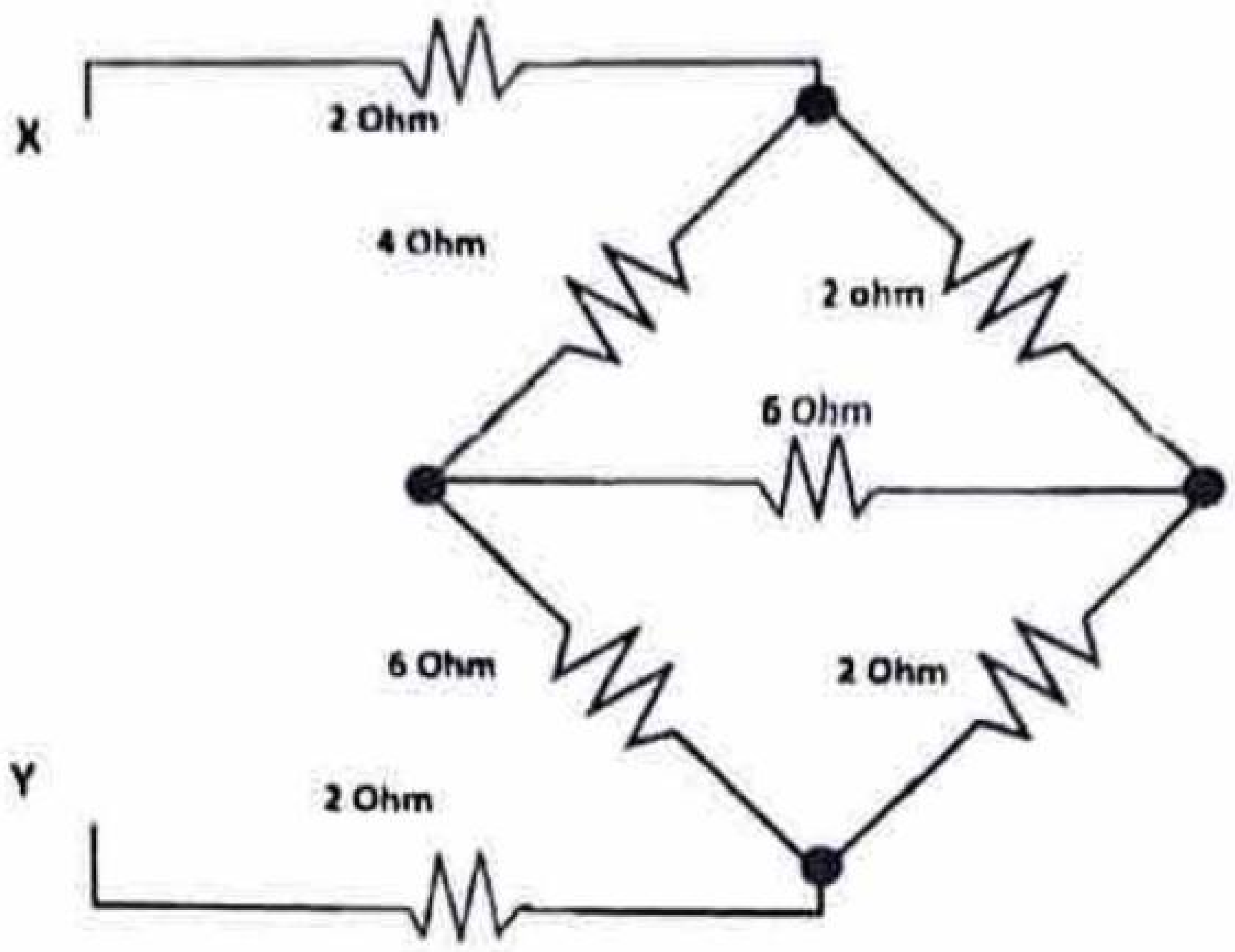
Module-I

6 Use nodal analysis to find voltages Va , Vb , Vc , Vd . (10)



OR

7 Find the equivalent resistance between terminal X-Y in the network (10)



Module-II

8 An iron ring has a cross section area of 3 cm^2 and a mean diameter of 25 cm. An air gap of 0.5mm is cut across the section of the ring. The ring is wound with a coil of 200 turns through which a current of 3A is passed. If the total magnetic flux is 0.28 mWb, find the relative permeability of iron, assuming no magnetic leakage. (10)

OR

9 a) The instantaneous value of an alternating voltage is given by v=110 sin 314t. Find the angular velocity, frequency, and time period of the voltage. (6)

b) Differentiate between statically and dynamically induced emfs. (4)

Module-III

10 A resistance of 10Ω, an inductance of 0.3 H and a capacitance of 100μF are connected in series across 230V, 50 Hz single phase supply. Calculate:

i) the impedance of the circuit ii) Current through the circuit iii) Voltage across R, L and C, and iv) Power consumed by the circuit. (10)

OR

11 A balanced delta connected 3 phase load is fed from a 3 phase, 400 V, 50 Hz power supply. The line current is 20A and the total power absorbed by the load is 10kW. Calculate (i) the impedance in each branch (ii) the power factor and (ii) the total power consumed if the same impedances are star connected. (10)

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1) Given $N = 180$ turns

$\phi = 0.03\ Wb$

$I = 10A$

$$\text{Inductance},\ L = \frac{N\phi}{I}$$

$$= \frac{180 \times 0.03}{10}$$

$$L = 0.54\ H$$

$$\text{induced emf},\ e = L \times \frac{di}{dt}$$

$$= 0.54 \times \frac{[10-(-10)]}{0.04}$$

$$e = 270\ V$$

2) $i(t) = i_m \sin(\omega t)$

Given $i_{(t)} = 14.14 \sin 377t$

i) Rms value

$$I_{rms} = \frac{i_m}{\sqrt{2}}$$

$$= \frac{14.14}{\sqrt{2}}$$

$$I_{rms} = 10V$$

ii) $\omega = 377$

$$2\pi f = 377$$

$$f = \frac{377}{2\pi}$$

$$\text{Frequency},\ f = 60\ Hz$$

iii) Timeperiod $t = \frac{1}{f}$

$$= \frac{1}{60}$$

$$= 0.01667\ sec$$

$$t = 16.67\ m\,sec$$

iv) At $t = 3ms$

$$i_{(t)} = 14.14 \sin(377t)$$

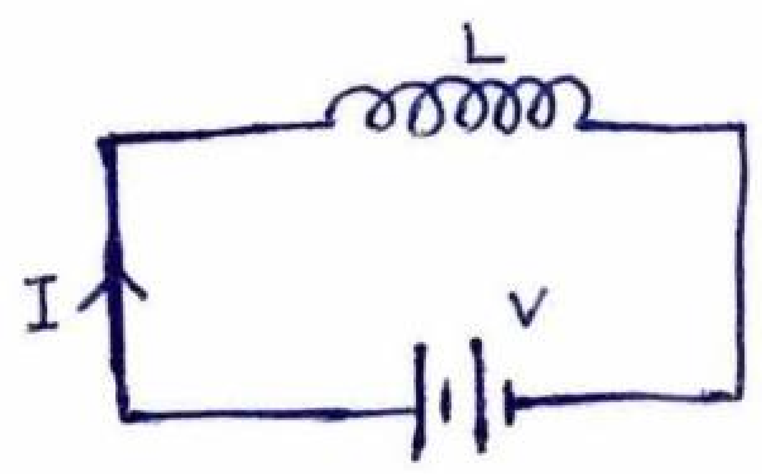
$$= 14.14 \sin(377 \times 3 \times 10^{-3})$$

$$= 14.14 \sin(1.131\ rad)$$

$$= 14.14 \sin\left(1.131 \times \frac{180}{\pi}\right)$$

$$i_{(3)} = 12.80\ V$$

3) Energy stored in an inductor



$$V_L = \mathcal{E} = -L\frac{dI}{dt}$$

So to pass current I, source does work against emf

$$\frac{dW}{dt} = -\mathcal{E} I$$

$$dW = -\mathcal{E} I \, dt$$

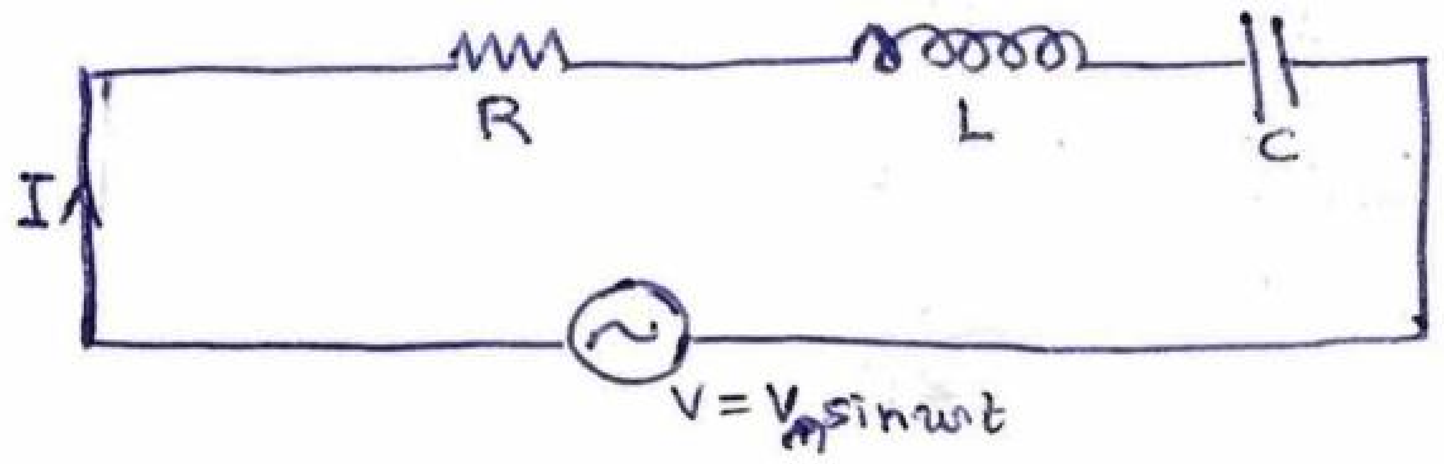
$$= L\frac{dI}{dt} \times I \, dt$$

$$\int_0^W dW = L\int_0^I I \, dI$$

$$W = L\frac{I^2}{2}$$

Energy stored in an inductor, $\boxed{U_L = \frac{1}{2}LI^2}$

4) Current in an AC series RLC circuit



$$V_R + V_L + V_c = V_m \sin\omega t$$

$$IR + L\frac{dI}{dt} + \frac{q}{C} = V_m \sin\omega t \qquad \boxed{I = \frac{dq}{dt}}$$

$$\frac{dq}{dt}R + L\frac{d^2q}{dt^2} + \frac{q}{C} = V_m \sin\omega t$$

where $q = q_m \sin(\omega t + \theta)$

and $q_m = \dfrac{V_m}{\left[L^2(\omega_0^2 - \omega^2)^2 + \omega^2 R^2\right]^{\frac{1}{2}}}$

also

$$i_m = \omega q_m$$

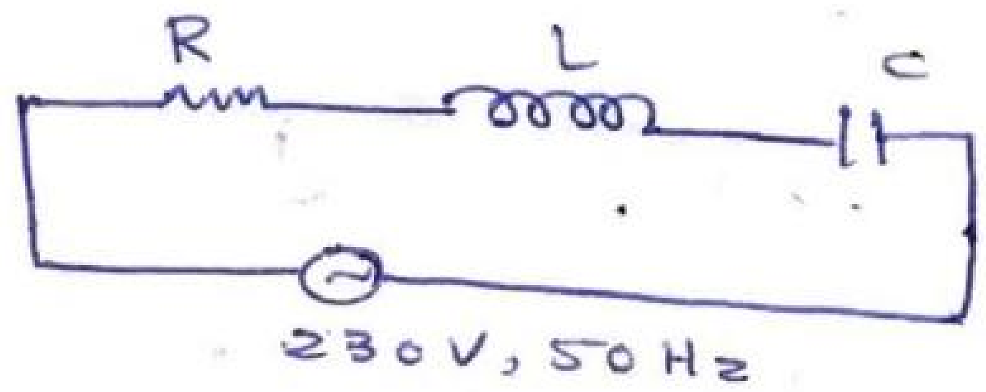
$$i_m = \frac{V_m}{\sqrt{R^2 + (X_c - X_L)^2}}$$

where $Z = \sqrt{R^2 + (X_c - X_L)^2}$

5) $R = 10\,\Omega$

$L = 0.3\,H$

$C = 100\,\mu F$



Total impedance $Z^2 = R^2 + \left(X_L - \frac{1}{X_C}\right)^2$

$$= 10^2 + \left[2\times 50\pi \times (0.3) - \frac{1}{2\times 50\pi\,(100\times 10^{-6})}\right]^2$$

$$= 10^2 + \left[30\pi - \frac{10^2}{\pi}\right]^2$$

$$Z = \sqrt{10^2 + (62.4)^2}$$

$$Z = 63.2\,\Omega$$

Circuit current, $I = \frac{V_0}{Z}$

$$I = \frac{230}{63.2} = 3.64\,A$$

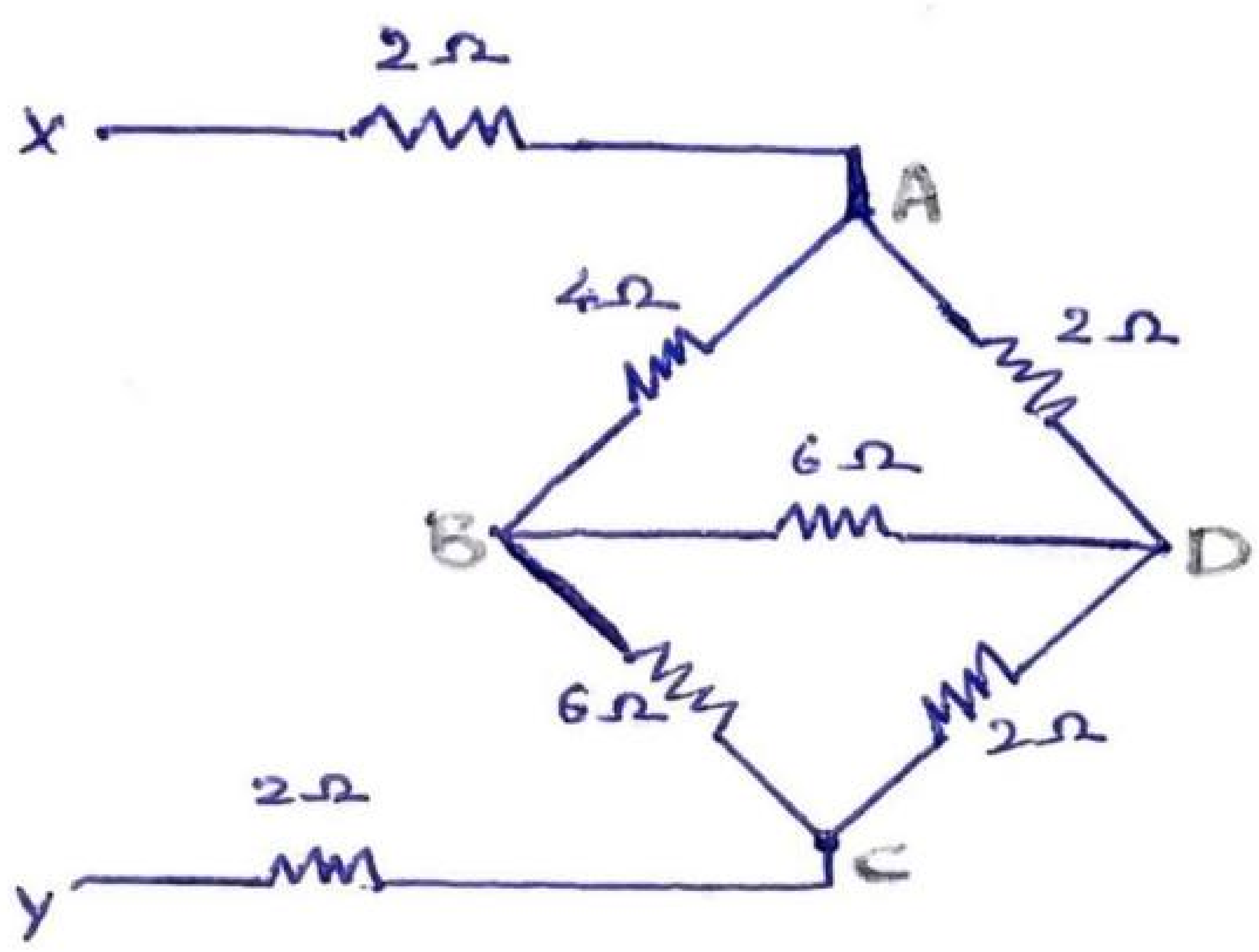
Power factor, $\phi = \tan^{-1}\left(\frac{X_L - \frac{1}{X_C}}{R}\right)$

$$= \tan^{-1}\left(\frac{30\pi - \frac{100}{\pi}}{10}\right)$$

$$= \tan^{-1}\left(\frac{62.4}{10}\right)$$

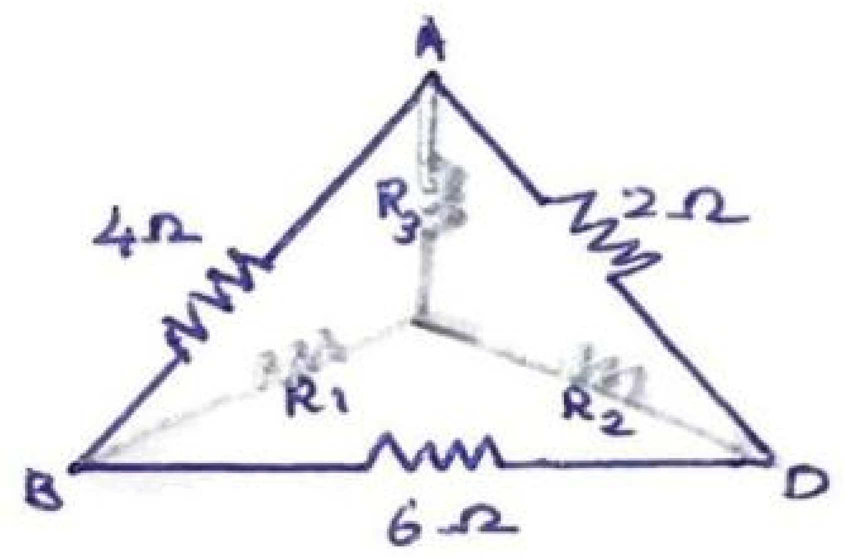
$$\phi = 81^\circ$$

7)



(STAR- DELTA)
conversion

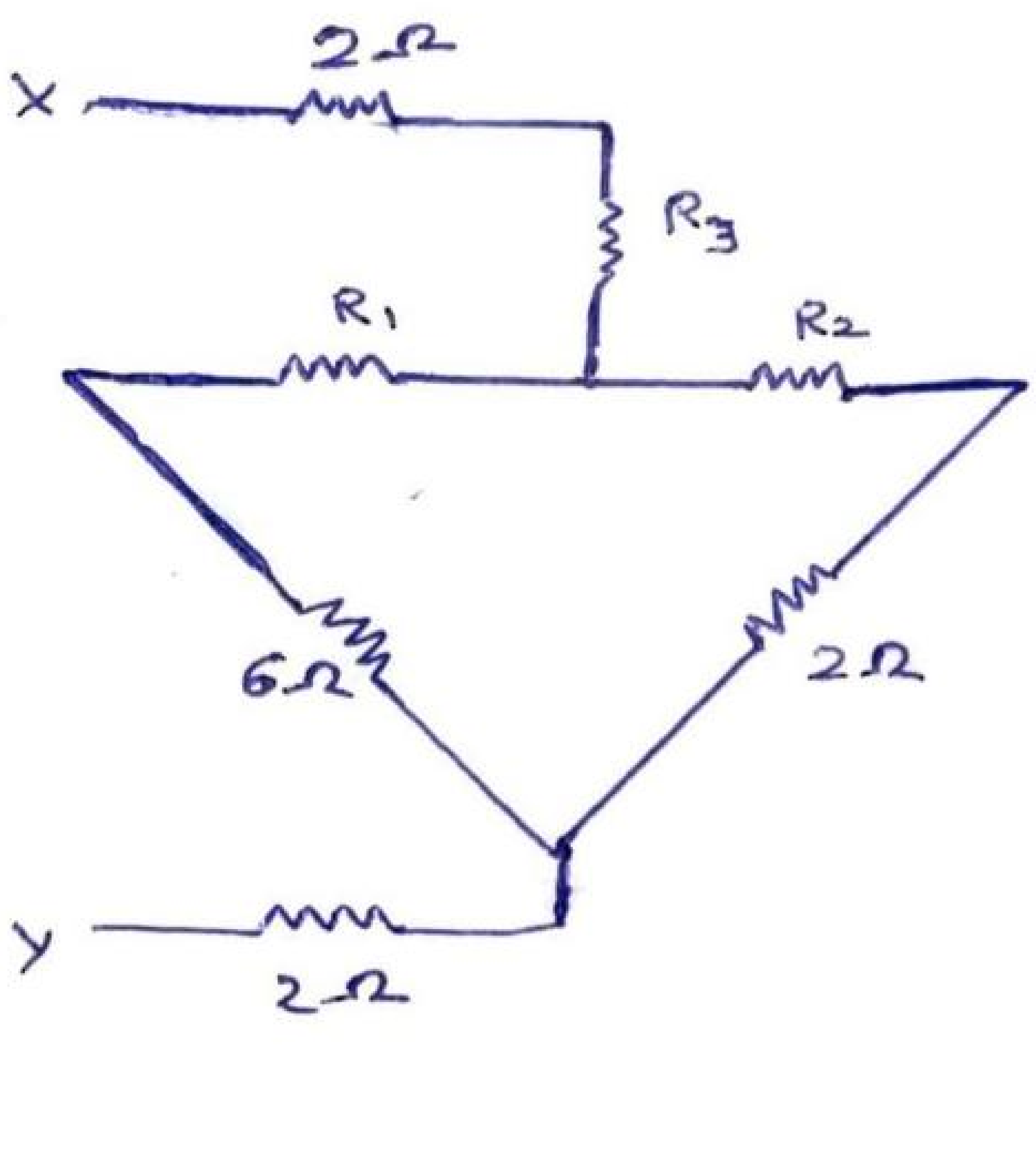
ABD



$$R_1 = \frac{4 \times 6}{4+6+2} = 2\,\Omega$$

$$R_2 = \frac{6 \times 2}{4+6+2} = 1\,\Omega$$

$$R_3 = \frac{4 \times 2}{4+6+2} = \frac{2}{3}\,\Omega$$



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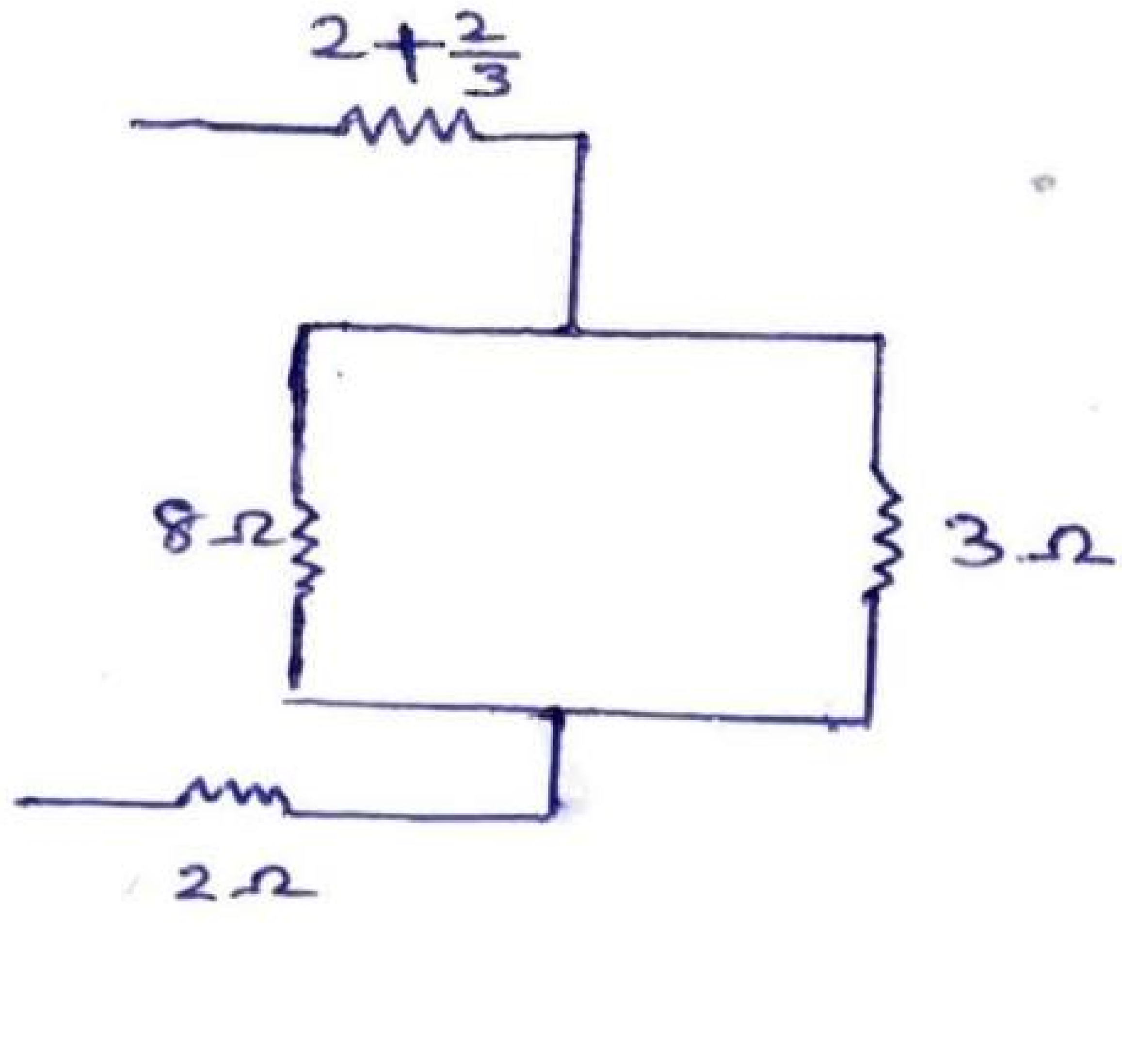


$$\therefore\ R_{eq} = 2 + \frac{2}{3} + 2 + \frac{8 \times 3}{8+3}$$

$$R_{eq} = 6.85\ \Omega$$

Given,

8) $\phi = 0.28 \text{ m Wb}$

$A = 3 cm^2 = 3 \times 10^{-4} m^2$

$$B = \frac{\Phi}{A}$$

$$B = \frac{0.28 \times 10^{-3}}{3 \times 10^{-4}} = 0.93 \text{ Wb/m}^2$$

$$\text{AT for iron ring} = H \times l$$

$$= \frac{B}{\mu_0 \mu_r} \times l$$

$$= \frac{0.93}{4\pi \times 10^{-7} \times \mu_r} \times 0.25$$

$$= 1.85 \times 10^{5} / \mu_r$$

$$\text{AT for air-gap} = \frac{B}{\mu_0} \times l$$

$$= \frac{0.93}{4\pi \times 10^{-7}} \times 0.5 \times 10^{-3}$$

$$= 370$$

$$\text{Total AT required} = (1.85 \times 10^5 / \mu_r) + 370$$

$$\text{Total AT provided} = 200 \times 3 = 600$$

$$\therefore (1.85 \times 10^5 / \mu_r) + 370 = 600$$

$$\underline{\mu_r = 804.35}$$

9 a) $V_{(t)} = V_m \sin \omega t$

Given $V = 110 \sin 314t$

Angular velocity, $\omega = 314$ rad/s

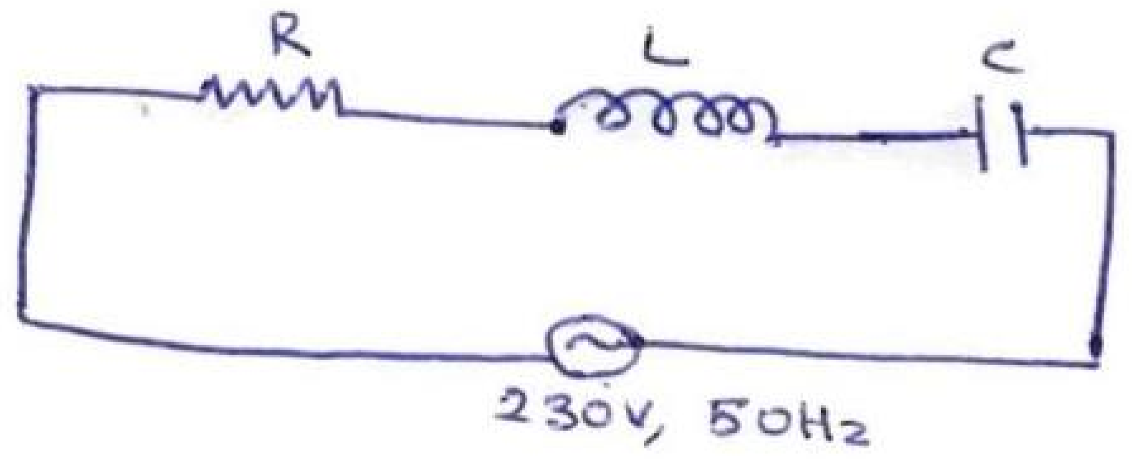
Frequency $f = \frac{314}{2\pi} = 50Hz$

Time period $T = \frac{1}{f} = 0.02$ seconds

b)

Statically induced emf	Dynamically induced emf
→ Emf is induced without any relative motion between conductor and magnetic field	→ Emf is induced due to relative motion between Conductor & magnetic field
→ Emf is induced when changing magnetic field links with a conductor $e = -L\left(\frac{di}{dt}\right)$	→ Emf is induced when conductor cuts the magnetic field due to relative motion between them $e = Blv \sin\theta$
→ Direction of statically induced emf is given by Lenz's law	→ Direction of dynamically induced emf is given by Fleming's Right hand rule
Two types: • Self-induced emf • Mutually induced emf	→ No such further classifications
Eg: emf induced in transformer windings	eg:- emf induced in generator

10)



$R = 10\,\Omega$

$L = 0.3\,H$

$C = 100\,\mu F$

i) Impedance, $Z^2 = R^2 + \left(\omega_L - \frac{1}{\omega_C}\right)^2$

$= 10^2 + \left[2\pi \times 50 \times 0.3 - \frac{1}{2\pi \times 50\,(100 \times 10^{-6})}\right]^2$

$= 10^2 + \left[30\pi - \frac{10^2}{\pi}\right]$

$Z = \sqrt{10^2 + (62.4)^2}$

$Z = 63.2\,\Omega$

ii) Current through the circuit, $I = \frac{V_0}{Z}$

$I = \frac{230}{63.2} = 3.64\,A$

(iii)

$V_R = IR$

$= 3.64 \times 10$

$= 36.4\,V$

$V_L = I X_L$

$= I \times 2\pi f L$

$= 3.64 \times 2\pi \times 50 \times 0.3$

$= 343.1\,V$

$V_c = I X_c$

$= I \times \frac{1}{2\pi f C}$

$= 3.64 \times \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}}$

$= 115.9\,V$

$\phi = \tan^{-1}\left(\omega_L - \frac{1}{\omega_C}\right)$

$= \tan^{-1}(62.4)$

$= 81^\circ$

(iv)

Power $= V_{rms} I_{rms} \cos\phi$

$P = VI\cos\phi$

$= 230 \times 3.64 \times \cos 81$

$P = 130.97\,J$