DATE 23/10/2018
Exam date
10.00 to 11.00 AM.

BEE IAT 2 Solution

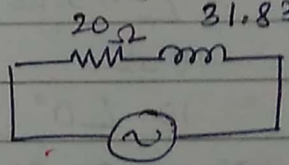
Q.1. Attempt any five. (2×5 = 10M)

(a). $C = 314\ \mu F$, $V = 230V$.
$f = 50\ Hz$, $1-\phi$ A.C. supply.

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 314 \times 10^{-6}} = 10.137\ \Omega$$ — 1M

$$I = \frac{230}{10.137} = \frac{V}{X_C} = 22.688\ A.$$ — 1M

(b) $v(t) = 282.85 \sin(100\pi t)$. V.



$\omega = 100\pi$ radian/sec.

$X_L = 2\pi f L = \omega L = 100\pi \times 31.83 \times 10^{-3}$.

$= 9.999\ \Omega$.

$|Z| = \sqrt{R^2 + X_L^2} = \sqrt{20^2 + 9.99^2}\ \Omega$

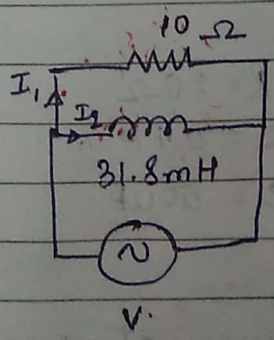
$Z = R + jX_L = 20 + j9.99\ \Omega$

$v(t) = 282.85 \sin(100\pi t)$.
$V_m = 282.85$ V
$V_{rms} = 200.0$ V

$Z = 22.35 \angle 26.54\ \Omega$ — (1M)

$$I_{rms} = \frac{V_{rms}}{Z} = \frac{200}{22.35 \angle 26.54} = 8.948 \angle -26.54\ A.$$ — (1M)

(c)



$V = 200V$
$f = 50Hz$.
$X_L = 2\pi f L = 9.99\ \Omega$

$I = ?$
$p.f = ?$

$$\frac{1}{Z} = \frac{1}{R} + \frac{1}{jX_L} = \frac{1}{10} + \frac{1}{j9.99}$$

$$\frac{V}{Z} = I_1 = \frac{200 \angle 0}{10} = 20 \angle 0\ A$$

$$I_2 = \frac{200 \angle 0}{9.99 \angle 90^\circ} = 20 \angle -90^\circ\ A$$

$I = I_1 + I_2 = 20 - j20 = 28.28 \angle -45.00^\circ$ A $= 28.28 \angle -4$

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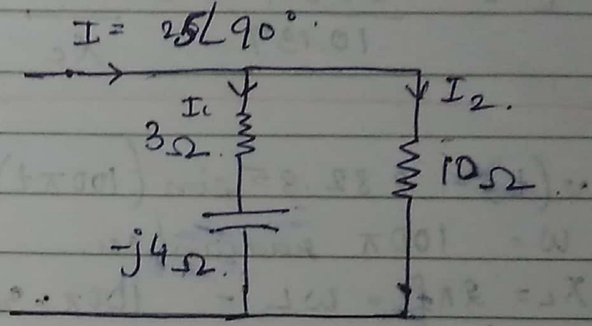
$I = 28.\cancel{28} \angle -45.00^\circ$ A. $= 28.28\angle -45^\circ$ A — 1M.

power factor $= \cos(-45.00^\circ)$

~~0.7071~~ lagging. — 1M.

$= 0.707$ lagging

(d) Find current I_1 and I_2.



$Z_1 = 3 - j4\ \Omega$

$Z_1 = 5\angle -53.13^\circ\ \Omega$

$Z_2 = 10\ \Omega$

$= 10\angle 0^\circ\ \Omega$

$Z_1 + Z_2 = 3 - j4 + 10 = 13 - j4 = 13.6\angle -17.10^\circ\ \Omega$

$$I_1 = \frac{I \times Z_2}{Z_1 + Z_2}$$

$$= \frac{(25\angle 90^\circ) \times (10\angle 0)}{(13.6\angle -17.10)}$$

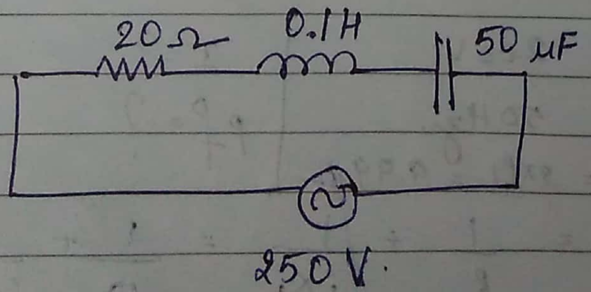
$$\boxed{I_1 = 18.38\angle 107.1^\circ\ A}$$ — (1M)

$$I_2 = \frac{I \times Z_1}{Z_1 + Z_2}$$

$$= \frac{25\angle 90 \times (5\angle -53.13^\circ)}{(13.6\angle -17.10)}$$

$$\boxed{I_2 = 9.19\angle 53.13^\circ\ A}$$ — (1M)

(e).



$R = 20\Omega$

$L = 0.1H$

$C = 50\mu F$

The current will be maximum at resonant frequency.

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.1 \times 50 \times 10^{-6}}} = 71.17\ Hz$$ — (2M)

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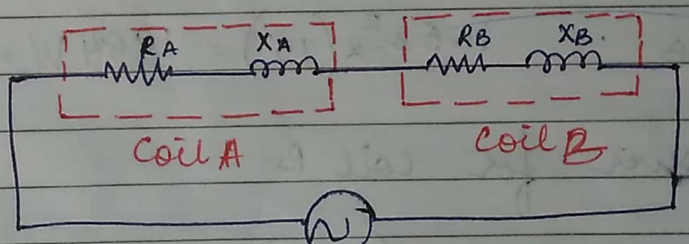
(f) Series Resonance	Parallel Resonance.
(i) Impedance at Resonance $Z = R$ and is minimum.	Impedance at resonance $Z = \frac{L}{CR}$ and is maximum. (1/2M)
(ii) Current at resonance $I = \frac{V}{R}$, is maximum.	Current at resonance $I = \frac{VCR}{L}$, is minimum. (1/2M)
(iii) $Q = \frac{\text{Voltage across Inductor or Capacitor}}{\text{Voltage at Resonance}} = \frac{2\pi f_0 L}{R}$ It magnifies voltage across L and C	$Q = \frac{\text{Current through Inductor or capacitor}}{\text{Current at Resonance}} = \frac{2\pi f_0 L}{R}$ It magnifies Current through L and C. 1M

Q.2(a)



200V, 50Hz supply.

$R_A = 5\Omega$
$X_A = 8\Omega$.
$R_B = ?$
$X_B = ?$

$P = 2\ KW$ $\qquad Q = 1.15\ KVAR.$

$$\tan\phi = \frac{Q}{P} = \frac{1.15}{2} = 0.575$$

$$\phi = \tan^{-1}(0.575) = 29.89°.$$

Apparant Power $S = \sqrt{P^2+Q^2} = \sqrt{2^2+1.15^2} = 2307.05\ VA$

$$\therefore I = \frac{S}{V} = \frac{2307.05}{200} = 11.53 \angle -29.89°\ A.$$

Now

total Impedance $Z = \frac{V}{I} = \frac{200\angle 0}{11.53\angle -29.89}$

$$\therefore Z = 17.34 \angle 29.89°\ \Omega.$$

$R_{TOTAL} = R_A + R_B = Z\cos\phi = 17.34\cos(-29.89)$

$= 15.03\ \Omega$

$\therefore R_B = 15.03 - 5 = \boxed{10.03\ \Omega}$

$X_{TOTAL} = Z\sin\phi = 17.34\sin(\cdot 29.89^\circ) = 8.641\ \Omega$ (Inductive coil).

$= X_A + X_B$

$\therefore X_B = 8.641 - 8 = \boxed{0.641\ \Omega}$

$V_A = V_{RA} + jV_{XA}$

$V_{RA} = 11.53 \times 5 = 57.65\ V$

$V_{XA} = 11.53 \times 8 = 92.24\ \Omega$

Active power of coil A

$P_A = 57.65 \times 11.53 = 664\ W$

Reactive power of coil B

$Q_A = 92.24 \times 11.53 = 1063.5$ VAR

$\frac{R_A}{X_A} = \frac{5}{8} \Rightarrow \cancel{\cot}\phi = 5/8$

~~p.factor~~ $= \phi_A = \cancel{32.00}^\circ\ 57.99^\circ$

$\cos\phi_A$ = power factor = $\cos \cancel{57}.99$

$= \cancel{0.847} = 0.52$

lag.

$V_B = V_{RB} + jV_{XB}$

$V_{RB} = 11.53 \times 10.03$

$= \cancel{115.75}\ V \cdot 115.6\ V$

$V_{XB} = 11.53 \times 0.641$

$= 7.39\ V.$

$P_B = 11.53 \times 118.76 = 1333\ W$ (coil B)

$= \cancel{133.78}\ W$ (Active Power)

$Q_B = 11.53 \times 7.39$

$= 85.206$ VAR.

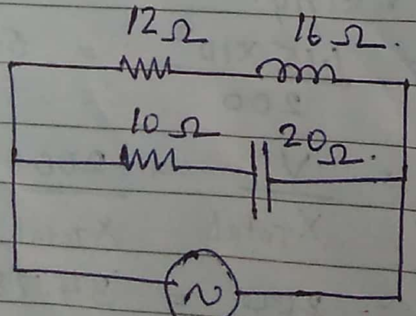
Reactive power of coil B

$\frac{R_B}{X_B} = \frac{10.03}{0.641} = 15.647\ \cancel{\cot}\phi_B$

$\phi_B = \cancel{86.34}^\circ\ 3.65^\circ$ 3.65

power factor = $\cos \cancel{86.34} = 0.9979$ lag.

Q2(b)



230V, 50 Hz

1-φ, AC Supply.

Branch 1 → $12 + j16\ \Omega$

Branch 2 → $10 - j20\ \Omega$.

PAGE NO.:
DATE / /

For Branch 1 (12 + j16 Ω Branch).

$$I = \frac{V}{Z_1} = \frac{230\angle 0}{12 + j16} = \frac{230\angle 0}{20\angle 53.3^\circ} = 11.5\angle -53.3^\circ \text{ A.}$$

(1/2M)

$Z_1 = 20\angle 53.3^\circ\ \Omega$ | $\phi_1 = 53.33^\circ$

Active power $= P_1 = VI_1 \cos\phi_1 = 230 \times 11.5 \cos(-53.3^\circ)$
$= 1580.7$ W $= 1.580$ kW

(1/2M)

Reactive power $= Q_1 = VI_1 \sin\phi_1 = 230 \times 11.5 \sin(-53.3^\circ)$
$= 2120.6$ VAR $= 2.12$ KVAR.

(-1/2M)

Apparent power $= VI_1 = 11.5 \times 230 = 2645$ VA
$= 2.645$ KVA (-1/2M)

power factor $= \cos(\phi_1) = \cos(-53.33) = 0.5972$ lagging

For Branch 2 (10 − j20 Ω).

$$I_2 = \frac{V}{Z_2} = \frac{230}{10 - j20} = \frac{230}{22.36\angle -63.43^\circ} = 10.28\angle 63.43^\circ \text{ A.}$$

(1/2M)

$P_2 = VI_2 \cos(\phi_2) = 230 \times 10.28 \cos(63.43) = 1.057$ KW (1/2M)

$Q_2 = VI_2 \sin(\phi_2) = 230 \times 10.28 \sin(63.43) = 2.114$ KVAR.

(1/2M)

$S_2 = VI_2 = 230 \times 10.28 = 2.364$ KVA.

(1/2M)

power factor $= \cos(\phi_2) = \cos(63.43) = 0.4472$ leading

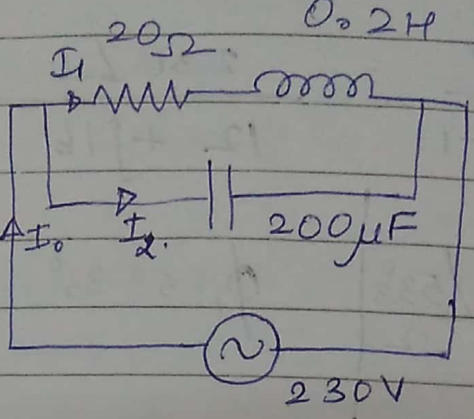
(1/2M)

Q.3 Attempt any one.

(a) $L = 0.2H$.

$R = 20\,\Omega$.

$C = 200\,\mu F$



(i)

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{1}{0.2\times 200\times 10^{-6}} - \left(\frac{20}{0.2}\right)^2}$$

$\boxed{f_0 = 19.49\ Hz}$ = Resonance frequency.

(ii) Dynamic Impedance

$$Z_D = \frac{L}{CR} = \frac{0.2}{200\times 10^{-6}\times 20} = 50\,\Omega$$

(iii) Current

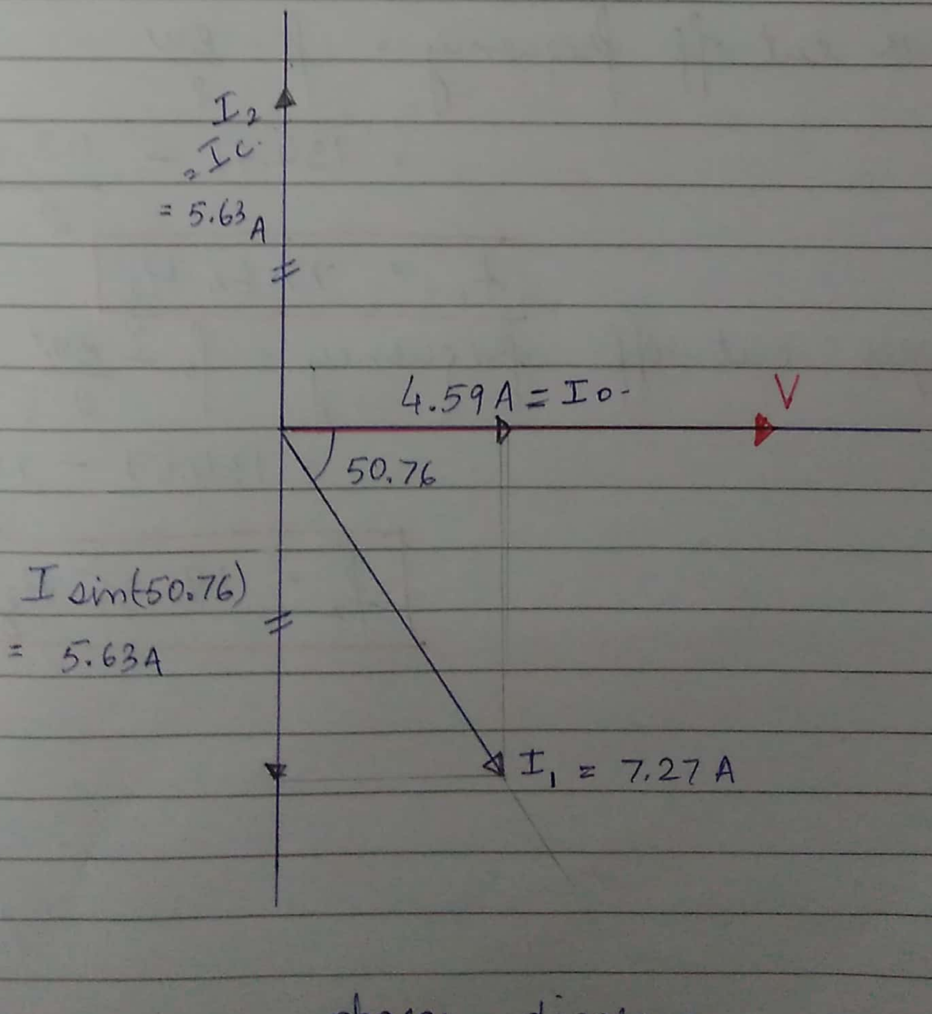
$$I = \frac{V}{Z_D} = \frac{230}{50} = 4.6\ A.$$

$$Z_1 = 20 + j2\pi f L \ \Omega$$
$$= 20 + j2\pi \times 19.49 \times 0.2 \ \Omega$$
$$= 20 + j24.49 \ \Omega$$
$$Z_1 = 31.62 \angle 50.76^\circ \ \Omega$$

$$Z_2 = -jX_c = \frac{-j}{2\pi f C} = \frac{-j}{2\pi \times 19.49 \times 200 \times 10^{-6}}$$
$$Z_2 = -j40.82 \ \Omega = 40.82 \angle -90^\circ \ \Omega$$

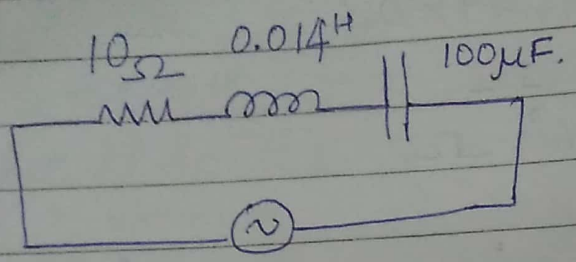
$$\therefore I_1 = \frac{V}{Z_1} = \frac{230}{31.62 \angle 50.76^\circ} = 7.27 \angle -50.76^\circ \ A$$

$$I_2 = \frac{V}{Z_2} = \frac{230}{40.82 \angle -90^\circ} = 5.634 \angle 90^\circ \ A$$



phasor diagram.

Q.3(b) R-L-C. series circuit



L = 0.014 H.
C = 100 μF
R = 10 Ω.

(i) Resonant frequency $= \dfrac{1}{2\pi\sqrt{LC}} = \boxed{134.51\ Hz}$.

(ii) Quality factor, $Q_0 = \dfrac{1}{R}\sqrt{\dfrac{L}{C}} = \dfrac{1}{10}\sqrt{\dfrac{0.014}{100\times10^{-6}}} = \boxed{1.183}$

(iii) Band width $= \dfrac{R}{2\pi L} = \dfrac{10}{2\pi\times0.014} = \boxed{113.68\ Hz.}$

(iv) lower cut-off frequency $= f_0 - \dfrac{BW}{2}$

$= 134.51 - \dfrac{113.68}{2}$

$\boxed{f_1 = 77.66\ Hz}$

(v) upper cut-off frequency $= f_0 + \dfrac{BW}{2}$

$= 134.51 - \dfrac{113.68}{2}$

$\boxed{f_2 = 191.35\ Hz.}$

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