BE END SEM EXAM RUBRIC

PART (I):

SOL (1):

Voltage Magnification: In Series Resonance of R, L & C circuit, the voltage across inductor 'or' voltage across capacitor is greater than the source voltage. This phenomenon is called as Voltage Magnification.

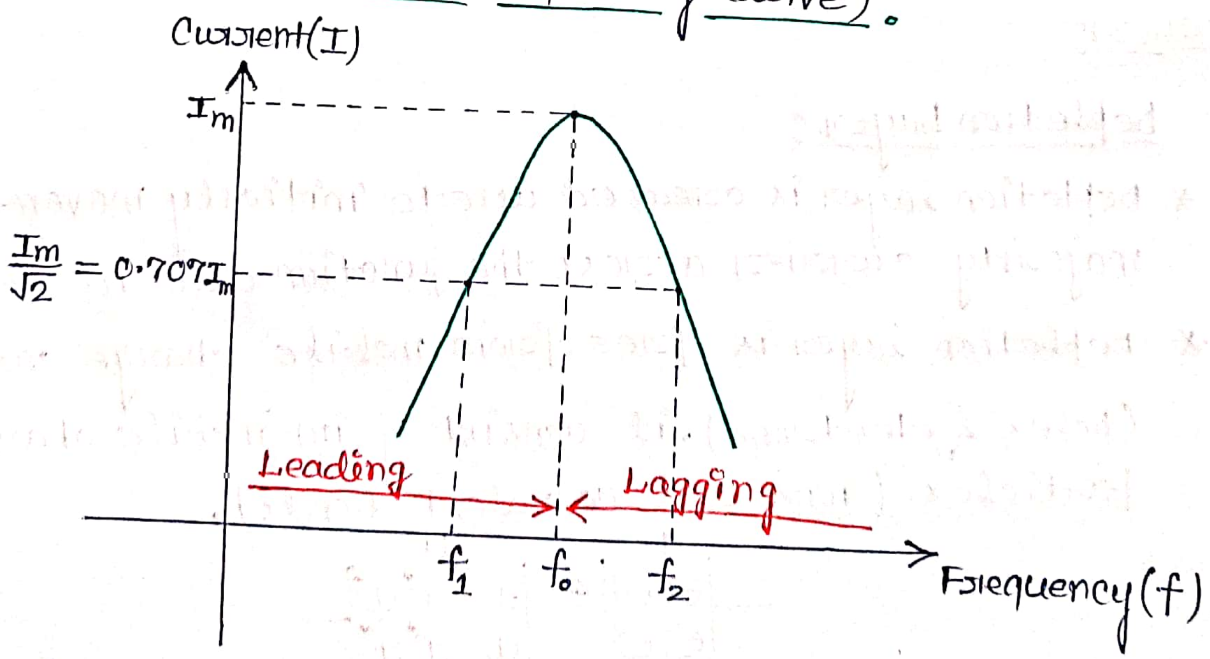
→ (1 Point)

Current Magnification: In Parallel Resonance of R, L & C circuit, the current in an inductor or the current in capacitor is greater than the source current. This phenomenon is called as Current Magnification.

→ (1 Point)

SOL (2):

Resonance Curve (Current vs Frequency Curve):



where, f_0 = Resonance frequency

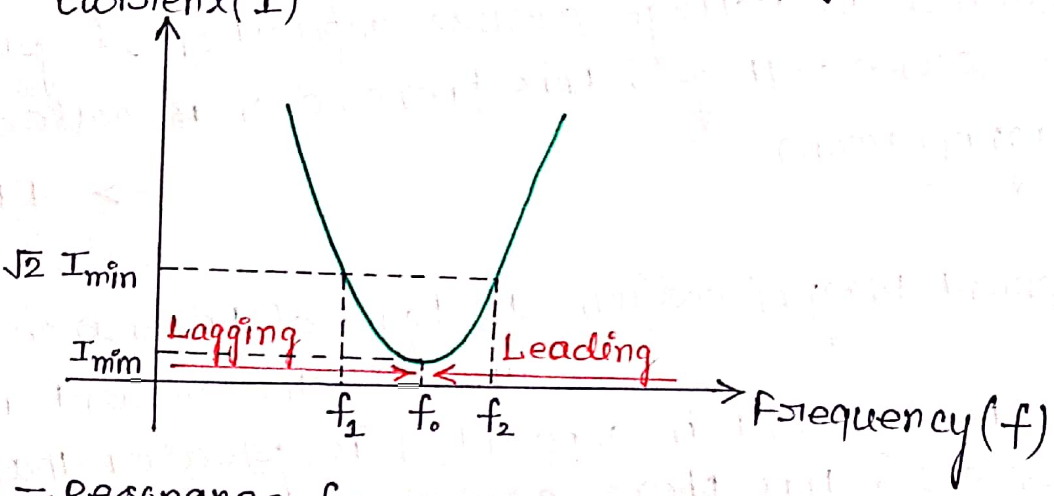
f_1 & f_2 = Half Power frequency 'OR' 3-dB Points

f_1 = Lower cut off frequency

f_2 = Upper Cut off frequency

I_m = Maximum Current → (1 Point)

Anti Resonance Curve (Current vs Frequency Curve):



where, f_0 = Resonance frequency

f_1 = Lower cut off frequency

f_2 = Upper cut off frequency

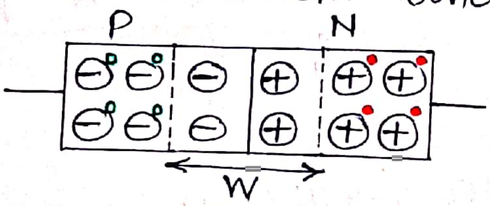
I_{min} = Minimum Current

→ (1 Point)

SOL(3):

Depletion Layer:

* Depletion layer is created due to initially movement of majority carrier across the junction due to diffusion.
* Depletion layer is free from mobile charge carrier (holes & electrons), it consist of im-mobile charge particles (ions and co-valent bonds).



W = Depletion layer width → (1 Point)

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Effect of Biasing on Depletion Width:

* Case (I): Forward Biasing

When P-N Junction is forward bias then the width of depletion layer slightly reduces. → (0.5 Point)

* Case (II): Reverse Biasing

when P-N Junction is reverse bias then the width of depletion layer slightly increases. → (0.5 point)

SOL (4):

Dark Current: When a reverse bias Photo Diode is kept under darkness then the Photo Diode will be working as normal diode & the current flowing through this is called as Dark current.

→ (1 Point)

* Photo diode is work under mainly Reverse Bias (RB) condition.

→ (0.5 Point)

* Solar cell is work under Unbiased Mode.

→ (0.5 Point)

SOL (5):

D_1 : ON

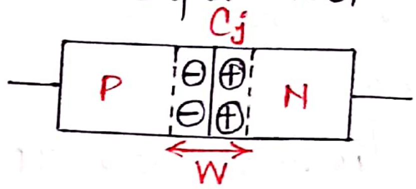
D_2 : OFF

D_3 : OFF

→ (2 Point)

SOL(6):

* Yes, Diode can be used as variable capacitor.
* In a P-N junction, the depletion layer will be working as a parallel plate capacitor.



Here, Junction Capacitance, $C_j = \left(\frac{A\epsilon}{W}\right)$ Farad

where $A =$ Junction area

$W =$ Depletion layer width

$C_j \propto A$

$C_j \propto (1/W)$

* Hence by varying Junction area 'OR' width of depletion layer, we can vary Junction capacitance.

→ (2 Point)

SOL(7):

Direct Band Gap (DBG) Semiconductor	Indirect Band Gap (IBG) Semiconductor
* During recombinations, most of the energy is released in form of light.	* During recombinations, most of the energy is released in the form of heat.
* During recombinations, most of free $\bar{e}$'s falling from CB will directly fell into VB & hence the name is DBGSC.	* During recombinations, most of the free $\bar{e}$'s falling from CB will go into intermediate level & then fell into VB & hence the name is IBG-SC.
* GaAs, GaSb, GaN, InAs, InSb, ZnS, ZnSe, CdS, CdSe, InP	* Si, Ge, AlP, AlSb, PbS, PbSe, GaP

→ (2 Point)

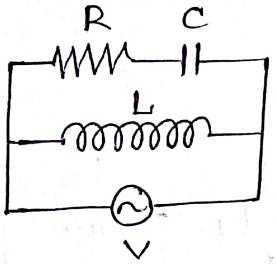
DBG Semiconductor

* The energy of the falling $\bar{e}$'s changes (both KE & PE changes)
* No change in direction of the falling $\bar{e}$'s (CB→VB)
* No change in the path of falling $\bar{e}$'s.
* The $\bar{e}$'s can release energy with or without a change in momentum of the falling $\bar{e}$'s.
* Relatively smaller carrier lifetime.

IBG Semiconductor

* The energy of the falling $\bar{e}$'s changes (both KE & PE changes)
* No change in the direction of the falling $\bar{e}$'s (CB→VB)
* The path of falling $\bar{e}$'s changes.
* No $\bar{e}$'s can release the energy without a change in momentum of the falling $\bar{e}$'s.
* Relatively larger carrier lifetime.

SOL(8):



Equivalent impedance $(Z_{eq}) = (R - jX_c) \,||\, (jX_L)$

$$= \frac{(R-jX_c)(jX_L)}{(R-jX_c+jX_L)} = \frac{(jRX_L + X_cX_L)}{R+j(X_L-X_c)}$$

$$= \frac{[jRX_L + X_cX_L][R-j(X_L-X_c)]}{[R+j(X_L-X_c)][R-j(X_L-X_c)]}$$

For resonance freq (f_0), $\text{Img}\,(Z_{eq}) = 0$

$$\frac{R^2X_L - X_cX_L(X_L-X_c)}{R^2+(X_L-X_c)^2} = 0$$

$$R^2X_L = X_LX_c(X_L-X_c)$$

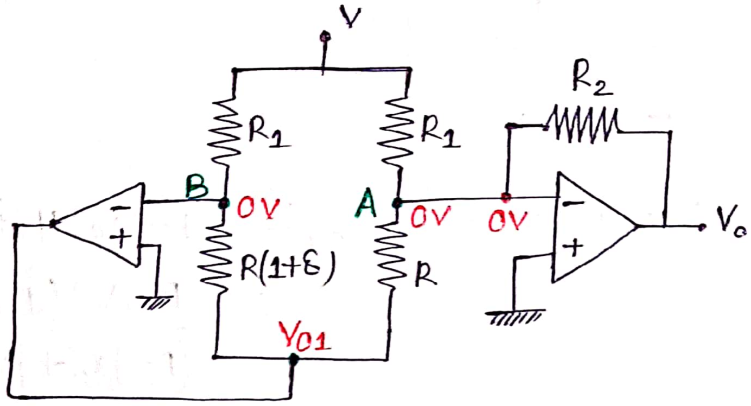
$$R^2 = \frac{1}{\omega C}\left(\omega L - \frac{1}{\omega C}\right)$$

$$\therefore f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{(LC-R^2C^2)}} \text{ Hz.}$$

→ (2 Point)

Part (II):

SOL(1):



KCL at node 'B'—

$$\frac{0-V}{R_1} + \frac{0-V_{o1}}{R(1+\delta)} = 0$$

$$\therefore V_{o1} = \frac{-R(1+\delta)}{R_1} V$$ → (3 Point)

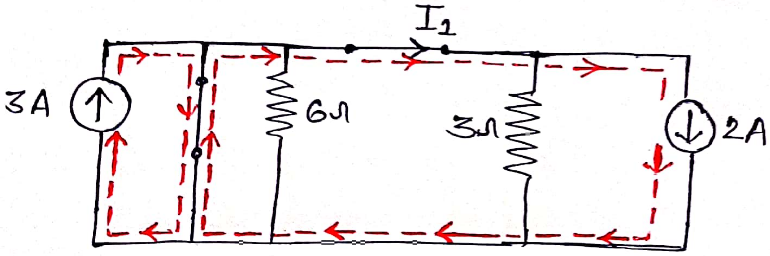
KCL at node 'A'—

$$\frac{0-V}{R_1} + \frac{0-V_o}{R_2} + \frac{0-V_{o1}}{R} = 0$$

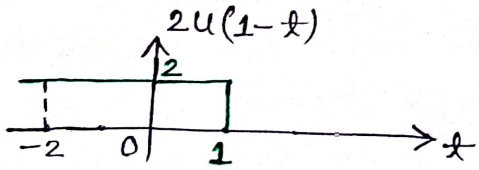
$$\therefore V_o = \left(\frac{R_2}{R_1} \delta V\right)$$ → (3 Point)

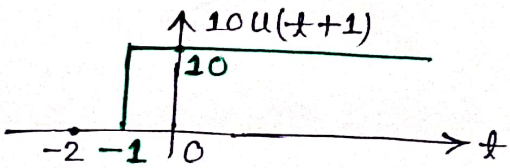
SOL(2):

Equivalent circuit at $t = (-2)$ sec



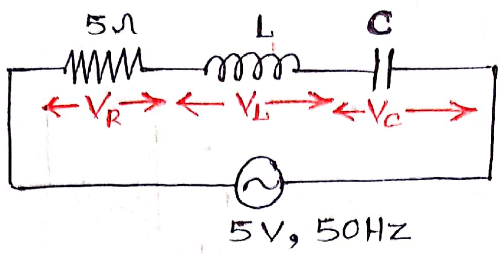
$\therefore I_1 = 2A$





→ (6 Point)

SOL(3):



Given— $V_L = V_C = 2V_R$ (Showing Resonance condition)

We know that at series resonance, $V_R = V$

$\therefore V_R = 5$ Volt

$\therefore V_L = V_C = 10$ Volt

For series resonance, Quality Factor $(Q) = \frac{X_L \text{ 'OR' } X_C}{R}$

$= \frac{V_L \text{ 'OR' } V_C}{V}$

$\therefore Q = \frac{V_L \text{ 'OR' } V_C}{V} = \frac{10}{5} = 2$

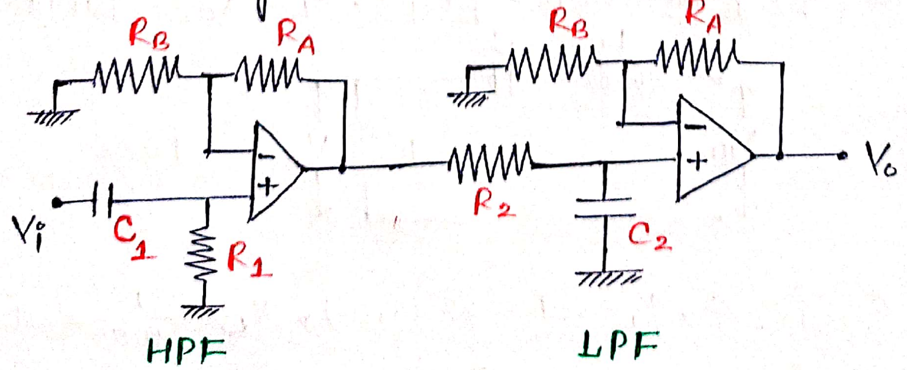
$Q = \frac{X_L}{R} = \frac{\omega L}{R}$

$2 = \frac{50 \times L \times 2\pi}{5}$

$\therefore L = (1/10\pi)\, H$ → (6 Point)

SOL(4):

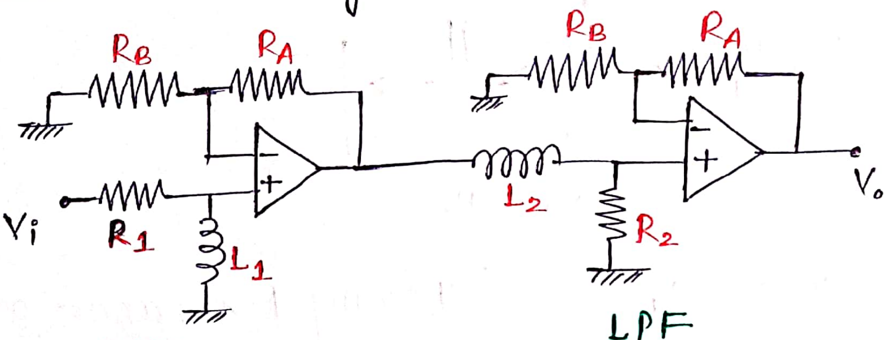
Case(I): BPF using op-amp, capacitor & Resistor



$f_L = \left(\frac{1}{2\pi R_1 C_1}\right)$ Hz $\qquad f_H = \left(\frac{1}{2\pi R_2 C_2}\right)$ Hz

where, $f_H > f_L$

Case(II): BPF using op-amp, Inductor & Resistor



HPF

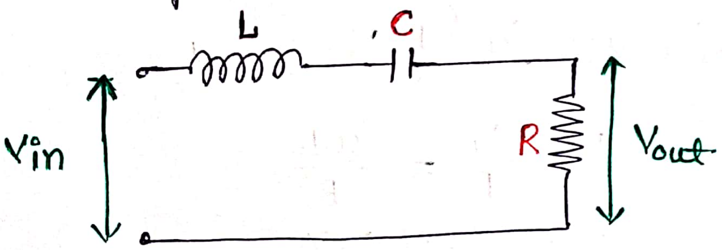
$$f_L = \frac{1}{2\pi(L_1/R_1)} \text{ Hz}$$

LPF

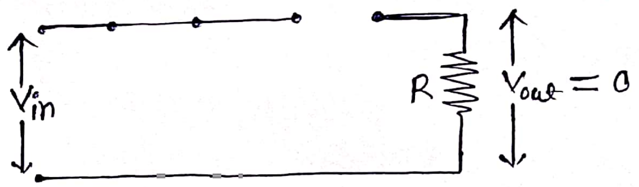
$$f_H = \frac{1}{2\pi(L_2/R_2)} \text{ Hz}$$

where $f_H > f_L$

* It is possible to make BPF using only R, L & C (Passive filters). One of the example is — RLC series BPF

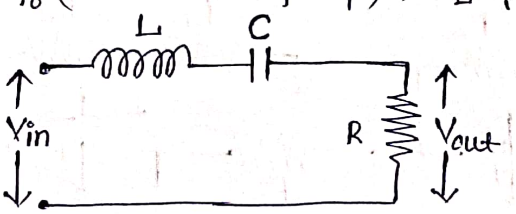


Case(I): at $f = 0\text{Hz}$, $X_L = \omega L = 0$ (S.C.), $X_C = \frac{1}{\omega C} = \infty$ (O.C.)



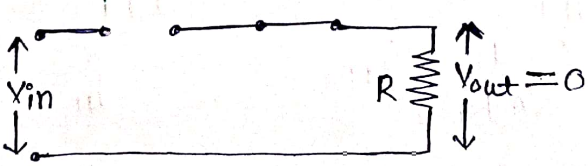
Stop

Case(II): at $f = f_0$ (resonance freq.), X_L & X_C = finite value



Pass

Case(III): at $f = \infty$, $X_L = \omega L = \infty$ (O.C.), $X_C = \frac{1}{\omega C} = 0$ (S.C.)

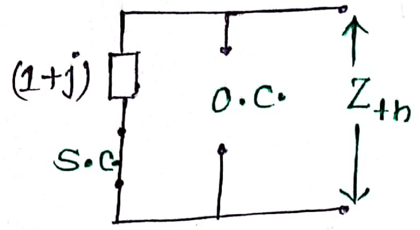


Stop

So, this is Band Pass filter (BPF).

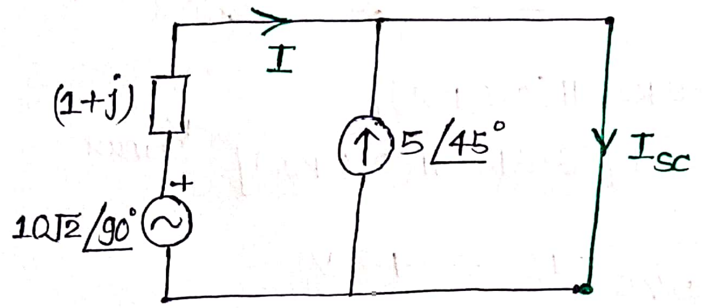
SOL(5):

Case (I): To find Thevenin Resistance (Z_{th})



$$\therefore Z_{th} = (1+j) = \sqrt{2}\angle 45^\circ \ \Omega$$ → (2 Point)

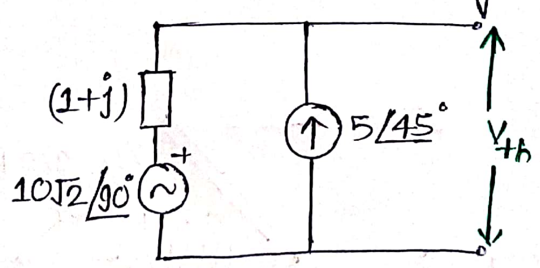
Case (II): To find Norton Current (I_N)



$$\therefore I_{sc} = I + 5\angle 45^\circ = \frac{10\sqrt{2}\angle 90^\circ}{\sqrt{2}\angle 45^\circ} + 5\angle 45^\circ$$

$$= 10\angle 45^\circ + 5\angle 45^\circ = 15\angle 45^\circ \ A$$ → (2 Point)

Case (III): To find Thevenin Voltage (V_{th})



$$\frac{V_{th} - 10\sqrt{2}\angle 90^\circ}{\sqrt{2}\angle 45^\circ} = 5\angle 45^\circ$$

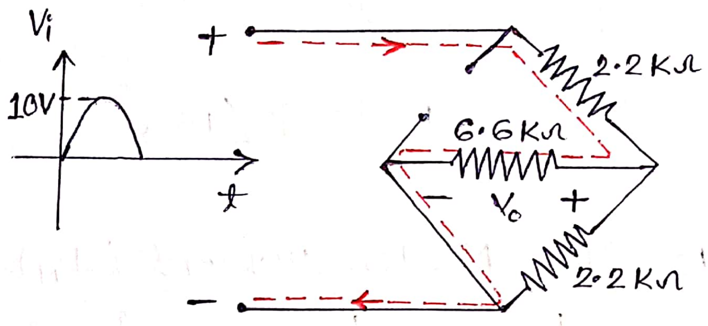
$$\therefore V_{th} = 15\sqrt{2}\angle 90^\circ \ \text{Volt}$$ → (2 Point)

SOL (6):

Case (I): For positive half cycle of input voltage

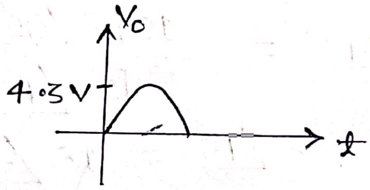
$D_1 \rightarrow OFF$

$D_2 \rightarrow ON$



$$\therefore V_{o\,max} = \frac{[(6.6K\Omega)\,||\,(2.2K\Omega)]}{2.2K\Omega + [(6.6K\Omega)\,||\,(2.2K\Omega)]}\, V_{i\,max}$$

$$= \frac{0.75}{1+0.75} \times 10 = 4.3\,V$$

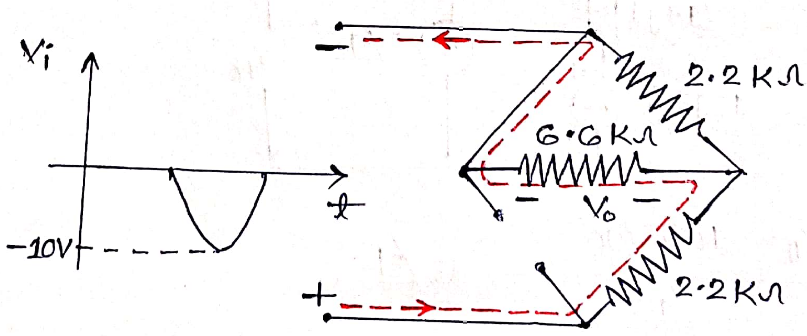


→ (2.5 Point)

Case (II): For Negative half cycle of input voltage

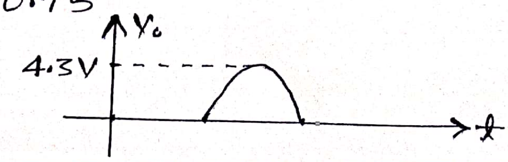
$D_1 \rightarrow ON$

$D_2 \rightarrow OFF$



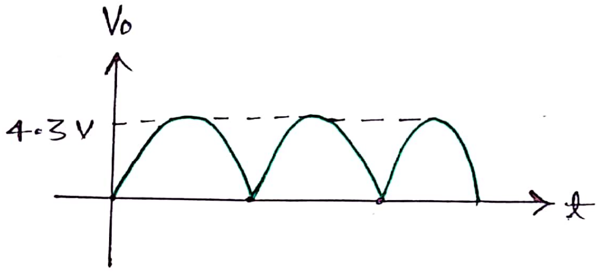
$$\therefore V_{o\,max} = \frac{[(6.6K\Omega)\,||\,(2.2K\Omega)]}{2.2K\Omega + [(6.6K\Omega)\,||\,(2.2K\Omega)]}\, V_{i\,max}$$

$$= \frac{0.75}{1+0.75} \times 10V = 4.3V$$



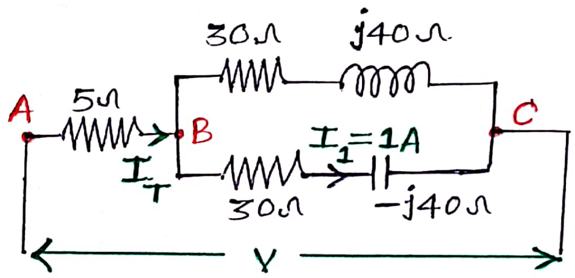
→ (2.5 Point)

Still the polarity of output voltage is in the same direction. So, net output of the circuit will be a full rectified wave.



→ (1 Point)

SOL(7):



$$I_1 = I_T \times \left(\frac{30+j40}{30+j40+30-j40}\right)$$

$$1 = I_T \times \frac{50\angle \tan^{-1}(4/3)}{60}$$

$$I_T = \frac{60}{50\angle \tan^{-1}(4/3)} = 1.2\angle \tan^{-1}(-4/3)\ A$$

$$\therefore V_{AB} = 5 \times I_T = 6\angle \tan^{-1}(-4/3)\ V$$

$$\therefore V_{BC} = 1 \times (30-j40) = 50\angle \tan^{-1}(-4/3)\ V$$

$$\therefore V = V_{AB} + V_{BC}$$

$$= 6\angle \tan^{-1}(-4/3) + 50\angle \tan^{-1}(-4/3)$$

$$= 56\angle \tan^{-1}(-4/3)\ \text{Volt}$$

→ (6 Point)