Q2 a)

Here, $N = 10/I = \frac{I}{0.5} = 2$

$$Q = \frac{\omega_0 L}{R} = 2\pi \times 75 \times \frac{9}{50}$$

$$= 84.8$$

Let f_1 and f_2 be frequencies at which current falls to half its max. value at resonance frequency.

$$f_0/f_1 - \frac{f_1}{f_0} = \frac{\sqrt{3}}{Q}$$

or $$\frac{75}{f_1} - \frac{f_1}{75} = \frac{\sqrt{3}}{84.4}$$

or $$\frac{(75^2 - f_1^2)}{75 f_1} = 0.02$$ or

$$f_1^2 + 1.5 f_1 - 5625 = 0$$

or $$\boxed{f_1 = 74.25 \text{ Hz}}$$

Also, $$\frac{f_2}{75} - \frac{75}{f_2} = \frac{\sqrt{3}}{84.4}$$

or $$f_2^2 - 1.5 f_2 - 5625 = 0$$

or $$\boxed{f_2 = 75.75 \text{ Hz}}$$

Selectivity $= \frac{f_0}{f_2 - f_1} = \frac{75}{75.75 - 74.25} = 50$ (Ans)

Frequency when $I = 0.5$ Amp is 75.75 Hz.

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Detune factor

$$X_C = \frac{1}{2\pi f_c} = \frac{1}{2 \times \pi \times 75.75}$$

$$= \frac{1}{2 \times 3.14 \times 75.75} = 2.1021 \times 10^{-3}\ \Omega$$

$$X_L = 2\pi f_L = 2 \times 3.14 \times 75.75$$

$$= 475.71\ \Omega$$

(b) $$V_1 = L_1 \frac{di_1}{dt} + M \frac{di_2}{dt}$$

$$L_1 \frac{d}{dt}(10t^{-1}) + M \frac{d}{dt}(10t^{-1} + 10t^{-1})$$

$$L_1\, 10(-10)\, t^{-2} + M\,[10(-1)t^{-2} + 10(-1)t^{-2}]$$

Putting values -

$$V_1(t) = 2(10)(-1)t^{-2} + 2(-20t^{-2})$$

$$= -20t^{-2} - 40t^{-3}$$

$$\boxed{V_1(t) = -60t^{-2}}$$

$$V_2(t) = L_2 \frac{d i_2(t)}{dt} + M \frac{d(i_1(t))}{dt}$$

$$L_2 \frac{d}{dt}(10t^{-1} + 10t^{-3}) + M \frac{d}{dt}(10t^{-1})$$

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$$\frac{1}{2}(20)(-1)e^{-t} + 10(H)(-1)e^{-t}$$

Putting values.

$$V_2(t) = 4(20)(-1)e^{-t} + 10(2)(-1)e^{-t}$$

$$= -80e^{-t} - 20e^{-t}$$

$$\boxed{V_2(t) = -100e^{-t}}$$

(c) $\frac{1}{2}\frac{(1)^2}{2} + \frac{1}{2}\frac{2^2}{2}$

$= 0.25 + 1$

$= 1.25 + 1.2H$

$= 2.45\ H$

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