

Exam-Elec1 Answer Key

Exercise 1 (4 points):

1. Questions:

Q1: Components R, L, and C are passive components (0.5 points)

Q2: Power is measured in watts (0.5 points)

2- Circuit (a): $V_2 = 10V$, $I = 25mA$, $R_2 = 400 \Omega$ (1.5 points)

3- Circuit (b): $R_{AB} = 4R$, current $I = 10mA$ (1.5 points)

Exercise 2 (6 points):

1) Number of nodes ($N = 2$), number of branches ($B = 4$), number of loops ($M = 6$). (1 pt)

2) Calculate V_{AB} (3 pts) (apply Millman's theorem) $V_{AB} = 8V$

3) Direction of currents I_1, I_2, I_3 on the diagram and calculation: $I_1 = 0.2mA$, $I_2 = 1.4mA$, $I_3 = 0.8mA$ (2 pts)

Exercise 3 (10 pts)

I)

1. $Z_1 = Z_R + Z_C = R - j/C\omega = 10 - j10$, $Z_2 = Z_R + Z_L = R + jL\omega = 30 + j10$ (2.5 pts)

2. $Z = Z_1 // Z_2 = Z_1 \cdot Z_2 / (Z_1 + Z_2)$ $Z = 10 - j5 \Omega$ (0.5 pts)

The circuit has a capacitive reactance of $-j5$; An inductance in series ($L=5$ mH) must be added to cancel this imaginary part. (1 pt)

3) Complex current: $I = U/Z = 0.8 + j0.4$ $|I| = 0.89$ A and $\varphi = 26.6^\circ$. I and V are out of phase (0.5 pts)

$I(t) = 0.89(\cos(\omega t + 26.6^\circ))$ (0.5 pts)

Currents $i_1(t)$ and $i_2(t)$: $i_1(t) = V(t)/Z_1 = 0.5 + j0.5$ and $i_2(t) = V(t)/Z_2$

$i_1(t) = 0.7 \cos(\omega t + \pi/4)$ A and $i_2(t) = 0.316 \cos(\omega t - 18.4^\circ)$ A (1 pt)

4. $P = 4$ W (1 pt) Active power is dissipated only in resistors. Ideal capacitors and inductors do not consume active power.

II)

1) Transfer function (0.5pts): $T(j\omega) = (R / (2R + jL\omega))$;

Its magnitude is given by $G_v = |T(j\omega)| = (1 / (4 + (L\omega/R)^2))^{1/2}$. (0.5 pts)

Its phase: $\varphi(\omega) = 0 - \arctan(L\omega/2R)$ (0.5 pts)

$L\omega/2R = 1$, $\omega = 2R/L = 10^3$ rad/s (0.25 pts)

G_v (dB) for $\omega = 10^3$ rad/s, giving a gain G_v (dB) = -9 dB (0.25 pts)

2. For $\omega = 10^7$ rad/s, $G_v = -86$ dB (0.5 pts)

As ω increases, G_v decreases (it tends towards 0). The circuit attenuates high frequencies. This circuit performs the function of a filter. (0.5 pts)