ESE 271 Final Exam Name:

Fall, 2009 ID Number:

Do not place your answers on this front page.

Each problem is worth 25 points.

Prob. 1:

Prob. 2:

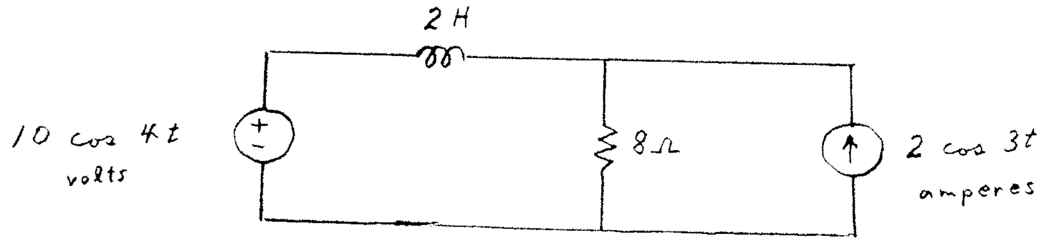
Prob. 3:

Prob. 4:

final exam

**Prob. 1:**

This circuit is in the AC steady state. Determine the average power dissipated in the 8 Ω resistor.

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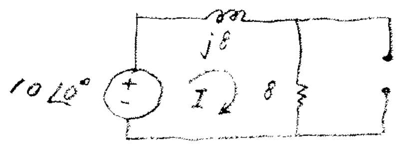
FOR THE 10 cos 4t SOURCE ALONE:




$$I = \frac{10}{8+j8} = \frac{10}{8\sqrt{2}\,\angle 45^\circ}$$

$$P = \frac{|I|^2 R}{2} = \left(\frac{10}{8\sqrt{2}}\right)^2 \frac{8}{2} = 3.125 \text{ WATTS}$$

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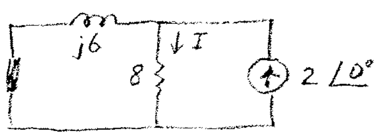
FOR THE 2 cos 3t SOURCE ALONE:




$$I = 2\,\frac{j6}{8+j6} = 2\,\frac{6\angle 90^\circ}{10\angle 36.87^\circ}$$

$$P = \frac{|I|^2 R}{2} = \frac{(1.2)^2\, 8}{2} = 5.760 \text{ WATTS}$$

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TOTAL AVERAGE POWER $= 3.125 + 5.760 = 8.885$ WATTS

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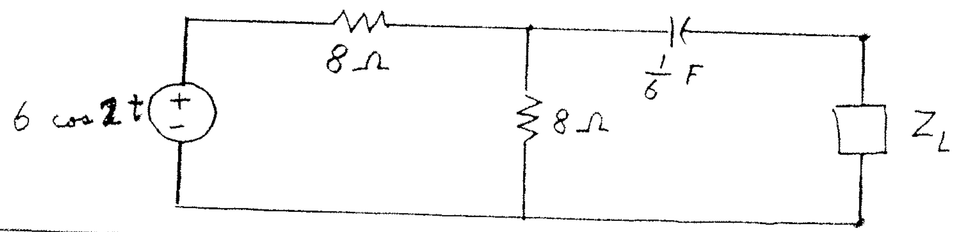
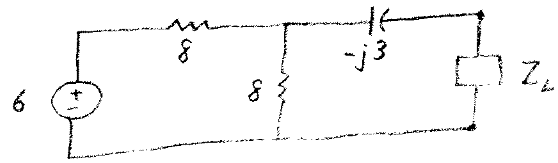
**Prob. 2:**

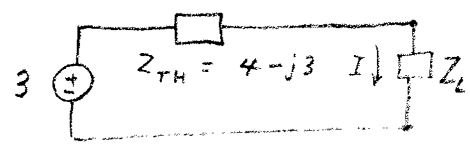
Determine $Z_L$ so that the average power dissipated in $Z_L$ is a maximum. Assume $Z_L$ is a resistor in series with an inductor or capacitor. Give the value of that resistor and also of the inductor or capacitor. Also, state the value of that maximum average dissipated power.




PHASOR CIRCUIT:




THE THEVENIN EQUIVALENT CIRCUIT TO THE LEFT OF $Z_L$:




$$Z_{TH} = -j3 + \frac{8 \times 8}{8+8} = 4 - j3$$

THEREFORE, $\quad Z_L = Z_{TH}^* = 4 + j3$

$$R_L = 3, \quad j\omega L = j3 \quad L = \frac{3}{2} \ H$$

$$I_{MAX} = \frac{3}{4 - j3 + 4 + j3} = \frac{3}{8}$$

$$P_{AV, MAX} = \frac{I_{MAX}^2 \ \mathrm{Re}\, Z_L}{2} = \left(\frac{3}{8}\right)^2 \frac{4}{2} = .28125 \text{ WATTS}$$

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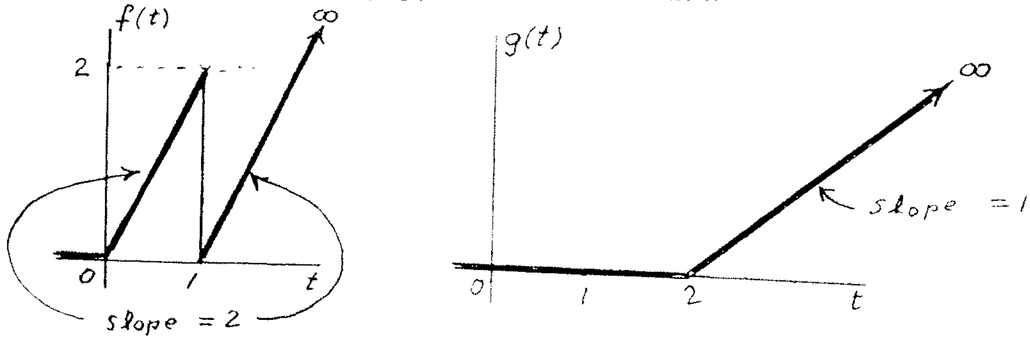
**Prob. 3:**

Determine the convolution $f(t) * g(t)$ as a function of time $t$.




$$f(t) = 2r(t) - 2u(t-1)$$

$$F(s) = \frac{2}{s^2} - \frac{2}{s} e^{-s}$$

$$g(t) = r(t-2)$$

$$G(s) = \frac{1}{s^2} e^{-2s}$$

$$F(s)\,G(s) = \left(\frac{2}{s^2} - \frac{2}{s} e^{-s}\right) \frac{1}{s^2} e^{-2s}$$

$$= \frac{2}{s^4} e^{-2s} - \frac{2}{s^3} e^{-3s}$$

$$f(t) * g(t) = \mathcal{L}^{-1} F(s)\,G(s)$$

$$= 2 \frac{(t-2)^3}{3!} u(t-2) - 2 \frac{(t-3)^2}{2} u(t-3)$$

$$= \frac{(t-2)^3}{3} u(t-2) - (t-3)^2 u(t-3)$$

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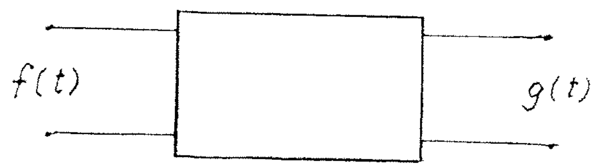
**Prob. 4:**

In this input-output system, when the input $f(t) = u(t)$, the output $g(t) = te^{-t}u(t)$. Determine $f(t)$ when $g(t) = (\cos t)(u(t))$.

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APPLY $\mathcal{L}$. IN THE FIRST CASE:

$$F(s) = \frac{1}{s}, \quad G(s) = \frac{1}{(s+1)^2}$$

THE TRANSFER FUNCTION $H(s) = \dfrac{G(s)}{F(s)} = \dfrac{s}{(s+1)^2}$

IN THE SECOND CASE:

$$G(s) = \frac{s}{s^2+1}$$

$$F(s) = \frac{G(s)}{H(s)} = \frac{(s+1)^2}{s^2+1} = \frac{s^2+2s+1}{(s-j)(s+j)}$$

$$F(s) = 1 + \frac{A}{s-j} + \frac{A^*}{s+j}$$

$$A = \left.\frac{s^2+2s+1}{s+j}\right|_{s=j} = 1$$

APPLY $\mathcal{L}^{-1}$

$$f(t) = \delta(t) + e^{jt} + e^{-jt} = \underline{\underline{\delta(t) + 2\cos t}}$$