**National Exams May 2004**

**98-Elec-A1 Circuits**

**3 hours duration**

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. Candidates may use one of two calculators, a Casio or Sharp model **No programmable calculators** are allowed.

3. This is a **closed book** examination. A table of Laplace transform is provided with this exam paper.

4. Any **five questions** constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.

5. All questions are of equal value.

**Question-1:**

Figure-1 shows a mutually coupled circuit. All the circuit parameters are shown in the figure.

(a) Write the Mesh current equations in terms resistance and the relevant reactances.

**(b)** Calculate current $\overline{I_1}$ . **[5+5]**

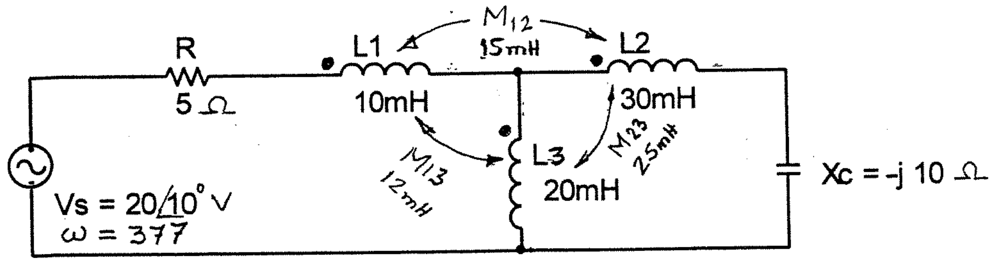


Figure - 1

**Question-2:**

Figure-2 shows a circuit with two Ideal Transformers (T1 and T2). Calculate the output voltage, $V_o$ . **[10]**

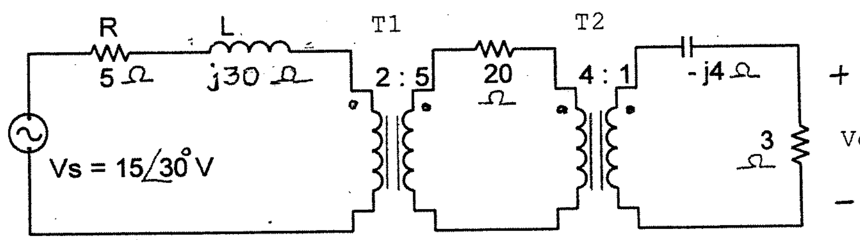


Figure - 2

**Question – 3**

**(a)** Find the **Laplace transform** of the following functions.

**(i)** $f(t) = \delta(t) - 5(t-1) + 10e^{-2t}$ **[2]**

**(ii)** $f(t)$ as shown in Figure – 3. **[3]**

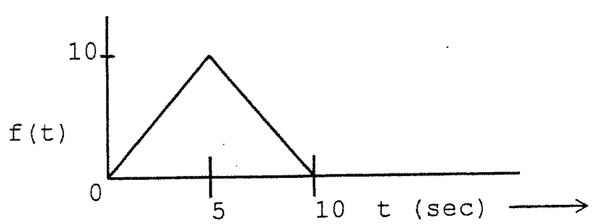


Figure-3

**Question - 3**

**(b)** Find the Inverse Laplace of the following Laplace Transforms:

**(i)** $F(s) = \frac{5(1+s)}{s^2\ (s+5)}$ **[2]**

**(ii)** $F(s) = \frac{10}{(s^2+2s+1)}$ **[3]**

**Question –4:**

In the circuit of Figure – 4, the switch was closed for a long time. At time $t = 0$, the switch is opened.

**(a)** Find $i_L(o^-)$, $\frac{di_L}{dt}(0^+)$, $v_c(o^-)$ *and* $\frac{dv_c}{dt}(0^+)$ **[5]**

**(b)** Draw the Laplace Transformed version of the circuit at $t \geq 0$. Do not solve the circuit.

**[5]**

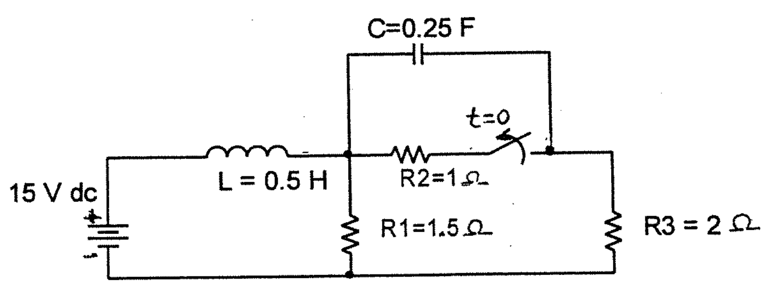


Figure - 4

**Question –5:**

**(a)** Determine the Impulse response of the circuit shown in figure -5. **[5]**

**(b)** If the input voltage $v_{in} = 5u(t)$, find $v_0(t)$. **[5]**

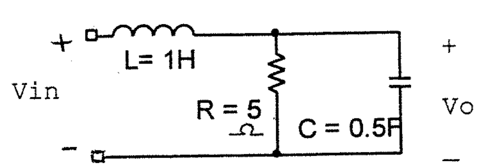


Figure - 5

**Question – 6:**

**(a)** For the circuit shown in Figure – 6, Thevenize at terminals **x – y.** [5]

**(b)** What must be the value of load $Z_L$ for maximum power dissipation in the load ? Calculate this maximum power dissipation at $Z_L$ . [5]

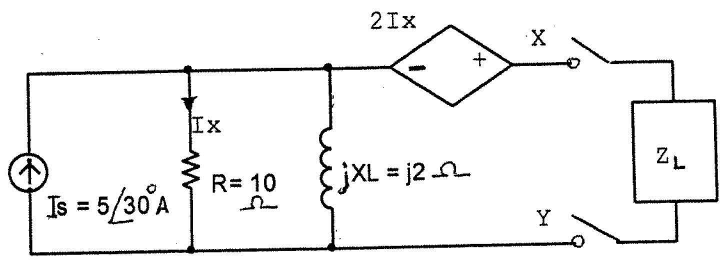


Figure - 6

**Question – 7:**

**(a)** For the circuit shown in Figure-7, determine its resonance frequency, $\omega_0$ in terms of L and C of the circuit.

**(b)** At its resonance frequency, determine the output voltage, $V_0$ . [5+5]

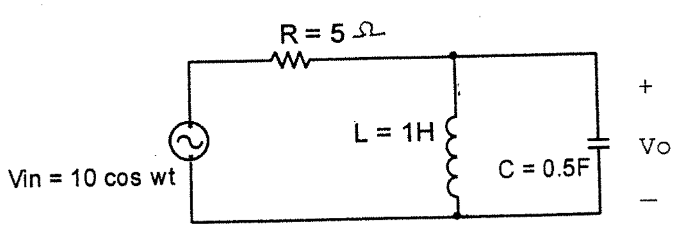


Figure - 7

Some useful **Laplace Transforms:**

| **f(t)** → | **F(s)** |
|---|---|
| $\delta(t)$ | 1 |
| $Ku(t)$ | $K/s$ |
| $t.u(t)$ | $1/s^2$ |
| $e^{-at}u(t)$ | $1/(s+a)$ |
| $e^{-at}f(t)$ | $F(s+a)$ |
| $\sin(wt).u(t)$ | $w/(s^2+w^2)$ |
| $\cos(wt).u(t)$ | $s/(s^2+w^2)$ |
| $e^{-at}\cos(wt).u(t)$ | $\frac{s+a}{(s+a)^2+w^2}$ |
| $e^{-at}\sin(wt).u(t)$ | $\frac{w}{(s+a)^2+w^2}$ |
| $\frac{df(t)}{dt}$ | $sF(s)-f(0^-)$ |
| $\frac{d^2f(t)}{dt^2}$ | $s^2F(s)-sf(0^-)-f'(0^-)$ |
| $\int_{-\infty}^{t} f(q)\,dq$ | $\frac{F(s)}{s}+\int_{-\infty}^{0} f(q)\,dq$ |