# National Exam May, 2011

## 07-Elec-A1 Circuits

## 3 hours duration

**NOTES:**

1. **No questions to be asked.** 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 logical assumptions made.

2. Candidates may use one of two approved Casio or Sharp calculators. **No programmable models** allowed.

3. This is a **closed book** examination.

4. Any **five questions** constitute a complete paper. Please indicate in the front page of your answer book which questions you want to be marked. If not indicated, only the first five questions as they appear in your answer book will be marked.

5. All questions are of equal value.

6. **Laplace Table** is given in the last page of this question paper.

Q1: In the Figure-1 solve the voltage, $V_o$ by the Superposition theorem. [20]

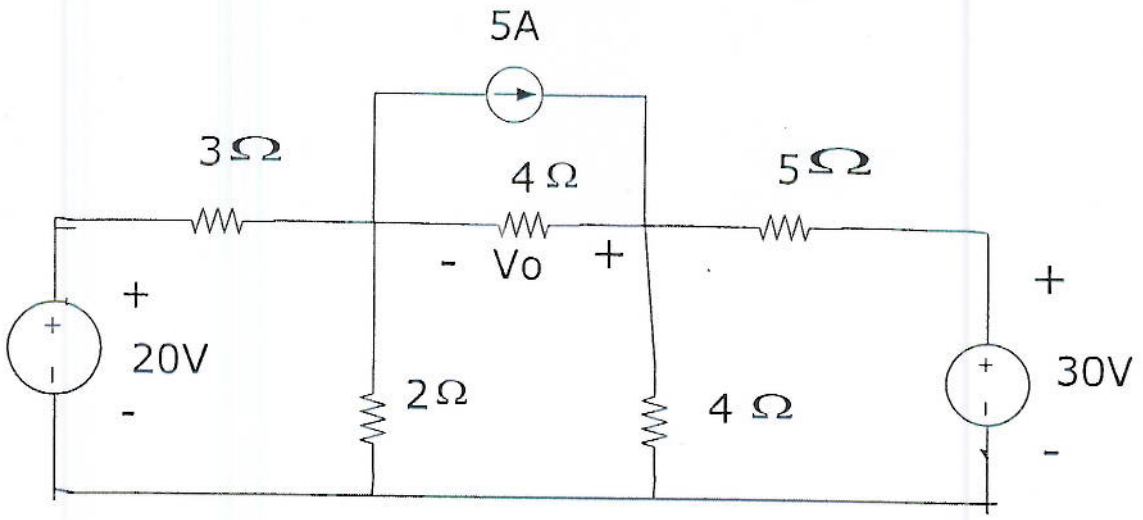


Figure-1

Q2: (a) Write the Node Voltage equations of the ac circuit shown in Figure-2. [8]

(b) Solve the node voltages, and calculate the current, $i_0(t)$. [6+6]

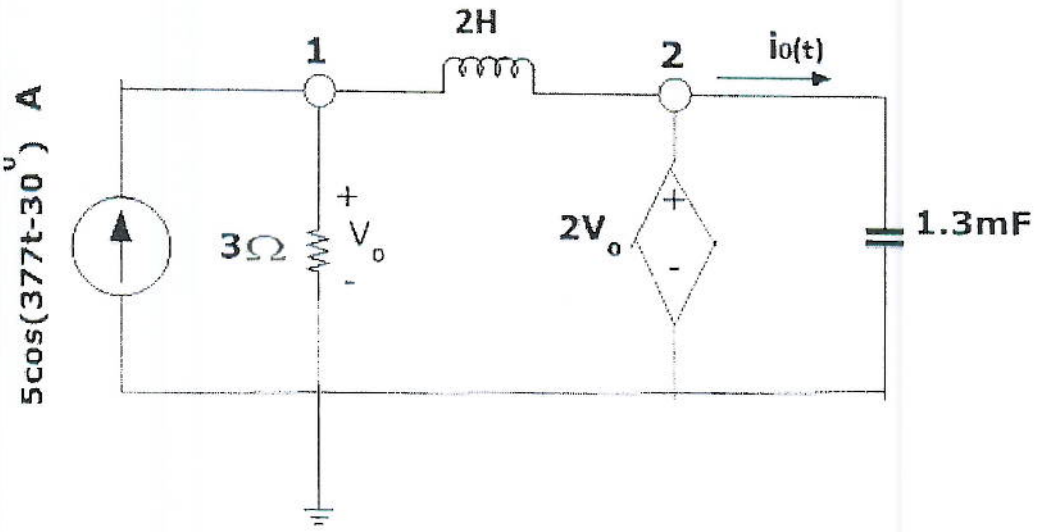


Figure-2

Q3: (i) Thevenize the circuit shown in Figure-3 at terminals **a** and **b**. [15]

(ii) What is the load, $Z_{Load}$ which should be connected to get maximum power output in $Z_{Load}$ ? [5]

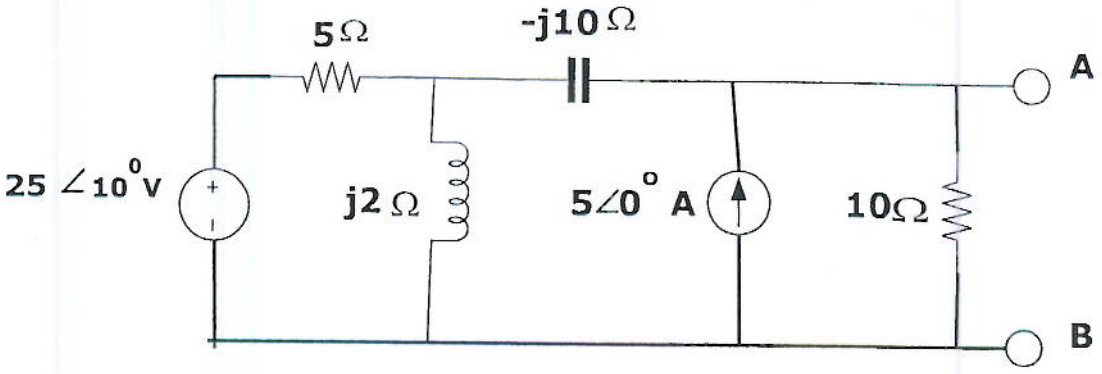


Figure-3

Q4: (a) Calculate the Transfer Function, $H(jw) = \frac{V_{out}(jw)}{V_{in}(jw)}$ of the circuit shown in Figure-4. [8]

(b) (i) State what type of filter is this circuit. (ii) Calculate its cut-off frequency, $w_c$. [4+8]

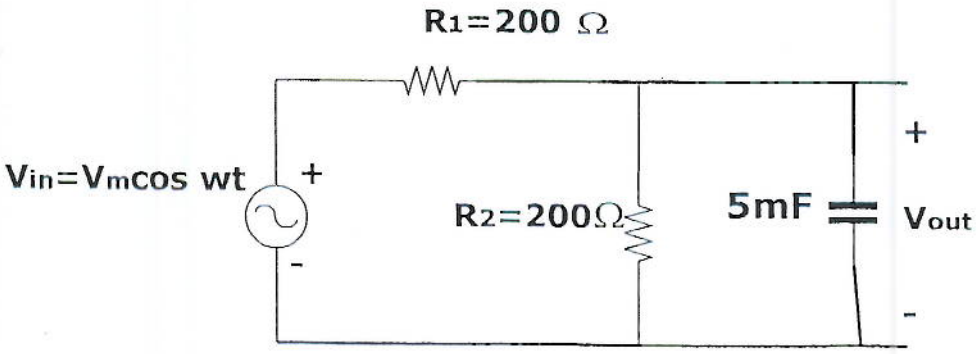


Figure-4

Q5: In Figure-5, the switch was initially closed for a long time. At t = 0, the switch is opened.

(i) Find Vc(0+) and i(0+) [3]

(ii) Determine $\frac{dVc}{dt}(0+)$ and $\frac{di}{dt}(0+)$ [5]

(iii) Derive the differential equation of i(t) for t >0. **Do not solve the equation.** [8]

(iv) State with reason whether i(t) is critically damped, under-damped or over-damped. [4]

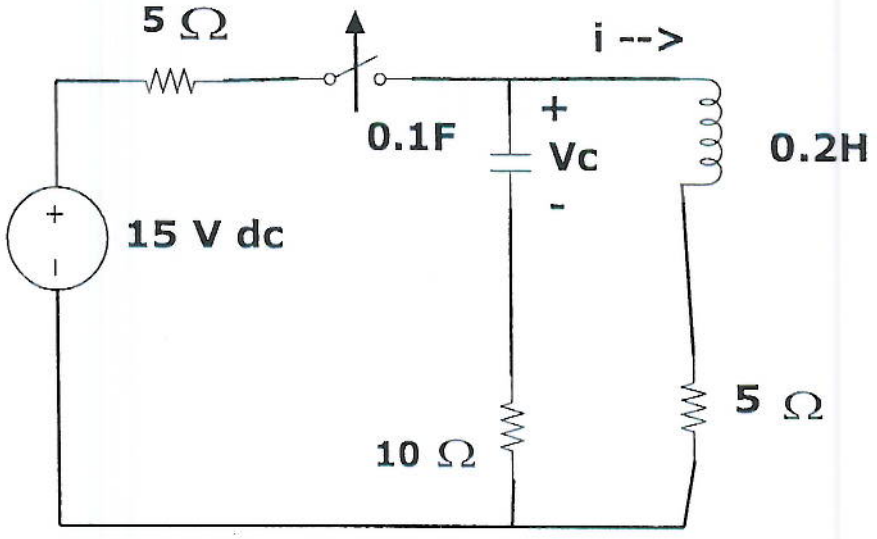


Figure-5

Q6: The voltage shown in the circuit in Figure-6 is a step function of 20V. The capacitor has an initial voltage of +5V, and the Inductor has an initial current of 1A.

(i) Draw the Laplace Transformed circuit at t >0. [5]

(ii) Derive the expression of $V_C(s)$. [5]

(iii) Solve $V_C(t)$ for t >0. [10]

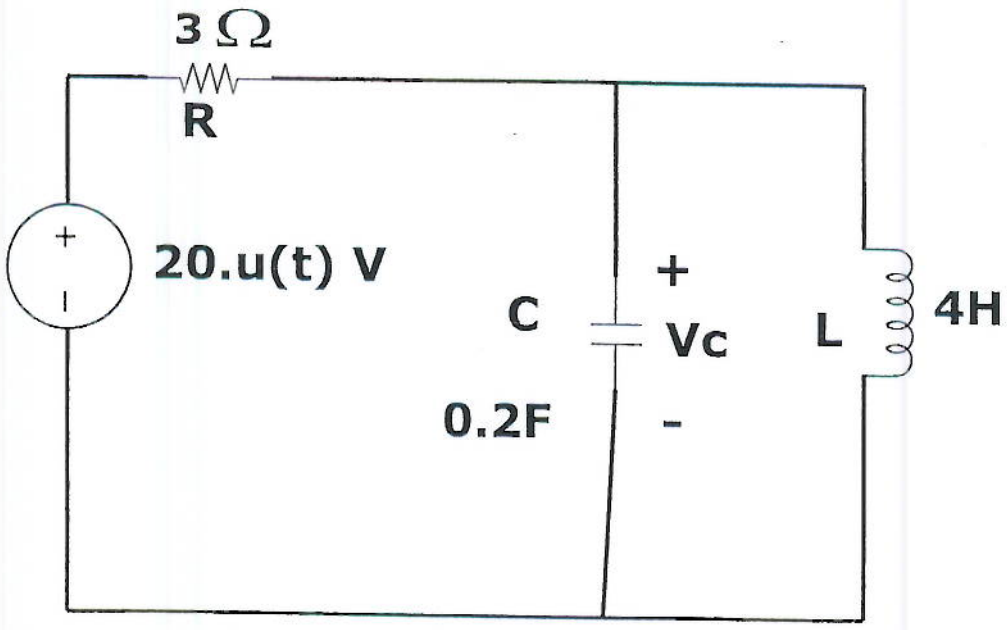


Figure-6

# Appendix

Some useful **Laplace Transforms:**

| f(t) | → | F(s) |
|---|---|---|
| Ku(t) | | K /s |
| $e^{-at}$ u(t) | | 1 / (s+a) |
| sin wt .u(t) | | w / ($s^2$+$w^2$) |
| cos wt . u(t) | | s / ($s^2$+$w^2$) |
| $e^{-\alpha t} \sin \omega t$ | | $\frac{\omega}{(s+\alpha)^2+\omega^2}$ |
| $e^{-\alpha t} \cos \omega t$ | | $\frac{(s+\omega)}{(s+\omega)^2+\omega^2}$ |
| $\frac{df(t)}{dt}$ | | s F(s) – f($0^-$ ) |
| $\frac{d^2 f(t)}{dt^2}$ | | $s^2$F(s) – s f($0^-$ ) –$f^1$($0^-$) |
| $\int_{-\infty}^{t} f(q)\,dq$ | | $\frac{F(s)}{s} + \int_{-\infty}^{0} f(q)\,dq$ |