Midterm NeSS 2021

Read questions carefully.

- Write your Roll Number neatly on top right of your each answer sheet. Put page numbers.
- State clearly any assumptions (if you are making one) and its reason in the answer.
- Plagiarism/cheating, use of electronic devices and/or communication apps/devices is prohibited. You can use only Moodle announcements for communication during the exam hour.
- There are total 6 questions in this paper 4 are from Circuits and 2 from Signals. Write the questions number and subpart correctly & neatly.
- Answer to the point.
- You have 60 minutes to complete the exam and 5 minutes to scan/photograph your answers, combine in one PDF file and upload. If there are any issues in uploading due to your internet, send your answer sheet to asarje@iiit.ac.in before the time limit 4:05 pm.

All the Best.

1. State the conditions under which super position theorem can be applied. [4 points]
For the circuit shown in figure 1, find current I using super position theorem. [6 points]

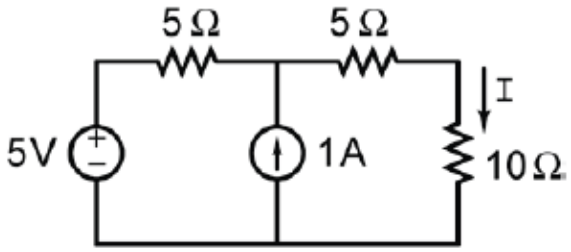

Figure 1

(a) Verify the results by considering 10 ohm resistor as R_L and finding the Thevenin equivalent voltage (V_{TH}) and Thevenin equivalent resistance (R_{TH}) across 10 ohms, drawing the equivalent circuit and then finding the value of I through R_L. [5 points]
(b) Now find the current through R_L (10 ohms), using Norton's equivalent. [5 points]

2. (a) State the Maximum Power Transfer Theorem. Derive the value of RL and find the maximum power. [10 points]
(b) In the figure 2 given below, I_L is a load current (current drawn by the load). What will be the value of load current I_L for which power absorbed by load is maximum. [10 points]

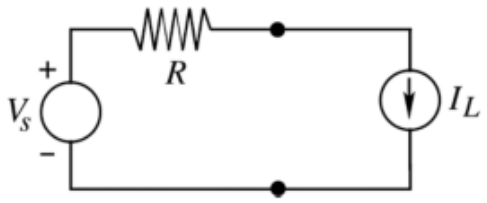

Figure 2

3.

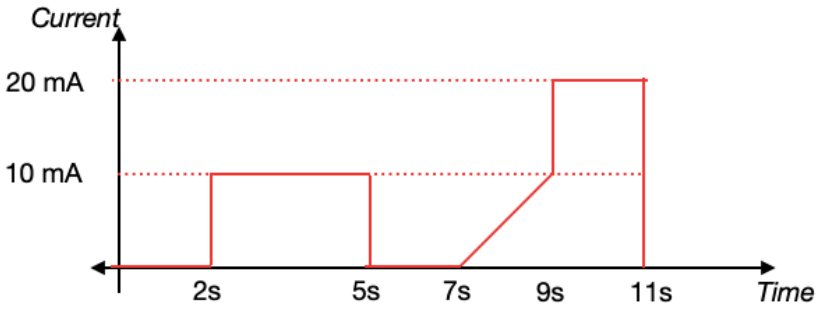

Figure 3

(a) The figure 3 shows the current flowing through a capacitor C= 1 uF. What will be the voltage across the capacitor C. Plot the voltage vs time. Neatly show the steps you followed. How will you find energy stored in the capacitor. [12 points]
(b) If an inductor L= 1 mH is allowing the same current (figure) to flow, what will be voltage across the inductor. [8 points]

4. In the circuit in figure 4, the equivalent Thevenin resistance between a & b is to be determined. Based on the steps discussed in the class, draw the circuit and write the equations (KCL or KVL) for the circuit. Will you be able to solve the equation? Why not? [10 points]
Now, apply a small test current Ix across a & b and calculate the voltage across a & b Vx. Find Vx/Ix, this is the equivalent resistance. [10 points]

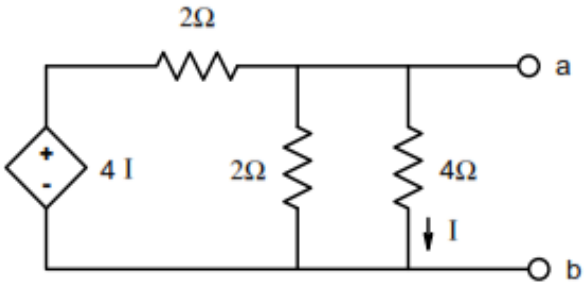

Figure 4

[Signals] Q1

(10 Marks) Madhuri is experimenting with developing an alternate form of Fourier Series representation and has proposed the following expansion for real periodic signal x(t) with frequency ω_0

$x(t) = a_0 + \sum_{k=1}^{\infty} a_k \cos^2(k\omega_0 t) + \sum_{k=1}^{\infty} b_k \sin(k\omega_0 t).$

Explain why the above proposed representation does not include all periodic signals represented by the original trigonometric FS representation. Justify your answer using appropriate equations.

Give an example of such a signal.

[Signals] Q2

(10 Marks) A periodic signal $x(t)$ has exponential FS coefficients given by $d_k = \frac{1}{r^{|k|}}$, $0 < r < 1$ for all integers k.

Shiva is performing partial reconstruction of this signal using the (2N+1)-term approximation given by

$\hat{x}_N(t) = \sum_{k=-N}^{k=N} d_k e^{jk\omega_0 t}.$

Estimate the value of N that should be used by Shiva so that the power in the error signal ($x(t) - \hat{x}_N(t)$) is less that 1% of original signal power.

Hint: Use Parseval's relation