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Paper Code : EE-301

ELECTRIC CIRCUIT THEORY

Time Allotted: 3 Hours   *Full Marks*: 70

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words
as far as practicable.

Group – A
(Multiple Choice Type Questions)

1.   Choose the correct alternatives for *any ten* of the following: 1×10=10

   (i)   When compared to a first-order low pass filter, a second-order low pass filter has

      (a) low voltage gain   (b) higher voltage gain

      (c) faster drop in filter response   (d) higher cut-off frequency

   (ii) F(s) = (1 – e^{-st})/s is the Laplace transform of

      (a) a pulse of width T   (b) a square wave of period T

      (c) a unit step delayed by T   (d) a ramp delayed by T

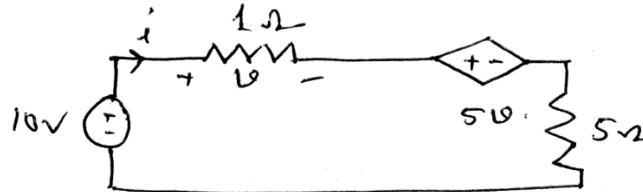   (iii) The total inductance of the three series connected coupled coils is
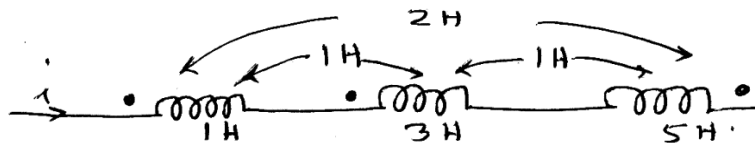
      (a) 6 H   (b) 5 H
      (c) 7 H   (d) 8 H

(iv) The output Y and input X of a system are related by the equation $Y = mX + c$, where m, c are constant. The system is

    (a) linear   (b) non-linear

    (c) bilateral   (d) unilateral

(v) The current 'i' in the circuit shown is given by


    (a) 10 A   (b) 5 A

    (c) 2 A   (d) 20 A

(vi) When a unit impulse voltage is applied to an inductor of 1H, the energy supplied by the source is

    (a) $\propto$ J   (b) 1 J

    (c) $\frac{1}{2}$ J   (d) 0 J

(vii) An initially relaxed RC series circuit with $R = 2M\Omega$ and $C = 1\mu F$ is switched to a 10V step input. The voltage across the capacitor after 2 seconds will be

    (a) 0V   (b) 3·68V

    (c) 6·32V   (d) 10V

(viii) The current and voltage profile of a circuit element vs time is shown in the figure. The element is
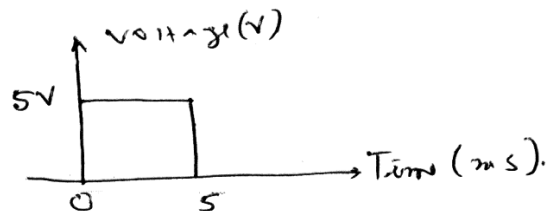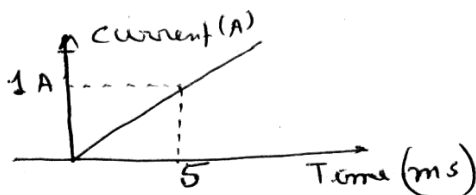
    (a) inductor   (b) capacitor
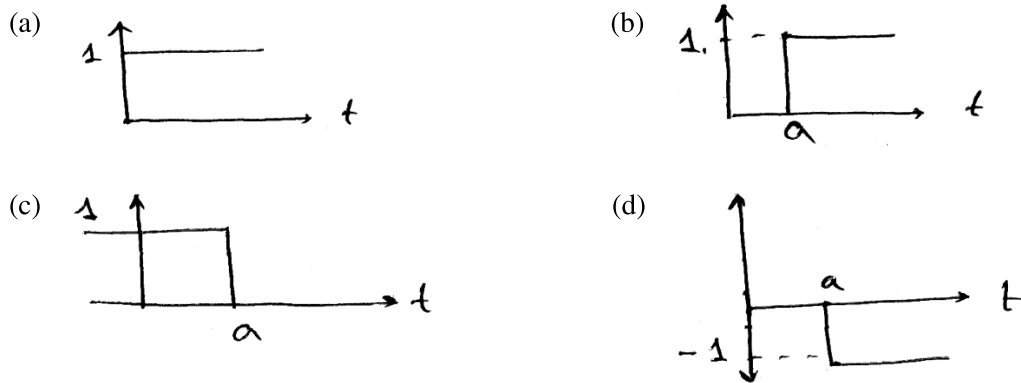
    (c) resistor   (d) transistor

(ix) The V-S characteristic of a resistor is $i = 2v^2$. The resistor is

    (a) linear, passive, bilateral   (b) nonlinear, active, bilateral

    (c) nonlinear, passive, bilateral   (d) nonlinear, active, unilateral

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(x) For a connected planner graph of v vertices and e edges, the number of meshes is

    (a) $e - v + 1$ (b) $e + v + 1$

    (c) $e + v - 1$ (d) $e - v - 1$

(xi) The graphical representation of $u(a - t)$ is given by

    (a)   (b)

    (c)   (d)

(xii) At steady state condition, the inductor and capacitor will behave as respectively

    (a) short circuit, open circuit   (b) open circuit, short circuit

    (c) both open circuit   (d) both short circuit

Group – B

(Short Answer Type Questions)
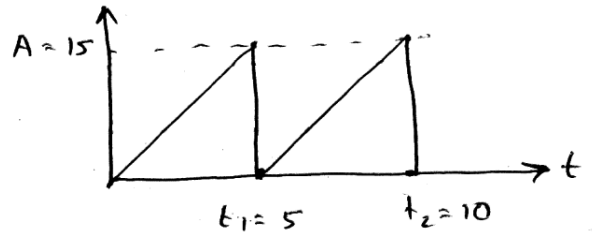
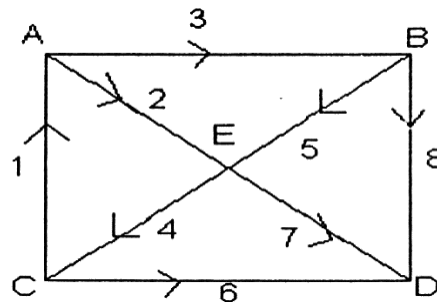**Answer *any three* of the following.**   5×3=15

2. In the circuit shown below, $V_1(t) = 2\cos t$, $c = 1F$, $L_1 = L_2 = 1H$ and $M = \frac{1}{4}N$. Find the voltage $V_a(t)$.
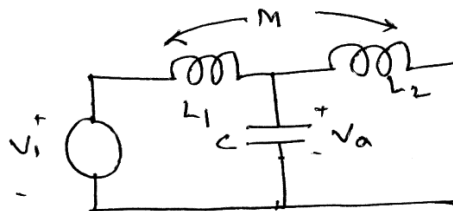
3. Find the Laplace transform of the following waveform.

4. ~~Consider the circuit shown in the figure~~. Draw the corresponding graph. Find the complete incident matrix and the reduce incident matrix. Find the possible no. of trees.

5. Draw the circuit of a second order low pass filter and calculate its cut off frequency for $R = 34\ k\Omega$ and $c = 0.0047\ \mu F$.

6. Find the Z-parameters of the circuit given below.
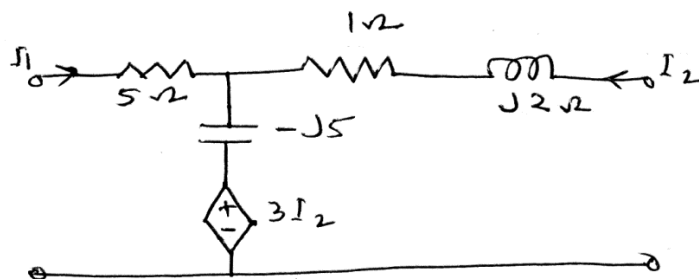
Group – C
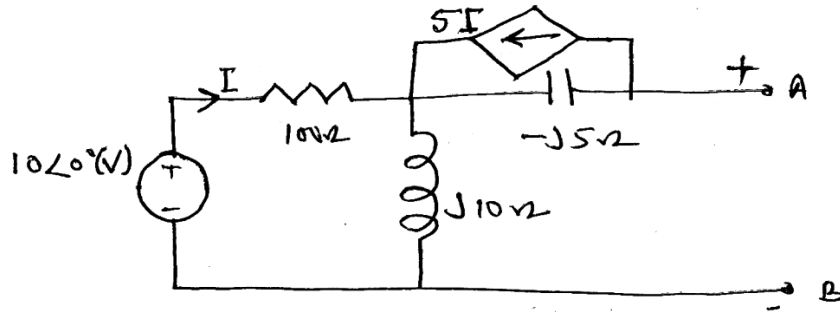
(Long Answer Type Questions)
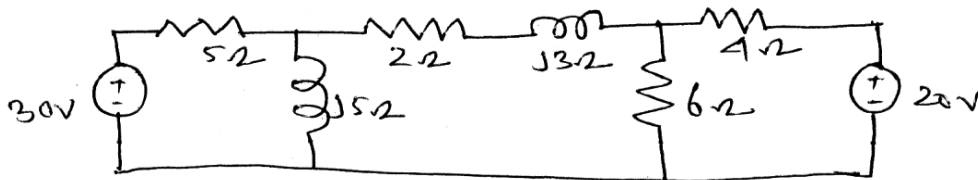
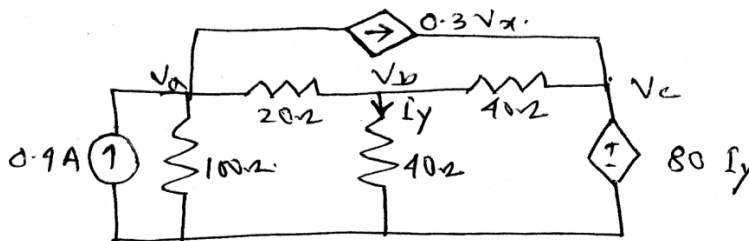**Answer *any three* of the following.**   15×3=45

7. (a) Compute Thevenin equivalent of the network shown:

   (b) Using superposition theorem, calculate the current through the (2 + J3) ohm impedance of the circuit shown:
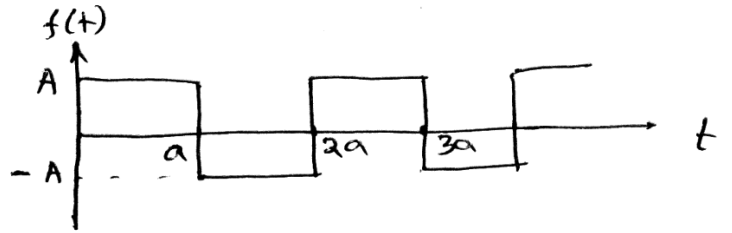

   (c) Use Nodal analysis method to find the voltages V_a, V_b, and V_x in the circuit shown.

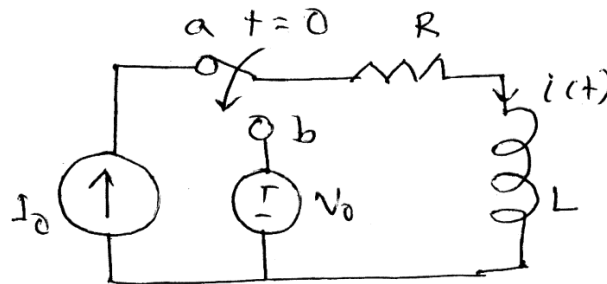
                                                      5+5+5=15

**8.** (a) Find the Laplace transform of the square wave shown below:

(b) In the circuit shown below, the switch moves from position 'a' to position 'b' at $t = 0$. Find $i(t)$ for time $t > 0$.


(c) Mention differences between the Laplace transform and the Fourier transform. What are the application of these transforms. 5+5+5=15

9. (a) Write down the conditions which a periodic function must satisfy to have its Fourier series expansion.

(b) Write down the trigonometric form of the Fourier series for a function $f(t)$ and evaluate various Fourier Coefficients.

(c) Determine the Fourier series for the square waveform shown in the figure and plot the magnitude and phase spectra. 2+5+8=15
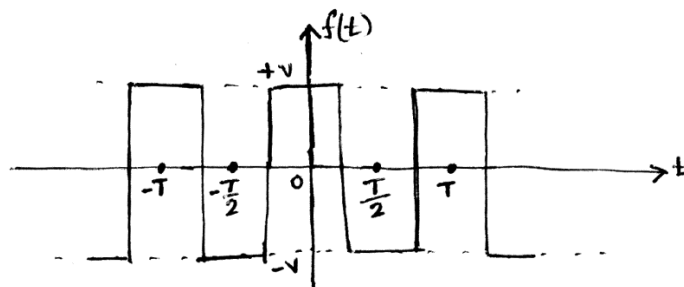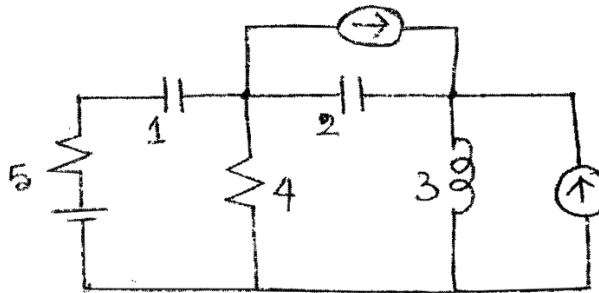
10. (a) Find the Y parameter of the network shown:
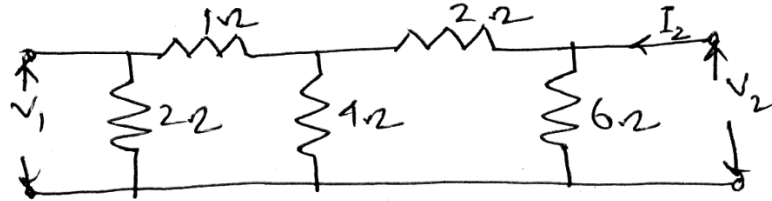
(b) Deduce the conditions for symmetry for the hybrid parameters of 2 port network.

(c) What are ABCD parameters? Prove that AD – BC = 1.   5+5+5=15

11. (a) Define incidence matrix. For the network shown in figure, construct the complete incidence matrix.

(b) For the same network shown in figure, determine all the tree and co-tree. Then considering the tree formed by branches 1, 2, 5 construct cut-set matrix and tie-set matrix.   (1+4)+10=15

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