Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **7** No. of Printed Pages : **8**

SEM-2016(02)-I
ELECTRICAL ENGINEERING
Paper – I

Time : **3** Hours] [Total Marks : **300**

Instructions to the candidates :

Please read the following instructions carefully before attempting questions.

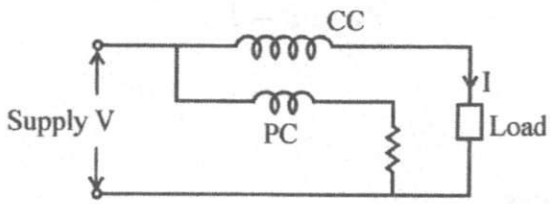
1. Candidates should attempt ***FIVE*** questions in all.
2. Question number **1** is compulsory. Out of remaining SIX questions, attempt any ***FOUR***.
3. ***All*** questions carry equal marks. The number of marks carried by a part of a question is indicated against it.
4. Answers must be written in **ENGLISH** only.
5. Unless otherwise mentioned, symbols and notations have their usual standard meanings.
6. Assume suitable data, if necessary and indicate the same clearly.
7. Neat sketches may be drawn wherever required.
8. All parts and sub-parts of a question are to be attempted together in the answer book.
9. Any pages left blank in the answer book must be clearly struck out.
10. Use of non-programmable scientific calculator is permitted.

1. All parts carry equal marks : **10 × 6 = 60**

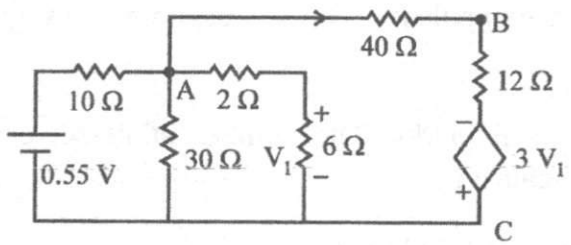
(a) A wattmeter has a current coil of 0.1 Ω resistance and a pressure coil of 6500 Ω resistance as shown in figure. Calculate the percentage error due to resistance when reading the input to an apparatus which takes

(i) 12 A at 250 V with UPF. **3**

(ii) 12 A at 250 V with 0.4 PF **3**



(b) Use Nodal analysis to find the potential between points B & C in the network. **6**



(c) A dielectric sphere ($\varepsilon_r = 5.7$) of radius 10 cm has a point charge of 2 PC placed at its centre. Calculate :

(i) The surface density of polarization charge on the surface of the sphere. **3**

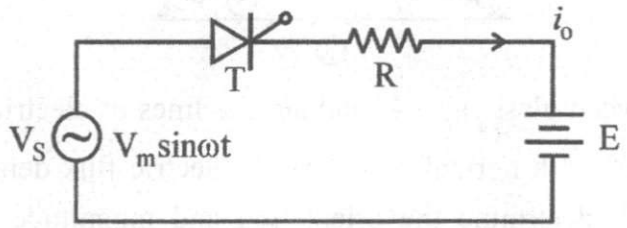
(ii) The force exerted by the charge on a –4 PC point charge placed on the sphere. **3**

(d) Implement a full adder circuit with a decoder and two OR gates.

(e) A dc battery is charged through a resistor R as shown in figure. Derive an expression for the average value of charging current in terms of Vm, E, R on the assumption that SCR is fired continuously

(i) For an ac source voltage of 230 V, 50 Hz find the value of average charging current for R = 8 Ω & E = 150 V. **4**

(ii) Find the power supplied to battery. **2**



(f) The system is defined by the following difference equation

$$Y[n] - \frac{1}{4} Y[n-1] = x[n]$$

Find the natural response of the system. **6**

(g) A coil of 50 Ω resistance and 0.05 H inductance is connected in parallel with a capacitor 'C'. Find the value of 'C' to give parallel resonance condition at 20×10^3 Hz.

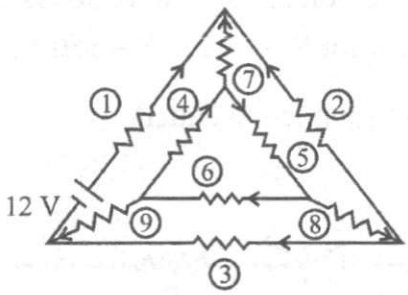
(h) A three phase converter is operated from a 3 phase, 230 V, 50 Hz supply with load resistance of R = 10 Ω. An average output voltage 50% of the maximum possible output voltage is required. Determine the firing angle.

(i) Derive the expression for Poynting Vector and energy density equation.

(j) A differential amplifier has common mode rejection ratio ρ = 1000. Let the first set of inputs be V_1 = 100 μV & V_2 = –100 μV. Let the second set of input signals be V_1 = 1100 μV & V_2 = 900 μV. Calculate the percentage difference in output voltage obtained for the two sets of input voltages.

2. All parts carry equal marks : **4 × 15 = 60**

(a) For the network shown, select branches 4, 5, 7, 8 and 9 as tree branches. Write loop incidence matrix and use it to write loop equations. All resistances are 1 Ω each.



(b) At the between glass ($\varepsilon_r = 4$) and air, the lines of electric field makes an angle of 40° with normal boundary. If electric flux density in the air is 0.25 μc/m^2, determine the orientation and magnitude of electric flux density in the glass.

(c) A strain gauge having a resistance of 100 Ω and gauge factor of 2 is connected in series with a ballast resistance of 100 Ω across a 12 V supply. Calculate the difference between the output voltage with no stress applied and a stress of 140 MN/m^2. The modulus of elasticity is 200 GN/m^2.

(d) Design a fourth order Butterworth low pass filter with a cut off frequency of 2 kHz.

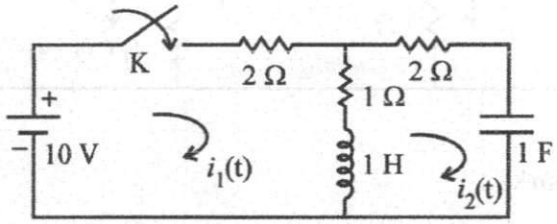
3. All parts carry equal marks : **4 × 15 = 60**

(a) A 50 μF capacitor and 20,000 ohm resistor are connected in series across a 100 V battery at t = 0. At t = 0.5 sec, the battery voltage is suddenly increased to 150 V. Find the charge on capacitor at t = 0.75 sec.

(b) In a free space $\vec{D} = D_m \sin(\omega t + \beta z)\, \vec{U}_x$. Using Maxwell's equation, show that $\vec{B} = \dfrac{-\omega \mu_0 D_m}{\beta} \sin(\omega t + \beta z)\, \vec{U}_y$.

(c) For a 5 bit ladder of linear resistors, if the input levels are 0 = 0V and 1 = +10 V, What are the output voltages for each bit.

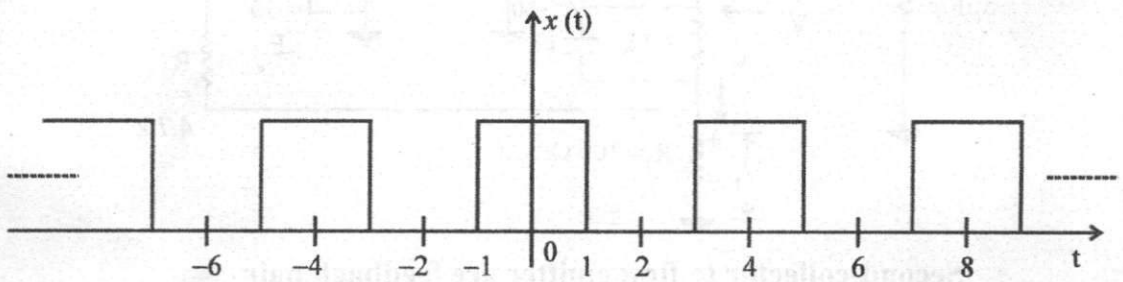
(d) For the circuit shown in figure, find $i_1(t)$ and $i_2(t)$. Use Laplace transform technique. The initial voltage in the capacitor is 2 V and the initial current through the inductor and capacitor is zero.



4. All parts carry equal marks : **4 × 15 = 60**

(a) Calculate the output frequency of a series inverter with the following parameters. Inductance L = 6 mH, Capacitance C = 1.2 μF, load resistance R = 100 Ω, T_{off} = 0.2 m sec. If load resistance is varied from 40 Ω to 140 Ω, find out the range of output frequency.

(b) Find the Fourier transform X(jw) representation of the following periodic signal :



(c) Considering the following Boolean functions given in sum of min terms. Discuss the design of combinational logic circuit using a programmable logic array (PAL)

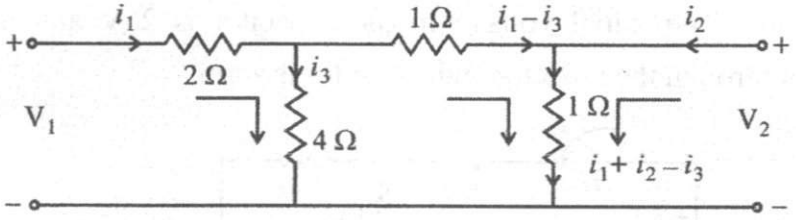
W(A, B, C, D) = Σ(2, 12, 13)

x(A, B, C, D) = Σ(7, 8, 9, 10, 11, 12, 13, 14, 15)

y(A, B, C, D) = Σ(0, 2, 3, 4, 5, 6, 7, 8, 10, 11, 15)

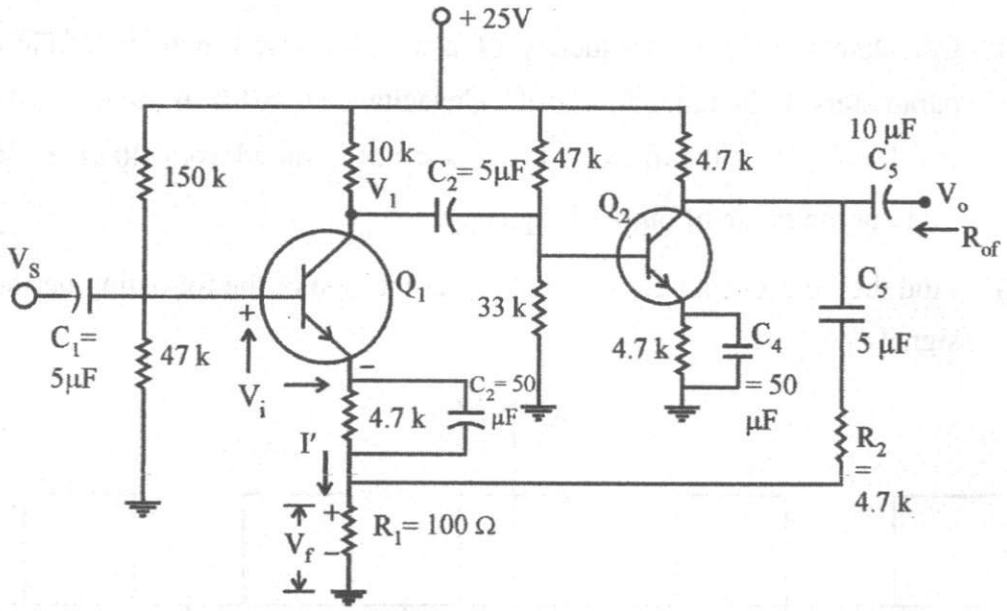
z(A, B, C, D) = Σ(1, 2, 8, 12, 13)

(d) Find impedance and admittance parameters of the circuit shown in figure.



5. All parts carry equal marks : **4 × 15 = 60**

(a) Calculate A_{vf}, R_{of} & R_{if} for the amplifier shown in figure. Assume $R_s = 0$, $h_{fe} = 50$, $h_{ie} = 1.1$ K, $h_{re} = h_{oe} = 0$ and identical transistors.



Second-collector to first emitter are feedback pair

(b) Characteristics of pure ice is given by table below :

Frequency	(a) 1 MHz	(b) 100 MHz	(c) 3 GHz
ε_r	4.15	3.45	3.2
tan δ	0.12	0.035	0.0009

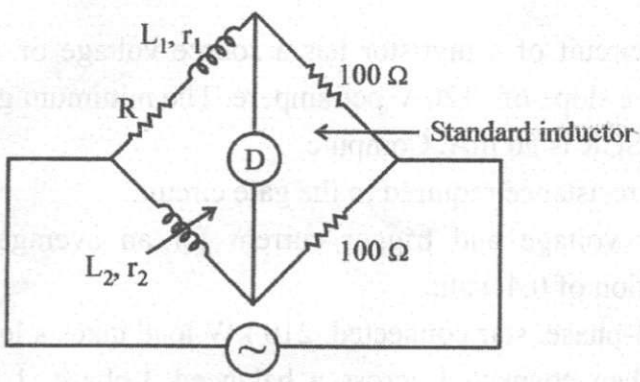
If a uniform plane wave with amplitude of 100 V/m at z = 0 is propagated through such ice, find the time average of power crossing an area of 1 m^2 at z = 0 & z = 5 m for each frequency.

(c) A step up chopper has an input voltage of 220 V and output voltage of 660 V. If the conducting time of thyristor chopper is 100 μ sec, compute the pulse width of output voltage. In case, if the pulse width of output voltage is halved for a constant frequency operation, find the average value of new output voltage.

(d) The output of an LTI system in response to an input $x(t) = e^{-2t}\, u(t)$ is $y(t) = e^{-t}u(t)$. Find the frequency response and impulse response of this system.

6. All parts carry equal marks : **4 × 15 = 60**

(a) A Maxwell's inductance comparison bridge is shown in figure. Arm ab consists of a coil with inductance L_1 and resistance r_1 in series with a non-inductive resistance R. Arm bc and ad are each non-inductive resistance of 100 Ω. Arm ad consists of standard variable inductor L of resistance 32.7 Ω. Balance is obtained when L_2 = 47.8 mH and R = 1.36 Ω. Find the resistance and inductance of the coil in arm ab.



(b) Use pole-zero plot to find the current response in time domain if,

$$I(S) = \frac{20\,S}{(S+2)\,(S+5)}$$

(c) Determine the sequence $x(n)$ having z-transform

$$X(Z) = \frac{1 + 3z^{-1} + z^{-2}}{1 - \frac{5}{4}z^{-1} + \frac{1}{4}z^{-2}}$$

(d) A steady voltage of 1500 V is applied across two parallel metal disc of 10 cm radius and 14 mm apart. Between the disc are three layers of dielectric

$t_1 = 2$ mm $\varepsilon r_1 = 3$

$t_2 = 5$ mm $\varepsilon r_2 = 4$

$t_3 = 7$ mm $\varepsilon r_3 = 6$

Calculate the potential gradient and the energy stored in each dielectric.

7. All parts carry equal marks. **4 × 15 = 60**

(a) By means of Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT), determine the sequence $x_3(n)$ corresponding to the circular convolution of the sequence $x_1(n)$ and $x_2(n)$ given

$x_1(n) = [2, 1, 2, 1]$

$x_2(n) = [1, 2, 3, 4]$

(b) The trigger circuit of a thyristor has a source voltage of 15 V and the load line has a slope of –120 V per ampere. The minimum gate current to turn ON the SCR is 50 mA. Compute

(i) Source resistance required in the gate circuit. **3**

(ii) Trigger voltage and trigger current for an average gate power dissipation of 0.4 watts. **12**

(c) A balanced 3-phase, star connected, 210 kW load takes a leading current of 160 A when connected across a balanced 3-phase, 1.1 kV, 50 Hz supply. Find the load circuit parameters per phase.

(d) A single phase full converter bridge is connected to RLE load. The source voltage is 230 V, 50 Hz. The average load current of 10 A is continuous over the working range. For R = 0.4 Ω & L = 2 mH, compute firing angle delay for E = +120 V and E = –120 V. Also indicate which source is delivering power to load in each part.