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Roll No.

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Candidate should write his/her Roll No. here.

Total No. of Questions : 7

No. of Printed Pages : 7

**SEM-2017(02)-I**

**ELECTRICAL ENGINEERING**

**Paper—I**

Time : 3 Hours ]

[ Total Marks : 300

**Instructions to the candidates :**

**Please read each of the following instructions carefully before attempting questions.**

Candidates should attempt all the **FIVE** questions.

Question Number **1** is compulsory. Out of remaining **SIX** questions, attempt any **FOUR**.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Answers must be written in **ENGLISH** only.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

Any pages left blank in the answer book must be clearly struck out.

Only non-programmable scientific calculator is allowed.

SEM-2017/EE-1

[P.T.O.]

( 2 )

1. All parts carry equal marks :

6×10=60

(a) Three numbers of  $700\ \Omega$  resistors are all connected in parallel across a  $210\ \text{V}$  DC source. It is desired to limit the voltage across these resistors to  $110\ \text{V}$  by connecting another resistor in series with these three parallel combination. Determine the value of the series resistor.

6

(b) In the circuit shown in Fig. 1, determine the value of the current at 10 sec after the switch is closed. Assume the circuit is initially relaxed.

6

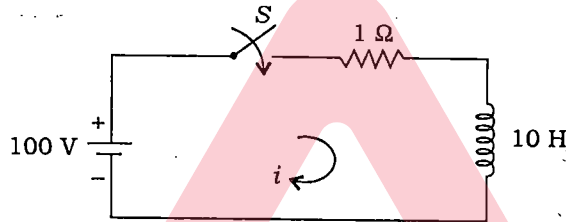


Fig. 1

(c) A dielectric slab of flat surface with relative permittivity 4 is disposed with its surface normal to a uniform field with electric flux density of  $1.5\ \text{coulombs/m}^2$ . The slab occupies a volume of  $0.08$  cubic meter and is uniformly polarized. Determine the polarization in the slab.

6

(d) A resistance wire strain gauge uses a soft iron wire of small diameter. The gauge factor is  $+4.2$ . Neglecting the piezoelectric effect, calculate the Poisson's ratio.

6

(e) Define the following terms :

2×3=6

(i) Repeatability

(ii) Resolution

(iii) Linearity

(f) For the diode resistance circuit shown in Fig. 2, the diode cut-in voltage is  $0.6\ \text{V}$  and the voltage drop across a conducting diode is  $0.7\ \text{V}$ . Calculate  $V_o$  and indicate the state of each diode for the following :

3+3

(i)  $V_1 = 10\ \text{V}$ ,  $V_2 = 0\ \text{V}$

(ii)  $V_1 = 10\ \text{V}$ ,  $V_2 = 5\ \text{V}$

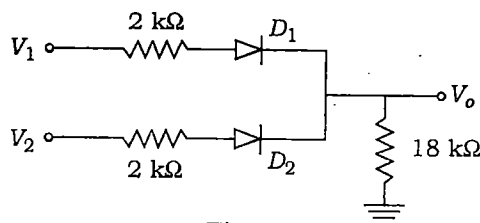


Fig. 2

( 3 )

(g) For the circuit shown in Fig. 3, calculate  $V_o$ . The OPAMP is ideal. 6

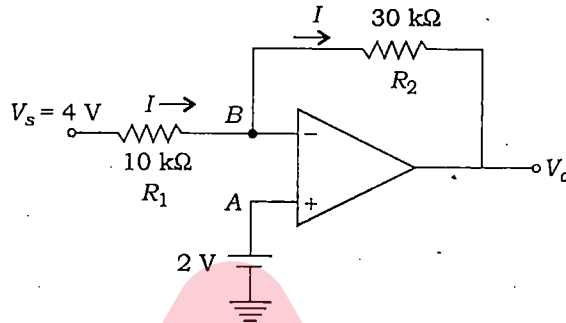


Fig. 3

(h) Draw the  $V-I$  characteristics of TRIAC. Also draw its equivalent circuit. 3+3

(i) Obtain the z transform of the following signal :

$$x(n) = 5\left(\frac{1}{4}\right)^n U(n) - 4\left(\frac{1}{3}\right)^n U(n)$$

6

(j) A signal  $f(t)$  has a duration of 2 msec and an essential bandwidth of 10 kHz. It is desirable to have a frequency resolution of 100 Hz in the DFT ( $F_0 = 100$ ). Determine  $N_0$ . Assume Nyquist sampling rate and zero padding is employed. 6

2. All parts carry equal marks :

15×4=60

(a) For the circuit shown in Fig. 4, obtain  $\frac{V_o(s)}{V_s(s)}$ . Assume OPAMP is ideal.

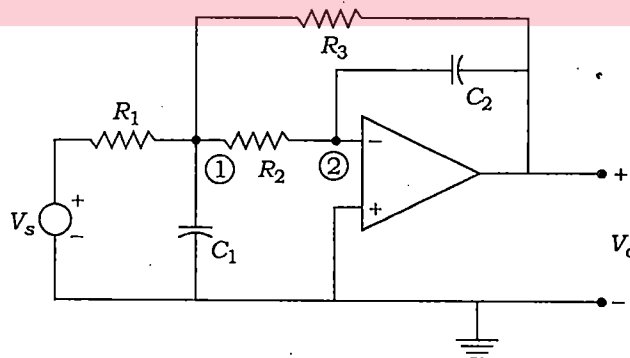


Fig. 4

( 4 )

- (b) Deduce an expression for the capacitance of a parallel-plate capacitor having two dielectric media. The capacitor has a plates separation of  $t$ . The capacitance with only air between the plates is  $C$ . When a slab of thickness  $t' < t$  and relative permittivity  $\epsilon_r$  is placed in the gap between the plates, the capacitance is  $C'$ . Show that

$$\frac{C'}{C} = \frac{\epsilon_r t}{t' + \epsilon_r (t - t')}$$

- (c) A Zener diode rated 10 V, 32 mA can be considered ideal, i.e.,  $R_Z = 0$ . Calculate the range of  $R_L$  (load) and  $I_L$  for  $V_L$  to be maintained constant. Given  $V_s = 50$  V and  $R_s = 1$  k $\Omega$ .
- (d) Four like charges of 30  $\mu$ C each are located at the four corners of a square, the diagonal of which measures 8 m. Find the force on a 150  $\mu$ C charge located 3 m above the centre of the square.

3. All parts carry equal marks :

15 $\times$ 4=60

- (a) Write Maxwell's equations for time-varying fields in differential form.
- (b) Set up a logic circuit with  $D$  flip-flops to generate 1011110.
- (c) A single-phase bridge rectifier that supplies a very high inductive load such as a DC motor. The turns ratio of the transformer is unity. The load is such that the motor draws a ripple free armature current  $I_a$ . Determine the total harmonic distortion (THD) of the input current.
- (d) Derive the expression for Poisson's equation.

4. All parts carry equal marks :

15 $\times$ 4=60

- (a) A 240 V, 5 A, single-phase energy meter has a registration constant of 1200 revolutions per kWh. It is tested by means of a 240 V, 5A wattmeter having 500 scale divisions which can be read to 0.1 division and a stopwatch which can be read up to 0.01 second and which has negligible error. When tested at full load at unity power factor, the meter makes 40 revolutions in 99.8 seconds. If the human error in timing be taken as  $\pm 0.05$  seconds, estimate the limits within which the error of the meter may lie. The wattmeter is accurate to within 0.05% of its full-scale reading.

( 5 )

(b) Solve the following second-order linear differential equation :

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y(t) = f(t)$$

where initial conditions are  $y(0) = 0$ ,  $\left. \frac{dy}{dt} \right|_{t=0} = 0$  and the input  $f(t) = e^{-4t}$ .

Assume the system is initially relaxed.

- (c) (i) Find the number of two-input NAND gates required for the implementation of  $f(A, B, C) = A + \overline{BC}$ . 8
- (ii) How many numbers of two-input NOR gates are required to implement

$$g(A, B, C) = A + BC?$$

7

- (d) A wattmeter has a current coil of  $0.03 \Omega$  resistance and a pressure coil of  $6000 \Omega$  resistance. Calculate the percentage error if the current coil in the wattmeter is connected on the load side, if the load takes 20 A at a voltage of 220 V and 0.6 power factor.

5. All parts carry equal marks :

15×4=60

- (a) Find the average power dissipated in the circuit shown in Fig. 5.

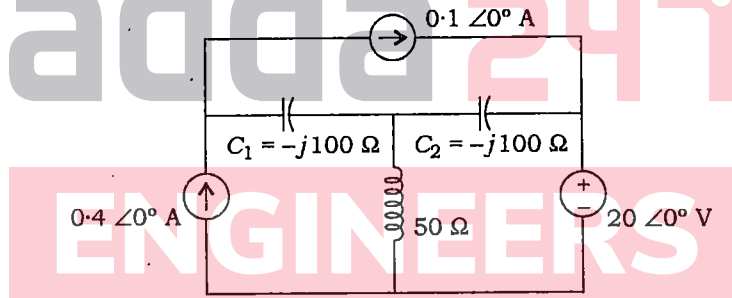


Fig. 5

(Voltage and current are in RMS form)

- (b) Find the Fourier transform of the unit-step function  $U(t)$ .
- (c) A thermistor has a resistance of  $3980 \Omega$  at the ice point of  $0^\circ \text{C}$ , and  $794 \Omega$  at  $50^\circ \text{C}$ . The resistance-temperature relationship is given by

$$R_T = aR_0 \exp(b/T).$$

Calculate the constants  $a$  and  $b$ . Also calculate the range of resistance to be measured in case the temperature varies from  $40^\circ \text{C}$  to  $100^\circ \text{C}$ . 8+7

( 6 )

(d) A Wheatstone bridge is shown in Fig. 6.

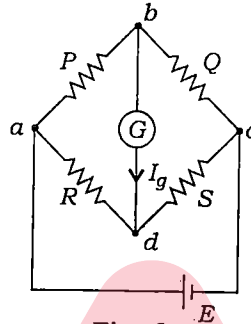


Fig. 6

The Thévenin source generator voltage  $E_0 = 24$  mV and the galvanometer current is  $13.6 \mu\text{A}$ . Calculate the value of  $Q$ .

6. All parts carry equal marks :

15×4=60

(a) Find the node voltages  $V_1$  and  $V_2$  using nodal analysis for the circuit shown in Fig. 7.

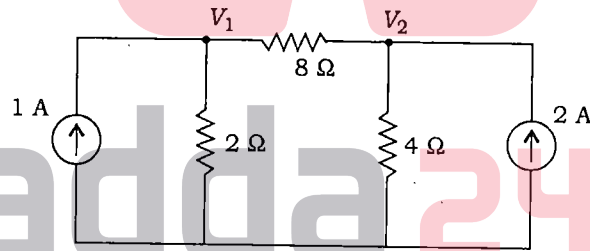


Fig. 7

(b) A series  $R$ - $L$ - $C$  circuit is connected to a 220 V, 50 cycles/sec supply. When  $L$  is varied the maximum current obtained is 0.4 A and the voltage across the capacitor then is 330 V. Find the circuit constants.

(c) For the circuit shown in Fig. 8, draw the Thévenin's equivalent circuit at the terminals  $AB$ .

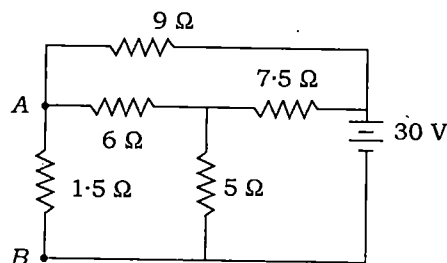


Fig. 8

( 7 )

(d) A DC chopper circuit connected to a 100 V d.c. source supplies an inductive load having 40 mH in series with a resistance of  $5\Omega$ . A freewheeling diode is placed across the load. The load current varies between the limits of 10 A and 12 A. Determine the time ratio of the chopper.

7. All parts carry equal marks :

15×4=60

(a) A single-phase half-bridge inverter has a resistive load of  $R = 3\Omega$  and the d.c. input voltage  $E_{dc} = 50$  V. Calculate—

(i) the RMS output voltage  $E_1$  at the fundamental frequency;

(ii) the average current of each thyristor.

8+7

(b) A single-phase fully controlled bridge converter supplies an inductive load. Assuming that the output current is virtually constant and is equal to  $I_d$ , determine the following if the supply voltage is 230 V and the firing angle is maintained at  $(\pi/6)$  radians :

5+5+5

(i) Average output voltage

(ii) Fundamental power factor

(iii) Supply power factor

(c) Consider the discrete time system shown in Fig. 9. Write a difference equation that relates the output  $y[n]$  and the input  $x[n]$ .

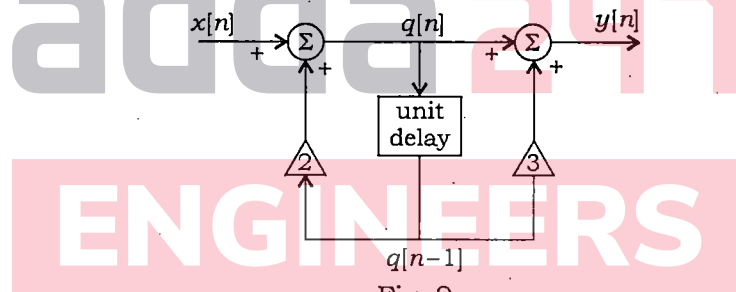


Fig. 9

(d) Find the discrete time Fourier transform of discrete time signal  $x[n]$  :

$$x[n] = U[n] - U[n - N]$$

$$\text{where } U[n] = \begin{cases} 1 & n \geq 0 \\ 0 & n < 0 \end{cases}$$

and  $N$  is some integer.

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