I.E.S.-(Conv.) 1988

ELECTRICAL ENGINEERING

PAPER - I

Time Allowed: Three Hours **Maximum Marks: 200**

Candidates should attempt SIX questions, selecting TWO questions from Part—A. One from Part—B, One from Pars—C and TWO from Part—D
The number of marks carried by each question is indicated at the end of the question
Answers must be written in English

PART A

1. (a) State and explain Reciprocity and Compensation theorems.

8

(b) Given the circuit of Fig. 1, determine the Thevenin equivalent circuit with respect to terminals A, B and hence find the current flowing through 10Ω resistor.

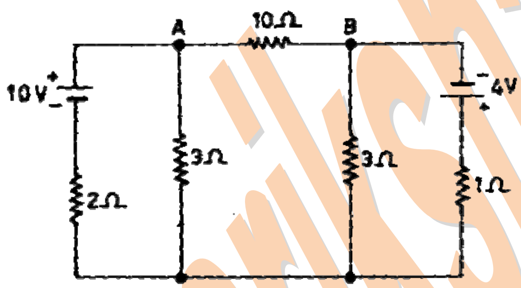


Fig. 1

12

(c) Write down the equations corresponding to the flow graph shown in Fig. 2. Evaluate the gain V_6/V_1 by using Mason's rule.

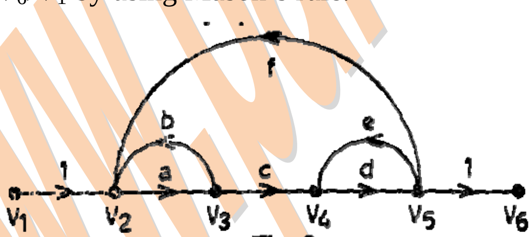


Fig. 2

12

2. (a) In the circuit shown in Fig.3, find the initial and final values of the currents i_1 and i_2 (using initial and final value theorems) when the switch is closed.

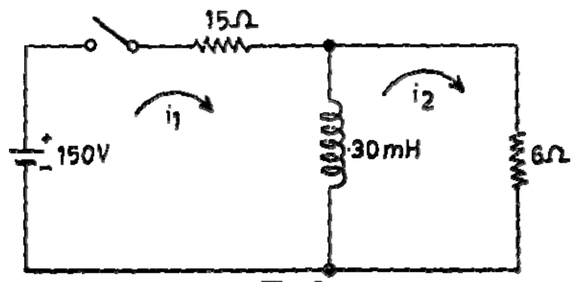


Fig. 3

16

(b) For the network shown in Fig. 4–

(i) determine the Admittance parameters y_{11}, y_{12}, y_{22} 6

(ii) find equivalent T-network 6

(iii) determine image impedances. 4

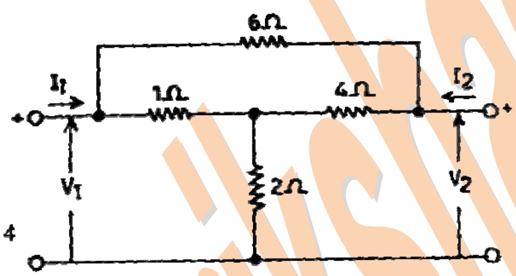


Fig. 4

3. (a) Discuss the properties of R-C driving point impedance functions. 12

(b) Synthesize the following function (i) as an Impedance function in the Fosters form (ii) as an Admittance function in Cauer's form:

$$Z(s) = \frac{(s+2)(s+4)}{(s+1)(s+3)}$$

20

PART B

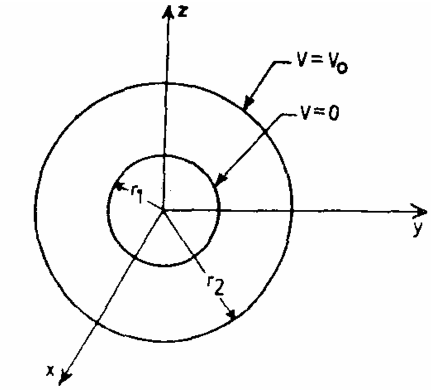
4. (a) Starting from Maxwell's equations, obtain the equation for a uniform plane wave in an unbounded, isotropic, homogeneous medium. 10

(b) Show that in a uniform plane wave motion propagating in z-direction, stored energy density at each point and each instant is equally divided between electric and magnetic field energy densities. 12

(c) Evaluate, using Poynting theorem, the power that is conveyed along a coaxial cable carrying a current I (d.c.) in the inner conductor and sheath forming the return path for the current. Voltage between inner conductor and the sheath is V. Neglect resistance of the conductors.

5. (a) Write the Laplace's equation in rectangular, cylindrical and spherical coordinate systems.

Fig. 5



9

(b) Find the potential function and electric field intensity for the region between two concentric circular cylinders whose cross-section is shown in Fig. 5.

12

(c) Define Magnetic Vector Potential. Find Magnetic Vector Potential A due to an infinite plane current sheet of uniform density K.

15

PART C

6. (a) Explain what is meant by Polarization in a Dielectric. Discuss the types of polarization mechanisms which may arise in a dielectric.

12

(b) Explain the phenomenon of Piezoelectricity exhibited by some crystals.

8

(c) Mention the properties of Ferroelectric material and explain the phenomenon of electrostriction.

16

7. (a) What is meant by Hysteresis loss in a ferromagnetic material?

Discuss the factors that govern the magnitude of this loss.

9

(b) Electrical conductivity of a metal conductor can be expressed as

$$\sigma_e = \frac{ne^2\tau}{m_e}$$

where n — density of free electrons

r — relaxation time

e — charge on an electron

m_e — mass of an electron

Find, using the above relation, an expression for conductivity of an intrinsic semiconductor in terms of electron and hole mobilities and the intrinsic carrier density.

12

(c) The resistivity of intrinsic germanium at room temperature is equal to 0.47 ohm m. Assuming electron and hole mobilities of 0.38 and 0.18 rn^2 vol^{-1} sec^{-1} respectively, calculate the intrinsic carrier density.

6

(d) How does the superconductive state differ from normal conducting state? What is the effect of (i) frequency and (ii) magnetic field on superconductivity?

9

PART D

8. (a) Explain as to what you understand by 'Primary' and 'Secondary' Transducers. Illustrate your answer with suitable examples.

6

(b) Draw a neat sketch of a Linear Variable Differential Transformer (LVDT) and explain briefly its principle of working.

12

(c) The output of an LVDT is connected to a 10-V voltmeter through an amplifier whose amplification factor is 250. An output of 1 m V appears across the terminals of the LVDT when the core moves through a distance of 0.5 mm. The voltmeter has 100 divisions and scale can be read to two tenth of a division. Calculate the sensitivity and resolution of the instrument.

The above arrangement is used in a force transducer for measuring deflection of a cantilever. The cantilever is deflected through 0.25 mm by a force of one newton. Calculate the minimum and maximum values of force that can be measured.

14

9. (a) What are the various sources of errors in a.c. bridge circuits? Outline the precautions and techniques used for reducing such errors.

6

(b) Explain the method of measurement of capacitance and dissipation factor using Schering bridge. What special features and needed when the bridge is supplied from a high voltage source?

16

(c) Explain how the relative permittivity of a dielectric material can be determined with the help of Schering bridge.

10

10. (a) What are the advantage of digital instruments over analogue ones?

5

(b) Explain with the help of functional block diagrams the principle of operation of a Digital frequency meter.

12

(c) What is meant by Multiplexing in Telemetering system? Describe briefly the method of Frequency Division multiplexing (FDM) in a telemetering system.

15

I.E.S.-(Conv.) 1988

ELECTRICAL ENGINEERING

PAPER - II

Time Allowed: Three Hours **Maximum Marks: 200**

Candidates should attempt FIVE questions in all.
choosing at least ONE from each Section
All questions carry equal marks
Answers must be written in English

SECTION A

1. (a) What do you understand by string efficiency? Why is it very low for an ordinary insulator string? Describe briefly the methods used for improving it.

10

(b) What is meant by bundle conductors? Give some typical arrangements of such conductors. What advantages do they offer over ordinary conductors? Explain briefly.

10

(c) A 3-phase, 125-km long line operating at 50 Hz is supplying a load of 40 MVA at a receiving end voltage of 110 kV (line-to-line) and a lagging power factor of 0.8. The resistance of the line is 11 ohms/phase, inductive reactance 38 ohms (line-to-neutral) and capacitive susceptance 3 x 10^{-4} mhos (line-to-neutral). Using nominal-pi representation for the line, calculate—

(i) line-to line voltage at the sending end, (ii) the sending-end power factor, and

2. (a) State the meanings of steady-state and transient stability limits and explain why the latter is lower than the former.

10

(b) Explain the principle of operation of a biased differential relay. What are the reasons for providing large bias settings in transformer differential relays?

10

(c) Starting with the Gauss theorem, derive an expression for the line-to-neutral capacitance in microfarads per km of a transmission line having conductors at the corners of an equilateral triangle. Each side of the triangle in D metres and the radius of each conductor is r metres.

20

PART B

3. (a) A d.c. shunt motor, whose armature resistance is 0.5 ohm, is to be starred by a controller which keeps the armature current between the limits of 60 A and 80 A, the supply voltage being 400 V. Calculate the number and values of the resistance steps. Prove the theory of the method of calculation you employ.

15

(b) Explain, with the help of neat sketches, how interpoles improve commutation in a d.c. machine. How are the interpole windings connected in (i) d.c. motors, (ii) d.c. generator?

15

(c) Explain why asynchronous motor does not start by itself.

10

4. (a) Using synchronous-impedance method, determine the voltage regulation of a 2000-volt single-phase alternator supplying a load current of 100 A at rated voltage and a power factor of (i) unity, (ii) 0.8 leading, and (iii) 0.707 lagging. The test results available are as follows: The full- load current of 100 A is produced on short-circuit by a field excitation of 2.5 A, an e.m.f of 500 V is produced on open circuit by the same excitation, and the armature resistance is 0.8 ohm.

15

(b) Describe briefly the construction of (i) woundrotor, (ii) deep-bar and (iii) double-cage type induction motors and explain how in each case a high starting torque is obtained

15

(c) Using double-revolving-field theory, develop an equivalent circuit for single-phase induction motor.

10

PART C

5. (a) Sketch the polar (Nyquist) plot on a plain paper for the following transfer function:

$$G(s) = \frac{10}{s(1+s)(1+0.5s)}$$

15

(b) Sketch the Bode plots in magnitude and phase versus frequency on a plain paper for the following transfer function:

$$G(s) = \frac{100(1+0.1s)}{s(1+0.2s)(1+0.5s)}$$

15

(c) Using Routh's criterion of stability, determine the range of K for which the system shown in figure 1 will remain stable.

Fig. 1

10

6. (a) Explain the meaning and significance of phase and gain margins of a control system. How will you obtain the values of these margins from (i) polar plot, and (ii) Bode plots? Illustrate by giving plots for stable and unstable systems separately.

20

(b) Obtain the state transition matrix of the system represented by the following state equations and, using the same, determine the time response for t≥0

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [r]$$

The initial conditions are $X_1(0) = 1$ and $x_2(0) = -1$ and the input r(t) is a unit step function at t=0.

20

PART D

7. (a) Describe, with the help of a block schematic, the principle and working of a modulo-5 counter using flip-flops along with appropriate feedback.

10

(b) Prove that the circuit shown in figure 2 has an outpute_2 given by

$$e_2 = \frac{2}{RC}\int e_1 dt$$

if the operational amplifiers an ideal one.

10

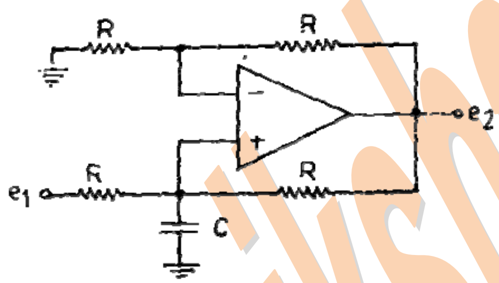


Fig. 2

(c) Discuss, with the help of a circuit example, the purpose of providing (i) negative feedback, (ii) positive feedback in amplifiers

10

(d) An average-responding electronic voltmeter has its scale calibrated to indicate correctly the r.m.s. value of sinusoidal voltages. Calculate the error in its reading if the instrument is used for measuring value of asymmetrical triangular-wave voltage.

10

8. (a) Prove mathematically that a sine-wave carrier amplitude-modulated by a sinusoidal signal has three frequency components. Identify the frequencies and amplitudes of these components in terms of those of the carrier and modulating signal.

10

(b) Giving circuit diagram of an FM detector, describe its operation.

10

(c) What is meant by single-side-band transmission? Comment on its merits and demerits relative to double-side-band transmission.

10

(d) Write a note of about 250 words on the use of open wires, coaxial cable, microwaves, waveguides and optical Mire as communication media.

10

PART E

9. (a) Bring out the difference between FUNCTION sub-programme and SUBROUTINE sub-programme with the help of an example.

10

(b) Identify the errors in the following FORTRAN statements and suggest correction:

10

(i) REAL ITEM, KIT, MASS, INTEGER, BETA.SIGMA

(ii) DO 200 VALUE = 0.1, 1.5, 0.2

(iii) IF (P–Q)/(R+S) 10,20,30

(iv) GO TO(0,20,50), NODE

(c) Draw a flow chart and write an efficient FORT—RAN programme to find the inverse of a given matrix.

20

10. (a) Draw a functional block diagram of digital computer and explain briefly the role of each unit therein.

15

(b) Write a programme in FORTRAN language using only logical IF statements and unconditional Go To where necessary to sum the series

$$sum = \sum_{k=1}^{n} \frac{1}{(5k+1)}$$

Use format-free INPUT/OUTPUT statements to input 'n' and output 'sum'.

15

(c) Translate the following mathematical expressions into FORTRAN statements. Use common pre-defined functions for parts (iii) and (iv):

10

(i) $x = a\left(\frac{p+q}{r}\right)^{7.9}$

(ii) $y = s^{5/7} - t^{-7}$

(iii) $z = \sin|a| + 1.8\log_{10} b + \sqrt{ab}$

(iv) $w = ae^{-bc} + \sqrt{p^2 + q^2}$