ELECTRICAL ENGINEERING

PAPER - I

PART A

1. (a) Define precisely unit step and unit impulse functions.

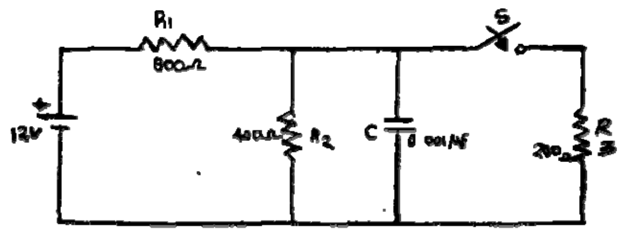
   (b) Sketch the following function from t = 0 to t = 10 units, indicating all salient values at different times

   50(1–½t[u(t)–u(t–4)]

   (c) Figure 1 shows a network which is in the DC steady state with switch S open. At t = 0 switch S closes.

   (i) Determine i(t) the current passing through R_2 and draw a sketch of i(t) versus time.

   (ii) Specifically determine i(0), i(∫) and i(t) at t = 114msec.



R_1=800Ω R_2=400Ω C=0.001μf R_3=200Ω

Fig. 1

2. (a) Explain clearly what is meant by each of the following:

   (i) Poles and zeros of a network function

   (ii) Frequency response of a network

   (iii) Z parameters of two port network.

   (b) Figure 2 is the circuit diagram of well-known filter network. are the input port and 22' are the output ports. The network element values are clearly shown in Fig. 2.

   (i) Find the Z parameters Z_{11} and Z_{12} of the network.

   (ii) On the s-plane clearly locate the poles of Z_{12}.

   (iii) Plot a rough sketch of the frequency response of the network.

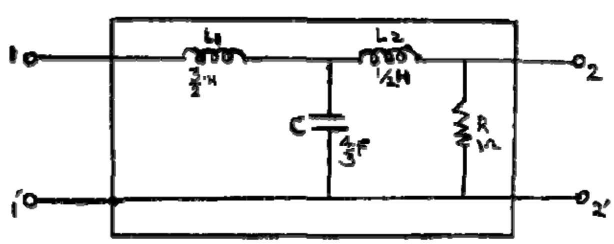


Fig. 2

3. (a) Figure 3(a) shows a Bridge T network used in control systems. The element values are clearly marked in the figure.

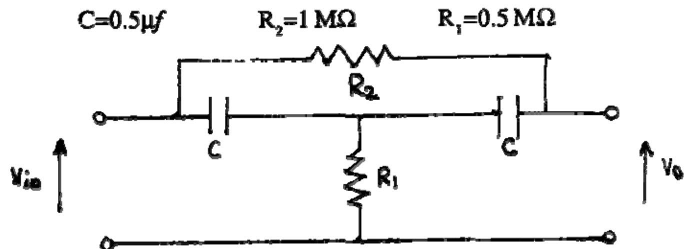


Fig. 3(a)

Show that the transfer function V_0/V_1 of this filter is $\frac{S^2+4S+8}{S^2+8S+8}$ by using Nodal Analysis.

(b) Figure 3(b) represents the signal flow graph of a transistor circuit.

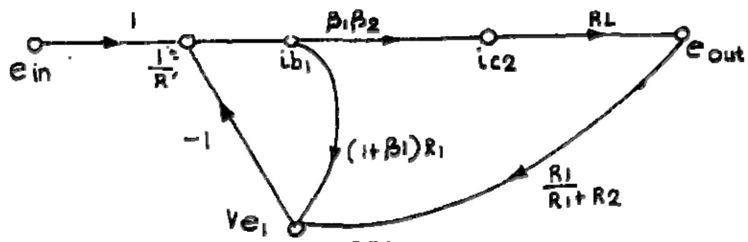


Fig. 3(b)

Adopting Mason's rule, compute the ratio of the output voltage e_{ou} to the signal input voltage e_{in}.

PART B

4. (a) Explain the different types of Electron emission from metals.

(b) Explain briefly 'work & function' and its measure.

(c) A tungsten emitter operates at a temperature of 2400 °K. By how many volts must the voltage equivalent of the work function change to reduce the emission current density by 15%?

$A = 60.2$ amp $em^{-2}°K^{-2}$

$b = 11605$ f(where f is the work function).

5. (a) Explain the basis on which solid materials are classified as Conductors, Insulators and Semi-conductors. Bring out the difference between these types of materials with reference to energy band diagrams.

(b) A silicon material is uniformly doped with phosphorus atoms at a concentration of 2 x $10^{19}/m^3$. At temperature of interest the mobilities of holes and electrons are

$\mu_p = 0.05\ m^2$/volt-sec

$\mu_v = 0.12\ m^2$/volt-sec

If $n_1 = 1.5 \times 10^{16}/m^3$

find the electron and bole concentrations and the electrical conductivity.

PART C

6. (a) What is meant by magnetic scalar potential? What axe the difficulties arising in using this quantity?

(b) Using the Magnetic Vector Potential Concept calculate the magnetic field H of an infinite Z-directed current filament of strength I.

(c) Calculate the energy of a sphere of charge of radius R in which the charge is uniformly distributed.

7. (a) Calculate the relaxation time constant for copper given s_{cu} = 5.8 x 10^7 υ/m, e = E, m = m. Interpret the result.

(b) Give the physical interpretation of

E x H

State and prove Poynting's theorem.

(c) A 100-MHz plane wave is normally incident on a plane copper interface from air. If the incident E field has an r.m.s. value of 1 V/m. How large are the reflected and transmitted waves?

PART D

8. (a) Defining a 'Transducer' give at least four examples of different types of transducers employed in Instrumentation practice.

(b) Describe the principle of a moving-iron transducer and prove that in such transducers force is directly proportional to the rate of change of inductance F = ½1^2 dL/dx

(c) An example of a versatile moving-iron transducer is the electromagnet Fig. 4 shows an electromagnetic relay whole contacts are held open by a spring exerting a force of 0.2 newton. The gap length is 4 mm when the contacts are open and 1 mm when the contacts are closed. The coil which has 5000 turns is wound on a core of 1 cm^2 cross-section. Predict the pick-up and drop-out currents for this relay. Find also the flux density B in Tesla across the air gap. State any assumptions made.

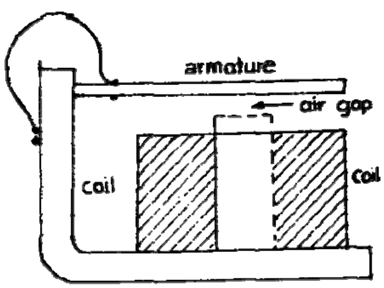


Fig. 4

9. (a) Outline briefly the different methods of measuring frequency of an incoming sinusoidal signal (audio frequency ranges).

(b) Draw a neat circuit diagram of a Wien-bridge circuit for measuring unknown frequencies in the audio range. What are the advantages of this bridge circuit over other methods for measurement of frequency?

(c) Explain how you would use a CRO to measure the phase between two sinusoidal signals.

10. You are required by an industry to design and set up an instrumentation system for precise measurement of speed of an industrial drive (Range of speeds up to 6000 r.p.m. with accuracy of measurement of one in six thousand). As analog methods are unsatisfactory, you have to think of digital methods for measurement display and recording.

(a) Draw a block schematic of your set-up explaining the functioning of various units.

(b) What type of digital display system will you use and why?

(c) You are required to record your data (speed) accurately for a few hours; what type of recording system will you use and why?

I.E.S.-(Conv.) 1987

ELECTRICAL ENGINEERING

PAPER - II

SECTION A

1. State whether the following statements are 'True' or 'False'. Briefly justify your statement with necessary theory, derivations, sketches etc.:–

   (a) Back e.m.f. acts like a governor i.e. it makes a motor self regulating so that it draws as much current as is just necessary.

   (b) The star-star connection of transformers is most economical for large, low-voltage transformers.

   (c) In an induction motor, the starting torque is maximum when rotor resistance equals rotor reactance.

   (d) The synchronous motor may be operated at any desired power factor by changing the d.c. excitation.

   (e) Series generators are better suited for stable parallel operation as compared with shunt generators.

2. (a) Illustrate with sketches the working of following motors:

   (i) Stepper motor (ii) Universal motor (iii) Hysteresis motor (iv) Reluctance motor.

   (b) Explain the 'V' curves of synchronous motors.

   (c) What types of motor would you employ for the following types of loads? State reasons for your choice:—

   (i) Hoist (ii) Rolling mill (iii) Textile mill (iv) Refrigeration and Air-conditioning.

   (d) Briefly enumerate the different types of starters used for induction motors.

3. (a) Describe the behaviour of space-charge effects inside a corona envelope and discuss why load current cannot flow in a conductor inside this envelope even though it is a conducting zone.

   (b) Describe a line filter for blocking corona energy from entering the source transformer.

   (c) Discuss briefly the types of lightning arresters used in EHV systems.

   (d) For a 750kv line, take the voltage crest travelling on the line V_w = 3000 kV and the protective level of voltage as V_p = 1700 kv. The line surge impedance is Z = 300 ohms. Calculate:

   (i) The current flowing in the line before reaching the arrester,

   (ii) The current through the arrester, and

   (iii) The value of the arrester resistance for this condition.

   Verify the reflection and refraction coefficients giving rise to the voltage and current conditions.

SECTION B

4. (a) Illustrate with suitable Nyquist diagrams the distinguishing features of a control system which has absolute stability and a system having conditional stability.

(b) Sketch, the root locus diagram for the closed loop system having a loop transfer function given by

$$G(s)H(s) = \frac{K(s+2)}{s(s+1)}$$

as K varies from zero to infinity.

(c) Explain the meaning of the terms:

(i) gain margin (ii) phase margin (iii) gain crossover frequency (iv) phase crossover frequency.

(d) The characteristic equation for a feedback control system is given by

$$s^3 + 20ks^2 + 5s^2 + 10s + 15 = 0.$$

Determine the range of values of k for which the system is stable

(e) Write the state equations for a system described by the differential equation

$$\frac{d^3c(t)}{dt^3} + \frac{6dc(t)}{dt} + 5c(t) = r(t)$$

5. (a) Give a flow-chart for grading a quiz paper having 100 objective type questions.

(b) Briefly describe the architecture of a minicomputer.

(c) Explain the roles of the assembler and the compiler

(d) Enumerate the special features of a microprocessor that make it amenable to a wide range of application

(e) Distinguish between the functions of a ALU and the CPU.

6. (a) Discuss the major differences between Fortran IV and Pascal as regards

(i) Control statements, (ii) Array handling.

(b) Distinguish between ROM, PROM and EPROM.

(c) Implement a typical arithmetic circuit like a full adder using logic gates.

(d) Briefly enumerate the standard procedures for simplifying logic expressions with suitable illustrations.

SECTION C

7. (a) Clearly explain the principles of P.C.M.

(b) Discuss the advantages of P.C.M.

(c) Briefly enumerate the chennel anomalies of communication system.

(d) State the Hartley-Shannon law for channel capacity and discuss its significance.

(e) Compare AM and FM systems with reference to S/N ratio.

8. (a) Explain how an OP-AMP can be used as

(i) Voltage follower (ii) R-C oscillator.

(b) Design a common emitter BJT amplifier using the potential-divider biasing scheme to meet the following specifications:—

Stability factor

$$St = \frac{\overline{\partial I_O}}{\partial O_{OB} O} = 5$$

$I_c = 1$ mA

$V_{cE} = 5$ V

$V_{cc} = 10$ V

$\beta = 100$

$V_{BE} = 600$ mW.

(c) Realise a divide by 6 ripple counter.

(d) Design a medulo-5 counter of the synchronous type.

9. (a) Distinguish between WET and MOSFET.

(b) Explain bow a WET can be used as a square-law modulator.

(c) Discuss how race-around condition is avoided in a JK Flip-Flop.

(d) Give the truth table for a binary subtractor.

(e) Simplify the following logic expression and realise it using NAND gates:-

F = AB + ABC + ABCD + ABCD.