ELECTRICAL ENGINEERING

PAPER – I

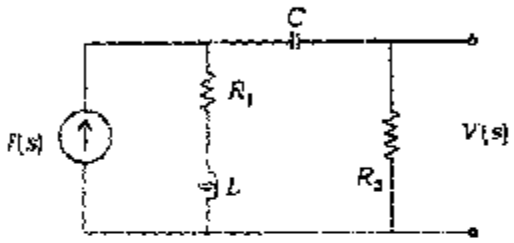
Candidates should attempt questions 1 and 5 which are compulsory and any three of the remaining questions selection at least one question selecting at least one question from each Section.

SECTION A

1. Answer any three of the following

(a) Determine the relationship between R_1, R_2, L and C of the circuit shown below so that the poles of the function V(s)/I(s) are complex.

20



(b) (i) Justify that a thin sheet of a conducting material acts as a low-pass filter for electromagnetic waves.

10

(ii) A radio signal at a frequency of 10 MHz is transmitted through sea-water having σ = 4 S/m and ε_r = 100. Find the distance at which 80% of the wave amplitude is attenuated.

10

(c) Justify the statement Commentator in a d.c. machine keeps the armature mmf stationary in space along the inter-polar axis even though the armature rotates.

20

(d) (i) What factors influence the performance of Yagi—Uda antenna? Explain it clearly with the help of a neat sketch showing the direction of e.m.w.

10

(ii) Determine field strength at a distance of 50 kin of a short vertical monopole radiating power of 20 kW at a frequency 1 MHz over ground with mean conductivity of 10 mS/metre

10

2. (a) The clock frequency of 1000 ns is connected to a 3-bit asynchronous counter with each flip-flip having 50 ns propagating delay. Which slate will never occur in it, if the clock frequency is decreased to 100 ns? Explain it by drawing wave- shapes for 1000 ns and 100 ns clock frequencies separately.

20

(b) A 230 V D.c. source feeds a separately-excited d.c. motor through a chopper operating at 400 Hz. The load torque at 1200 r.p.m. is 32.5 Nm. The motor has $r_a = 0$, $L_a = 3$ mH and $K_m = 1.3$ V-s/rad. All motor and chopper losses are neglected.

Calculate (i) the armature current excursion and (ii) the armature current expressions during on and off periods.

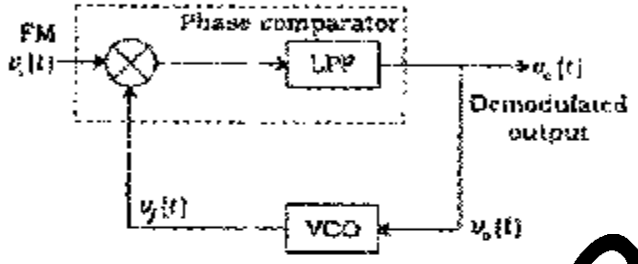
20

(c) Draw the equivalent circuit of a 1-phase induction motor based on two-revolving field theory. Identify the various parameters involved in it. Prove, there from, that the forward flux wave is several times greater than the backward flux wave ϕ_b at normal rotor speed, hut at standstill. $\phi_f = \phi_b$.

20

3. (a) Describe the principle of working of linearized model of phase lock loop shown in the figure given below and show that the output voltage is proportional to the change in frequency in the FM signal

20



(b) Two transformers A and B, operating in parallel have equal voltage ratios and leakage impedances. Their reactance to resistance ratios are 10 and 4 respectively. Determine the ratio of the full-load kVA delivered by the parallel combination to the sum of their individual kVA ratings. Comment on the result.

20

(c)

For the circuit shown above, thyristor T is turned on at a triggering angle greater than that given by $\sin^{-1}(E/V_m)$. Draw waveforms for u υ_s, i_0 and υ_T. Derive an expression for the average charging current I_0.

For supply voltage of 30 V, 50 Hz and constant battery e.m.f. of 6 V find the resistance to he inserted in series with the battery to limit the average charging current to 3 A in case thyristor T is turned on at a firing angle of 20°.

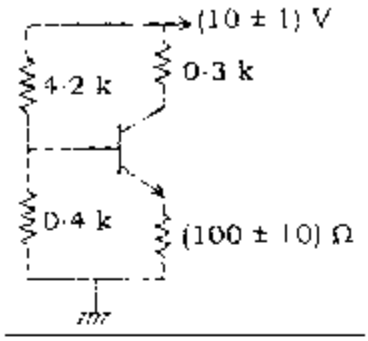
20

4. (a) Why do the maximum voltages across the inductance and capacitance in a series R - L - C resonant circuit occur at different values of frequencies? Explain.

20

(b) (i) Calculate the quiescent collector current I_{CQ} or room temperature for the amplifier circuit shown in the figure given below.

10



(ii) Describe the applications of clipping and clamping circuits. 10

(c) What is the difference between TWT and Klystron? How TWT operates as microwave oscillator?

Determine (i) the gain parameter; (ii) the power gain, and (iii) any two propagation constants in a traveling wave tube having the following parameters

Beam voltage $V_0 = 2$ kV

Beam current $I_0 = 20$ mA

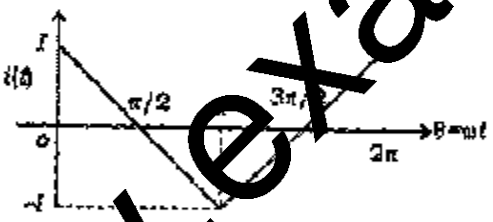
Frequency $f = 10$ GH

Characteristic impedance of helix $Z_0 = 10\Omega$

Circuit length = 50 (wavelength) 20

SECTION B

5. (a) Answer any three of the following



A non-sinusoidal current i(t) as shown in the above figure is passed through a capacitance C = 100 μF. Determine the voltage across the capacitance when ω = 1000 rad/sec. 20

(b) (i) Design a combinational circuit having 3 inputs and 6 outputs with the condition that the output number is square of the input number. 10

(ii) A computer uses RAM chips of capacity 1024 × 1. How many chips are required and how their address and data bus be connected to provide a memory capacity of 1024 bytes? How chips would be connected to provide memory of 16 K bytes? 10

(c) For a single-phase one-pulse controlled converter system, sketch waveforms for load voltage and load current for (i) RL load and (ii) RL load with freewheeling diode across RL. Compare these waveforms and discuss the advantages of using a freewheeling diode. State the assumptions made.

20

(d) Justify the statement pulse modulation is not digital whereas pulse code modulation is digital

Obtain the bandwidth for 128 quantization levels and 8 kHz sampling frequency of a practical PCM system consisting of 24 telephone channels, each band limited to 3.4 kHz in time division multiplexing. Deduce formulae used.

20

6. (a) (i) Explain the phenomenon of attenuation in TE and TEM waves.

10

(ii) Determine the guide wavelength to propagate a 20 GHz signal through a parallel plate waveguide having a plate separation of 5 cm.

10

(b) (i) Which type of communication system will you prefer for speech processing? Why?

10

(ii) With the help of a suitable schematic diagram describe the working of a delta modulation system. Discuss its limitation.

10

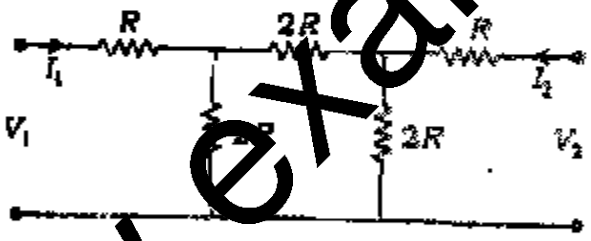
(c) (i) Derive relationship between critical frequency and the maximum density of a layer N.

10

(ii) Calculate skip distance for a wave of frequency 4.5 MHz when the maximum ionization in the E - region has a value of 10^{10} electrons/m^3 at a height of 105 km.

10

7. (a)



Obtain Z-parameters of the 2-port network given above and deduce Y-parameters from the result.

20

(b) (i) A n-type Gats Gunn diode of length 10 μm, doping concentration $2 \times 10^{14}/m^3$ and threshold field 3 kV/cm operates at a frequency of 10 GH with applied voltage of 3.5 kV/cm. Calculate electron drift velocity, current density and negative mobility of electron.

10

(ii) A circular loop of 20 cm radius made of 3 mm dia of copper wire is used as an antenna. Calculate its radiation resistance. ohmic resistance, input resistance and radiation efficiency at 1 MHz.

10

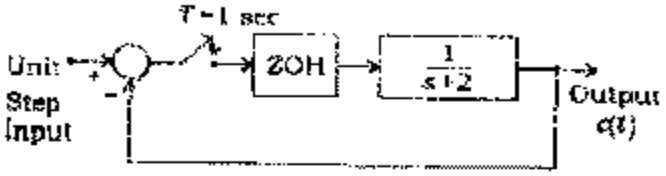
(c) A signal $\upsilon_i(t) = k\{1 + m\,f(t)\} \cos \omega_c t$ is applied to the input of an average (diode) detector with load resistance R. The diode is characterized as

$i_b = 0$ for $\upsilon_b \leq 0$

$i_b = v_b/r_d$ for $v_b > 0$

Obtain an expression or low frequency component of the output voltage of the detector for $|m f(t)| < 1$

20



ZOH : Zero Order Hold

Determine the output c(t) at t = 2 sec for the system shown in the above figure.

20

(b) A star - connected synchronous machine with $Z_S = 1 + j\ 10$ ohm per phase, is synchronized with an infinite bus of 11 kV. The machine is made to operate at a leading power factor of 0.8 with an armature current of 50 A and with terminal voltage ahead of the excitation e.m.f. Calculate the magnitude of excitation e.m.f.

How can this machine be made to operate at unity pf? Under this condition, find the armature current and load angle,

20

(c) A single-phase full bridge inverter feeds a load that allows load commutation. Explain how load commutation is achieved. Describe the conduction of various elements of the inverter circuit.

20

ELECTRICAL ENGINEERING

PAPER – II

SECTION A

1. Select any three of the following statements, read them carefully and identify the correct and the incorrect ones. Justify your answer using not more than 200 words in each case.

$20 \times 3 = 60$

(a) State variable approach for analysis is applicable only to linear time invariant systems.

(b) The problem of drift may assume very serious problems in electronic instrumentation system.

(c) Power carrying capability of transmission lines decreases with increase in the length of transmission, and can be improved by providing shunt reactors.

(d) Optical fibre is the best choice for heavy demand long line telephone communication systems.

2. (a) The open hop transfer function of a unity feedback system is given by

$$G(s) = \frac{k}{s(1+st_1)(1+st_2)}$$

(i) Using the Routh—Hutwitz method, determine the necessary conditions for the system to be stable.

(ii) Sketch the root locus diagram for the system described for positive values of k, t_1 and t_2. Show how the root locus gets modified with addition of a zero.

20

(b) Incremental cost characteristics of two thermal plants is given by

$$\frac{dC_1}{dP_{G1}} = (60 + 0.2P_{G1})\ Rs./MW - hr$$

$$\frac{dC_2}{dP_{G2}} = (40 + 0.3P_{G2})\ Rs./MW - hr$$

Evaluate the sharing of a load of 200 MW for most economic operation. If the plants are rated 150 MW and 250 NW. what will be the saving in cost in Rs./hour in comparison to loading in the same proportion to rating?

20

(c) Describe the construction and principle of working of a solid-state and over-current relay.

20

3. (a) Boron is doped in n-type Si wafer having 2×10^{22} phosphorus atoms m^3 through a circular window of 0.1 μm diameter for 10 minutes at 1100° C The gaseous atmosphere of BH_3 used for doping provides the B concentration of 1×10^{23} atoms m^3 at the surface of the wafer Estimate the location of the p-n junction beneath the surface. Given the diffusivity of B in Si at 1100°C is $4 \times 10^{-17}\ m^2\ s^{-1}$.

20

(b) What is load flow solution? What is its significance in power system Classify various types of buses in a power system for load flow studies. Explain, with a flow-chart, the computational procedure for load-flow solution using Gauss-Siedel method.

20

(c) What are solar concentrators? Describe various components of a solar concentrator giving their functions.

20

4. (a) One method of measuring a small capacitance C_x is shown in fig. 1. C_1 and C_2 are equal high-quality variable air capacitors. C_3 is a fixed high quality capacitance of much smaller value than maximum value of C_2 (about 1/10 of C_2). The following two balances are obtained

(i) With switch S open, C_2 at its maximum value and C_1 is adjusted for balance

(ii) With switch S closed, C_1 left unaltered and C_2 is adjusted to C_2 to get a new balance

Prove that

$$Cx = \frac{C_3^2(C_2 - C_2)}{(C'_2 C_2 + C'_2 C_3 - C_2 C_3)}$$

If R = 1000Ω, C_1 and C_2 are 1000 pF and C_3 = 50 pF and assuming the variable capacitors are readable to ± 5 pF with what accuracy could a capacitance of 1 pF be measured?

20

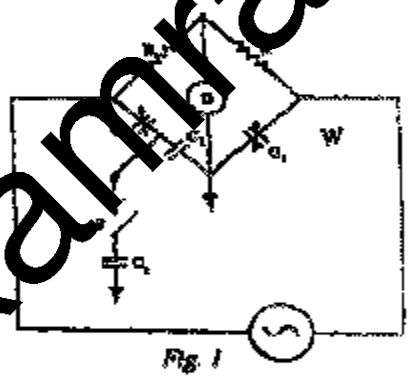


Fig. 1

(b) Discuss three kinds of error-detection codes and explain how they detect errors.

20

(c) Explain with the help of block diagram a CW Doppler radar using an intermediate frequency in the receiver. Give its advantages applications and limitations.

20

SECTION B

5. Select any three of the following statements, read them carefully and identify the correct and the incorrect ones. Justify your answer using not more than 200 words in each case.

20 × 3 = 60

(a) Feedback provides same control on the steady state error to standard inputs by adjustment of open-loop gain.

(b) One disadvantage of magnetic tape recorder is that its characteristics limit its use at higher frequencies.

(c) The cost of fabrication and installation of system for utilizing solar energy is too high to be viable.

(d) ICs, although cheaper, axe less reliable as compared to discrete components interconnected by conventional techniques.

6. (a) A system is described by the following state and output equations

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$$

And $Y = [1 \quad 0]X$

where u(t) is a unit step input and the initial conditions $X_1(0) = 0$, $X_2(0) = 0$. Obtain the time response of the system.

20

(b) Briefly explain the principle of PCM, differential PCM and delta modulation.

20

(c) Discuss salient features of a fibre optic communication system. List some of the optical components used to interconnect a digital voice or data systems.

20

7. (a) Discuss the functions of various Registers and ALU of 8085.

20

(b) Discuss multiple access techniques for satellite communications. Explain the meaning of the following

FDMA, TOMA, COMA and SOMA

20

(c) Briefly describe two different types of phase array radars. How can phased arrays overcome the difficulties occasioned by the use of moving radar antennae?

20

8. (a) Give the construction, principle of working and apperceptions of an LVDT.

20

(b) Develop receiving end power circle diagram of a transmission tine. Explain, how from the power circle diagram, capacity of a synchronous phase modifier be determined.

20

(c) Establish block diagram for load-frequency control of an isolated power system.

(d) 20

Table of the Error Function

y	erf(y)
0.0	0.0000
0.1	0.1125
0.2	0.2227
0.3	0.3268
0.4	0.4284
0.5	0.5205
0.6	0.6039
0.7	0.6778
0.8	0.7421
0.9	0.7970
1.0	0.8427
1.1	0.8802
1.2	0.9103
1.3	0.9340
1.4	0.9523
1.5	0.9661
1.6	0.9763
1.7	0.983
1.8	0.9891
1.9	0.992
2.0	0.995