ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed: 3 hour *Maximum marks: 200*

Candidates should attempt Question 1 which is compulsory and any four of the remaining question.

The number of marks carried by each question is indicated at the end of the question.

Answers must be written in English.

1. (a) Draw the equivalent circuit of a practical resistor, taking Its lead inductance and stray capacitance into account. Show that, at low frequencies, the practical resistor may behave as an ideal resistor if the element values are properly related. Find this relation.

8

(b) Draw the equivalent circuit of a practical) capacitor, taking its lead inductance, lead resistance and leakage resistance into account. What is the frequency above which the capacitor actually behaves as an inductor?

8

(c) The impedances of the two networks shown in Fig. 1 are the same. Find the values of C_1, B_2, R_2 and O_2.

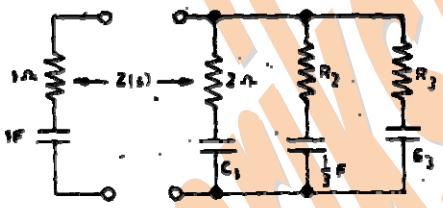

Fig. 1

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(d) State and prove the initial value theorem of Laplace transforms.

8

(e) Find the intrinsic carrier concentration of Germanium, if its intrinsic resistivity at 300 °K is 0.47 ohm-m. It is given that the electronic charge is 1.6×10^{-19} coulombs, and that electron and bole mobilities at 300 °K are 0.39 an 0.19 m^2/(volt.sec),

8

(f) An antenna array is required to produce the normalized radiation pattern shown in Fig. 2. Specify all that you can about the array.

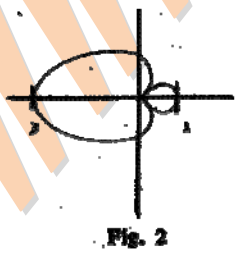

Fig. 2

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(g) A voltmeter having a sensitivity of 1000 Ω/V reads 100 V on its 150 V scale when connected across an unknown resistor R_x in series with a milliammeter which reads 5 mA. Find R_x.

8

(h) What is the resolution of a 3½ digit display DVM for 0 to 1 V range ? What is the resolution on the 0 to 10 V range?

4

2. (a) Give a schematic diagram of the SCR and derive its equivalent representation in terms of transistors. Express the current in the SCR in terms of the I_{co}'s and alphas of the individual transistors.

12

(b) The diode shown in Fig. 3 is nor ideal, and has a reverse saturation current of 10 μA. Find the peak forward current In the diode and the peak forward voltage drop across it.

13

(c) Draw the complete hybrid-vs equivalent circuit of a transistor and find an expression for the short-circuit current gain.

10

3. (a) Explain, with a neat block diagram, the principle of operation of an instrument for measurement of the harmonic content of a waveform, using a null network.

10

(b) A coil was tested using a Q-meter and the following results were obtained:

Oscillator Frequency	*Tuning Capacitance Setting*
3 MHz	251 pF
6 MHz	50 pF

Find the self-capacitance of the coil.

12

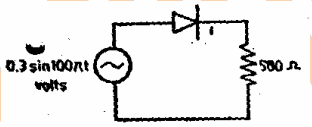

Fig. 3

(c) A strain gauge of resistance 1kΩ and gauge fact 2 is mounted on a cantilever beam and connected in one arm of a Wheatatone bridge, whose other three arms have a resistance of 1kΩ each The bridge is supplied by a 10V source and the detector has a resistance of 1kΩ and a sensitivity of 10 mm/μA.. What is the detector deflection for 0.1% strain ?

13

4. (a) Explain how Hall effect can be used to the carrier concentration in a semi-conductor.

10

(b) Synthesize a network to realize the voltage transfer function

$$\frac{V_0(s)}{V_t(s)} = K\frac{s+a}{s+b}$$

where a<b. What is the highest possible value of K that can be realized?

13

(e) Determine the relationship(s) between the elements of the network of Fig. 4 so that its Impedance is resistive at all frequencies.

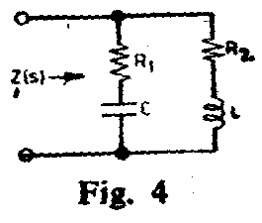

Fig. 4

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5. (a) The switch in the circuit shown in Fig. 5 has been In position a for a long time. At t=0, the switch is moved to position b. Find v_c (0+), v_o. (0^-,)

$\left.\frac{dv_o(t)}{dt}\right|_{t=0+}$, v_0 (t) for t>0 and i_c (t) for t>0. At what value of t will v_c (t) pass through zero value?

18

(b) Find the transfer function of the network shown in Fig. 6. Plot the magnitude response of the network and show that it behaves a band-pass filter. What are its centre frequency and Q?

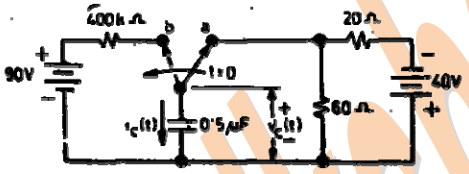

Fig. 5

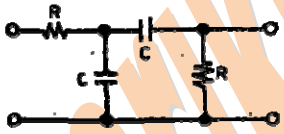

Fig. 6

17

6. (a) Calculate, from first principles, the capacitance of a spherical condenser, formed by two concentric conducting spherical shells of radii a and b, b>a, when the region between the spheres is a dielectric with permittivity ε.

15

(b) Carry out appropriate mathematical analysis to derive a physical interpretation of the quantity $\vec{E} \times \vec{H}$ for a uniform plane electromagnetic wave.

20

7. (a) A two wire lossless transmission line of characteristic impedance 300Ω, length 2m and velocity of propagation 2.8×10^8 m/s is driven by a sinusoidal source of 300Ω internal resistance, 60V amplitude and 100 MHz frequency, and is terminated in a resistance of 150Ω. Determine –

(i) the reflection coefficient at the output end

(ii) the VSWR on the line

(iii) input impedance

(iv) input current

(v) average power supplied to the line

(vi) average power supplied to the load

(vii) the amplitude of the load voltage.

20

(b) A pure sine wave at a frequency of ω_0 rad/s is required for a particular application. The available signal generator produces a waveform at ω_0 tad/a, which is rich in the second and third harmonics. Give a simple means of getting rid of these harmonics using the LEAST possible number of circuit elements. Give the element values in terms of ω_0.

15

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time allowed: 3 hours *Maximum marks: 200*

*Candidates should attempt five questions choosing not more than **three** questions from each Section.*

The number of marks carried by each question is indicated at the end of the question.

Answers must be written in English.

SECTION A

1. (a) Discuss the different types of transistor biasing circuits. Derive an expression for the stability factor in self-biasing circuit.

12

(b) In an R-C coupled amplifier using transistors, find the mid-band gain and the two half-power frequencies neglecting the effect of biasing components in the circuit. The device parameters are

h_{ie}=2 kΩ, ; h_{fe}=50; C_{bie}=100pF: C_{bje}=4pF; $R_c = R_L$ = 10kΩ; R_s = 1kΩ; $C_e = C_b$ = 1μF; C_E=20μF; R_E = 1kΩ.

14

(c) In the circuit shown in Fig. 1, R_d=12kΩ, R_g=1MΩ.; R_s=2kΩ; V_{DD}=25 volts; C_s=100μF; I_{DSS}=4 mA; V_P=–4 volts; g_m=1m℧; $r_d \geq R_d$.

Determine V_{DS}; I_d; V_{gs} and AV.

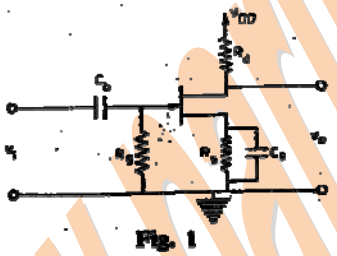

Fig. 1

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2. (a) Draw the equivalent circuit or a CE amplifier using hybrid π model at high frequencies and derive the expression for voltage gain and band-width taking source resistance into account.

10

(b) A silicon transistor has the following parameters:

h_{fa}=50; h_{ie}= 1kΩ; f_T=300 MHz; C_{bie} = 4pF; I_e =2.0 mA; T=25°C.

Calculate g_m; $r_{b,e}$; r_{bb}, and C_{bie}.

10

(c) Design a series voltage regulator to give an out put voltage of 20 volts d.c. and a load current of 500 mA. Provide current limiting circuit and preregulator. The Unregulated supply has V_i=50±5 volts.

10

(d) Draw the circuit of a cascode amplifier using BJT and FET. Explain its working.

10

3. (a) Draw the clipping circuit to clip the 20 volts sinusoidal waveform at +4 volts and –3 volts. Assume ideal diodes. Sketch the transfer characteristics, input and output waveforms.

10

(b) Draw the circuit of an astable multivibrator using transistors and explain its action. Sketch the waveforms at various points. Design an astable circuit using silicon transistors to generate a square waveform of amplitude 10 volts at a frequency of 10 kHz with a duty cycle of 04. Choose $C_1=C_2=.01\ \mu F$.

10

(c) With the help of a circuit diagram explain the operation of a UJT relaxation oscillator. Sketch the waveforms at base 1, base 2 and emitter. Derive the expression for frequency of oscillations. Modify the circuit to get linear sweep.

20

4. (a) Minimize the following Boolean expression and realize it using only NAND gates :

8

$$f(A,B,C,D) = A\bar{B}\bar{C}D + AB\bar{C}D + \bar{A}BC\bar{D} + ABCD + A\bar{B}\bar{C}D + \bar{A}BCD$$

(b) Simplify

f(A, B, C, D) = ∑m(0, 1, 4, 5, 9, 11, 14, 15) + ∑d(10, 13).

8

(c) Draw the circuit diagram of a Master Slave J-K flip-flop using NAND gates. What is race around condition? How is it eliminated in Master Slave J-K flip-flop.

14

(d) Design a Modulo 9 asynchronous counter using Master Slave J.K flip-flops.

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5. (a) Construct an equivalent signal flow graph for the block diagram shown in Fig. 2 and evaluate the transfer function C (s) R (s).

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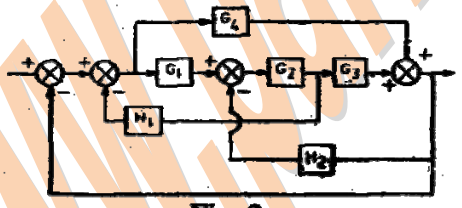

Fig. 2

(b) The transfer function of a feedback control system is given as $G(s)=\dfrac{K}{s^2(s+2)(s+5)}$ and H(s) = 1. Sketch the root locus diagram for the system indicate the crossing points of the loci on the jω-axis and the corresponding values of K and ω.

15

(c) For the given loop gain function, sketch the Nyquist diagram and Investigate the stability of the system:

$$G(s)H(s)=\frac{1+4s}{s^2(1+s)(1+2s)}$$

10

SECTION B

6. (a) Explain the process of 'drift space bunching' and reflector bunching' using Applegate diagrams.

7

(b) Prove that the electronic admittance in a Reflex Klystron is a soiral.

15

(c) Design a rectangular waveguide with copper conductor and air dielectric so that the dominant mode will propagate with 30% safety factor (f=1.3 fc) but also so that the wave type with next higher mode cutoff is 30% below its cutoff frequency. Assume f=3.0 GHz.

10

(d) To identical 20 db directional couplers are connected back to back in a microwave reflectometer measurement setup. The reading on the power-meter in the forward direction was 1.0 mW and in the reverse direction was 0.1 mW. Calculate the reflection coefficient and VSWR on she line.

8

7. (a) Explain the principle and Working of a GUNN oscillator.

12

(b) Determine the resonant frequency of a cube of side 1.0 cm in TE_{111} mode.

8

(c) Explain the importance of scattering parameters in microwave measurements and write the scattering matrix for a 3-port ideal circulator and a 3-db 3-port power divider.

10

(d) Draw the block diagram of a Microwave Link Repeater and explain its working.

10

8. (a) Describe the different tones used in an auto-telephone exchange.

6

(b) Why are TV standards required? Compare the US and Indian TV standards (monochrome) giving at least 10 selected parameters.

7

(c) Using a circuit diagram explain how sync. pulses are obtained from the composite video signal and how in turn horizontal sync. pulses are extracted.

15

(d) State Hartley-Shanon theorem and explain.

A system has a bandwidth of 4.0 kHz and an 8/N ratio of 28 db at the input to the receiver, calculate (i) its information carrying capacity and (ii) the capacity of the channel if its bandwidth is doubled while the transmitted signal power remains constant.

12

9. (a) Explain the working of an MTI Radar system with the help of a block diagram.

15

(b) Calculate the maximum range of a guided Missile Tracking Radar operating at 5.0 GHz with a 1.0 MW peak power output. The antenna diameter is 3.66 m and the receiver has a bandwidth of 16 MHz with 11.0 db noise figure. The target cross-section is 1.0 m^2.

(c) Explain the terms uniselector, group selector and final selector. Give the Trunking diagram of a 1000 line auto exchange and explain.

15

10. Write short notes on any four:

(a) PCM and its advantages. (b) Magnetron. (c) Colour TV (d) Companding (e) Lag-lead compensation networks. (f) Phase locked loop. (g) A/D converters. (h) Full adder circuit.

40