ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum Marks: 200*

*Candidates should attempt Question 1 and any **FOUR** of the remaining questions*

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

Answers must be written in English.

1. (a) A linear time-invariant system has the frequency response $IH(\omega)/e^{j\phi(\omega)}$. (i) Give the expression for the group delay of the system. (ii) State whether the phase response of the system is an even or odd function in ω (iii) State whether the magnitude response as an even or odd function in ω.

6

(b) (i) The EHT (Extra High Tension) of a CRO has decreased significantly from its rated value, but not to the extent to cause serious defocusing. State whether the y-input sensitivity of the CRO will be affected and, it affected, state whether it will be increased or decreased.

(ii) What is the important advantage of a sampling oscilloscope over the conventional oscilloscope.

(iii) Why is a difference amplifier configuration preferred in the first stage of a d.c. amplifier?

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(c) Pieso-electric crystals are used for generating stable sinusoidal oscillations. (i) Give the equivalent circuit of a crystal including the mounting capacitance. (ii) Sketch magnitude and phase of the crystal impedance against frequency.

6

(d) The behaviour of the ionospheric layers is usually described by virtual heights and critical frequencies. Define these two terms.

6

(e) (i) What is a broadside array?

(ii) What is precipitation static?

6

(f) Describe the major (i) advantage and (ii) disadvantage of double stub impedance matching over single stub matching system.

6

(g) A lossless transmission line with air dielectric is 20 m long. What is the line length in wavelengths in wavelengths and what is the value of (phase constant) at 10 MHz?

6

(h) Find the equivalent inductance between the terminals a, b, L_1, L_2 are the self-inductances of the coils and M is the mutual inductance between the coils.

6

Fig. Q. 1 (b)

2. (a) The schematic diagram of the tuning capacitor of a radio receiver is shown below. The plates are separated in air by a distanced. Neglecting the fringe effects at the edges, determine the maximum capacitance of the tuning capacitor

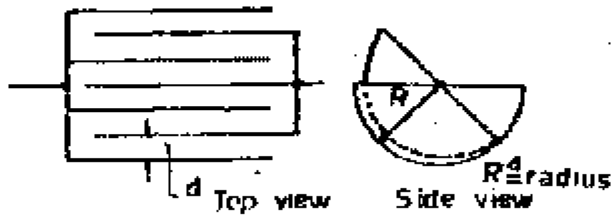

Fig. Q. 2(a)

(b) A sample of germanium is doped to the extent of 10^{14} donor atom/cm^3 and 5×10^{13} acceptor atoms/cm^3. At 300°K, the resistance of the intrinsic germanium is 60 Ω-cm. If the applied, electric field is 2 V/cm, find the total conduction current density. Assume = μ_p/μ_n =1/2 (μ=mobiligy), and n_i=2.5×10^{13}/cm^3 at 300K.

38

3. (a) Both emitter and collector junctions of a transistor are reverse biased by about 2 volts. Assume I_{CO} (reverse saturation current of the collector-base diode) = 6 μA, I_{EO}(reverse saturation current of the emitter base diode)= 2 μA, and $\int_N = 0.96$. Find I_E and I_C (Emitter and collector currents). Note that $\int_I I_{CO} = \int_N I_{EO}$ where $\int_N$ and $\int_I$ are, respectively, the common-base current gain under normal and reverse operations.

(b) The hybrid-π model of a transistor is shown below. Find h_{12} (the open-circuit reverse voltage gain of a two-poll parameter) of the model at 10^9 rad/s.

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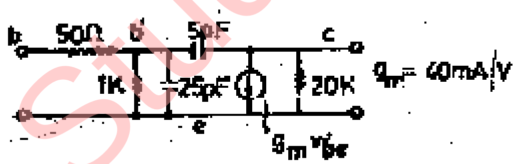

Fig. Q. 3 (b)

4. (a) In the network shown below, the switch is closed at t=0. At t=t_0>0, It is found that i(t)=1.0A and dv(t)/dt=10 V/sec. Find C.

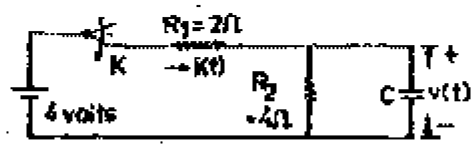

Fig. Q. 4(a)

(b) In the network shown below, the initial voltages on C_1 and C_2 are: $v_1(0)$=2V, $v_2(0)$=1V. At t=0 the switch is closed. Find i(t), $v_1(t)$, $v_2(t)$ for t > 0 and the final values of $v_1(t)$ and $v_2(t)$.

38

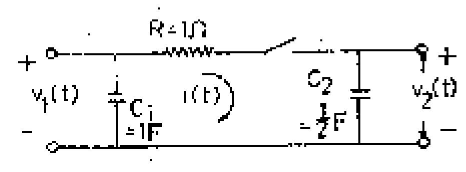

Fig. Q.4 (b)

5. (a) (i) Find the y-parameters of the 2-port network shown below.

(ii) Then obtain, from these y-parameters, the z-parameters of the network.

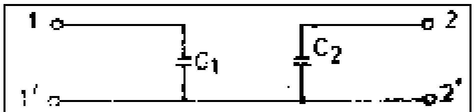

Fig. Q.5 (a)

(b) The input x(t) and the output(t) of a linear time-invariant system is shown below, find the transfer function of the system.

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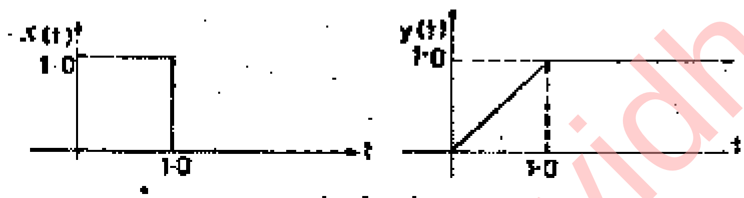

Fig. Q.5 (b)

6. (a) In the circuits shown below, voltage is measured by a voltmeter with sensitivity of 20kΩ/volt and using the 10-volt range. Find the percentage error in the measurement.

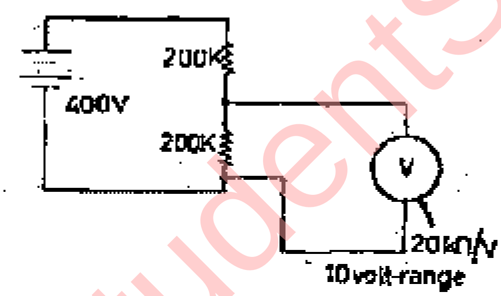

Fig. Q.6 (a)

(b) A CRO has a rise time 20 nanoseconds. The rise time of a signal measured by this CRO is 25 nanoseconds. Find the true rise time of the signal.

(c) An oscilloscope test probe is shown below. Assume that the cable capacitance in 90pF. The input impedance of the CRO is 2MΩ in parallel with 10 pF. What is the attenuation of the probe, taking account the input impedance of the CRO? Find the value of C for best response.

38

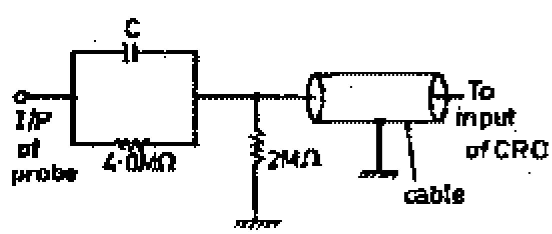

Fig. Q.6(c)

7. (a) A lossless transmission line of characteristic impedance $Z_0=150\Omega$ is connected through a lossless section of length d and characteristic impedance Z_1 to a load of 250+j 100 Ω. Find d (in wavelength) and Z_1 which match the load to the 150-Ω line.

(b) A lossless transmission line of characteristic impedance $Z_0=50\ \Omega$ is terminated by Z_L. A VSWR of 3.0 and a voltage minimum at a distance of 0.75 meter from the load were observed. Find the load, the operating wavelength being one meter.

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: Three 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) A bias circuit for a bipolar transistor is shown in Fig.1. Find an expression for the output current I_2 and indicate its variation with R_E. Draw the circuit of a similar current bias circuit for CMOS.

15

(b) Mention the types of loads that may be used with an n-channel MOS transistor driver. Show how the quiescent operating point for an a channel depletion load can be found.

10

(c) Draw the equivalent circuit of an n-channel junction FET grounded source amplifier. Calculate the voltage gain and 3 db cut-off frequency if load resistance=10 kΩ, (trans-conductance = 1 millimho, C_{ds}=1 pf, C_{gd}= 0.1 pf, C_{gs}=1 pf and generator resistance = 1 kΩ.

15

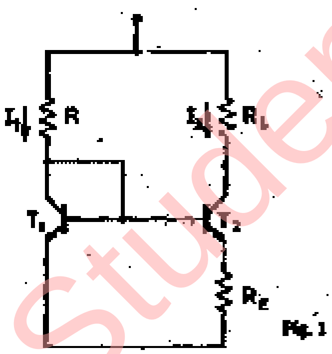

Fig.1

2. (a) List the important applications of operational amplifiers. State the advantages of a differential amplifier input stage. Develop appropriate relations for comparing the gains obtainable in matched pan PET and bipolar transistor.

12

(b) Explain with circuit diagram the operation of the following op-amp based circuits: (i) current to voltage converter, (ii) square wave and triangular wave generator and (iii) sane wave oscillator.

12

(c) The current voltage relation in a MOSFET may be expressed as:

$I_d = K[2V_{GS}-V_T)V_{DS}-V^2_{DS}]$, if $V_{DS}<(V_{GS}-V_T)$

$= K(V_{GS}-V_T)^2$ if $V_{DS}<(V_{GS}-V_T)$

Given a scheme for multiplying two voltages using the above relation.

6

(d) Given the design of an astable multivibrator using discrete transistors to generate a symmetrical square wave at a frequency of 5 kKz. How does one realize a monostable multivibrator using gates?

10

3. (a) Develop the logical expression for a comparator involving two variable A and B.

10

(b) Give the logic diagram of a 8:1 multiplexer. How many logic functions can one realize using a 4:1 multiplexer?

8

(c) Write down the logic equations of RS and JK F/Fs. Give a realization of RS flip-flop using MOS gates:

8

(d) Shown how add-Shift multiplication can be made faster by regarding a string of ones as the difference of two numbers.

8

(e) Minimize the following expressions:

$\sum m(0,1,2,3,4,9,10,12, 13, 14,15)$

6

4. (a) An MOS shift register stage sis shown in Fig. 2. Draw the waveforms of the voltages at the circuit nodes for an input '1' or input '0' during a clock cycle.

10

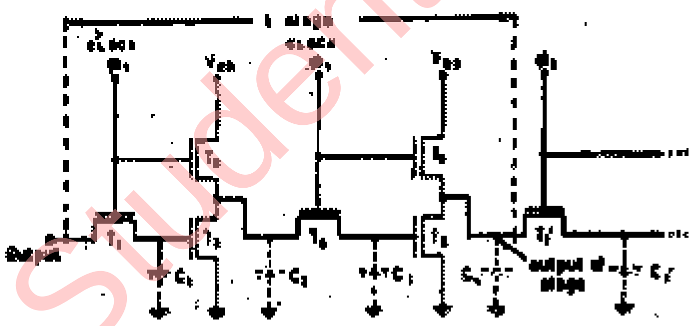

Fig. 2

(b) Explain with a schematic diagram the operation of an up-down counter. How does one realize a programmable counter?

10

(c) Show how maximal length sequences may be generated. What are their uses?

10

(d) Compare the performance of TTL, ECL and CMOS in respect of density, speed and power.

10

5. (a) Draw the root loci for a unity feedback control system with a forward gain G(s) given by

$$(i)\, G_1(s) = \frac{K}{s(s+1)}, \text{ or}$$

$$(i)\, G_2(s) = \frac{K}{s(s+1)(s+2)}$$

Indicate the change in root locus if an equalizer given by

$$Ge(s) = \frac{1+0.2s}{1+0.04s}$$

is placed in cascade with $G_2(s)$ Draw the Bode plot for the modified system and comment on the performance obtainable.

15

(b) Give examples of applications of control systems where the signals encountered are in sampled form. Obtain the z-transform of the closed loop response corresponding to $G_1(s)$ above for K = 2.

10

(c) Develop the state equation formulation for the system described by

$$\frac{d^2x(t)}{dt^2} + \frac{dx(t)}{dt} + 2x(t) = y(t)$$

and given the simulation diagram.

10

(d) State how time response may be found from the phase-plane trajectory.

5

SECTION B

6. (a) The modulating signal is a single sinusoid given by $m(t)=2\cos(1000\,\pi t)$.

Sketch the corresponding DSB-SC and SSB-SC signals for a carrier frequency of 15 kHz. Indicate the effect of carrier leakage.

10

(b) Explain the operation of single sideband generator using the phase-shift method. Compute the ratio of the undesired to desired sideband if tie audo 90° phase shifter has an error of 1 degree at the measurement frequency.

Give the schematic diagram of a quadrature phase multiplexed transmission.

12

(c) A frequency modulated signal is applied to an ideal delay line. Two outputs are derived by adding and subtracting the output of the delay line to its input. Plot the variation of the amplitudes of the outputs with the input frequency.

6

(d) Draw the schematic diagram of a resistive R-2R ladder network for D/A conversion. Discuss why the resistances must have high precision. Explain the operation of a successive approximation A/D converter. On what parameters does the quantization noise in PCM encoder depend?

12

7. (a) Plot the variation of electron arrival time as a function of the departure time in a two cavity klystron. Hence, sketch the variation of catcher current as a function of time. The value of the bunching parameter may be assumed to be unity.

8

(b) Derive an expression for the d.c. transit time in a reflex klystron. Discuss how the electronic admittance would vary with transit angle, and explain how the power output and frequency of a reflex klystron vary with repeller voltage. What are the methods for amplitude and frequency modulating the output of a reflex klystron oscillator?

12

(c) The helix of a particular travelling wave tube has 10 turns per mm and a mean diameter of 2.5 mm. Determine approximately the value of the anode voltage that is required.

8

(d) Give the schematic diagram of a multi-cavity magnetron oscillator. Use dimensional analysis to show that the d.c. voltage V and the axial magnetic filed B_c for cut-off would satisfy the relation:

where K is a numeric and γ_p is the plate radius.

Briefly discuss the conditions for obtaining high efficiency and high power.

12

8. (a) Sketch the electric and magnetic field distribution inside a coaxial transmission line operating in TEM mode. Derive an expression for the power density as a function of radius Calculate the ratio of the outer to inner diameter of a coaxial line filled with a dielectric of relative dielectric constant of 3 for obtaining a characteristic impedance of 50 ohms.

12

(b) Explain the principle of operation of a waveguide hybrid junction. Indicate how a magic T can be used for impedance measurement.

12

(c) A multihole directional coupler has coupling coefficients of 1, 3, 3, 1. Sketch how the powers in the desired and undesired directions would vary with frequency.

8

(d) List the factors that determine the directive gain of aperture antennas. State the methods of illuminating a parabolic antenna.

8

9. (a) Give the block diagram of a typical high power microwave radar, indicating the different components of the transmitter, receiver, antenna and indicator. A line type pulser is to drive a magnetron delivering a power of 100 kW. How would one choose the parameters of the line?

15

(b) What is transferred electron effect? Describe the operation of a microwave oscillator and amplifier using Gunn Effect devices.

10

(c) Draw the d.c. electric field profile in an IMPATT diode. Why are Impatt diodes more commonly used as microwave oscillator than as amplifiers?

9

(d) List the main applications of varactor diodes. What are the factors that determine the tuning curve and Q?

10. Write notes on any four of the following:

(a) Fibre Optic communication

(b) Local Area Network

(c) Error Connecting Codes

(d) Phase Locked Loops and Their Applications

(e) Microwave Link

(f) Programmable Memory and Logic

(g) Facsimile

(b) Millimeter Waves.

40