# ELECTRONICS AND TELECOMMUNICATION ENGINEERING

## PAPER - I

*Time allowed: 3 hours* *Maximum marks: 200*

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

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

*Answer must be written in English.*

1. (a) Calculate the following:

(i) The conductivity of a sample of germanium in which electron-hole pair density is $10^{19}$ $m^{-3}$. Assume electron and hole mobilities to be respectively 3600 $cm^2$/volt sec and 1800 $cm^2$/volt sec, and electronic or hole charge to be $1.6 \times 10^{-19}$ Coulomb.

(ii) The mutual inductance of two coils, viz., 100 µH and 240 µH, which are connected in series to yield a total inductance of 146 µH.

(iii) The attenuation in dB of a symmetrical T attenuator using two resistor, each of 409 ohms in the series arm and a resistor of 101 ohms in the shunt arm, and employing sources and load resistances equal to the characteristic resistance of the attenuation.

(iv) The characteristic impedance of a quarter-wave transmission line used to match a two-wire transmission line of 600 ohms characteristic impedance with a load resistance of 300 ohms.

(v) The strength of the radiated field produced at a distance of 1 km by a vertical wire of 1 m length (in free space) in a direction at right angles to the axis of the wire, when it carries a current of 5A at a frequency of 1 MHz.

20

(b) Explain the following, with neat sketches wherever necessary:

(i) Input and output V-I characteristics of a junction transistor.

(ii) Transients in a series RL circuit driven by a stepped input voltage.

(iii) Impedance versus frequency characteristic of a parallel–turned LC circuit.

(iv) Effect of array length on the directional characteristics of an end-fire array.

(v) Characteristics of stain-guage.

20

(c) Draw neat diagrams to illustrate the following and explain their important features:

(i) A non-inductive wire wound resistor.

(ii) An epitaxial planar transistor.

(iii) A ground station antenna for satellite communications.

(iv) Long distance propagation of radio waves at SW frequencies.

(v) A moving-coil ammeter.

20

2. (a) Define the following terms relating to a bipolar transistor:

(i) $BV_{CEO}$, (ii) $f_T$,

(iii) $F_{max}$, (iv) Rise time,

(v) Storage time.

10

(b) A silicon n-p-n transistor with, $h_{FE}$=100 $I_{CBO}$ = 0.1 µA. Calculate the IC for this transistor under following base circuit conditions:

(i) $I_B$=0 (ii) $I_B$=20 µA,

(iii) $V_{BE}$=0, (iv) $V_{CB}$=0.

10

(c) Draw the Ebers Moll model for a bipolar transistor. And using this, show that the collector-emitter voltage drop of a saturated transistor is higher in the normal mode of operation than in the inverted mode of operation of the transistor. What is the practical use of this result?

10

3. (a) A single-layer air-cored coil of 100 µH is realized by winding 60 turns on a former of 3 cm diameter and 3 cm length. Determine the number of turns necessary to realize the same inductance in miniature form by only reducing the coil former diameter and length to 1 cm each.

10

(b) Bring out the important differences between the following devices:

10

(i) Carbon film resistor and metal film resistor.

(ii) Low frequency inductor and very high frequency inductor.

(iii) Mica capacitor and electrolytic capacitor.

(iv) PN junction diode and Schottky barrier diode.

(c) (i) Describe a method of measuring the value and quality factor of an unknown inductance in the range 1 µH-1 mH with high accuracy.

(ii) An unknown inductance resonates at a frequency of 1 MHz with, an external capacitance of 210 pF and has a Q of 100. If the frequency of the source is double, it is found that the tuning capacitor required for resonance is 45 pF. Determine the values of the unknown inductance and the other components associated with it in the equivalent circuit.

15

4. (a) State Thevenin's theorem and explain how it is useful in network analysis.

10

(b) In the circuit of Fig. 1 solve for the steady-state voltage across the iF capacitor using Thevenin's theorem.

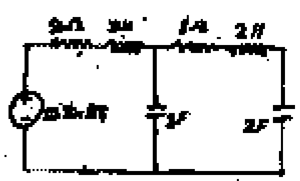

Fig. 1

10

(c) (i) A voltage supply of 10V DC is applied to a series circuit of 50 μF capacitor and a resistor. If the voltage across the capacitor is observed to be 5V at t=2 sec, determine the value of the series resistance in the circuit.

(ii) A rectangular pulse of 10V amplitude and 10μ sec duration is applied to a series RL circuit using R=2 ohms and L=5 μH. Plot the current waveform iii the circuit.

15

5. (a) What is a true RMS voltmeter? With the help of a neat circuit/block diagram, describe a method of realizing this instrument. Give typical uses of this instrument.

10

(b) Draw the experimental set up for measuring the sensitivity of a MW radio receiver and explain how this measurement is carried out.

10

(c) (i) With the help of a neat block schematic explain the method of measuring harmonic distortion is an unknown waveform.

(ii) A signal has a fundamental with an RMS value of 5 V. The signal also has a second, third and fourth harmonic with RMS values of 1 V, 0.5 V and 0.3 V respectively. Determine the harmonic distortion in the signal.

15

6. (a) Explain what you understand by the following terms used in antenna literature :

10

(i) Radiation resistance

(ii) Radiated power.

(iii) isotropic radiator.

(iv) isotropic radiator.

(v) Polar diagram.

(b) Sketch the current distributions and directional characteristics of grounded vertical antennas of height λ/8, λ/4, λ/2 and λ. Which of these antennas is preferred in MW broadcasting? Discuss this.

10

(c) (i) The antenna of a TV transmitter is located at a height of 150 m. Calculate and plot, as a function of distance to the transmitter, the height that the receiving antenna must have for being above the radio horizon. Assume standard atmosphere.

(ii) Explain why the ratio of lower frequency limit to maximum usable frequency for establishing radio communication in the SW band is generally smaller at night than in the day time.

15

7. (a) Explain the basic principle underlying electronic weighing. Compare the performance of this system with conventional mechanical scales and discuss the relative advantages and limitations.

10

(b) Sketch a displacement transducer capable of electrical output and, explain its operating characteristics. What factors decide the linearity of the transfer characteristic? Discuss this.

10

(c) Describe experimental techniques to determine the following in the laboratory: 10

(i) The trans-conductance of a JFET.

(ii) The loss factor of a capacitor.

(iii) Atmospheric radio noise interference to Radio Communication.

(iv) Characteristic impedance of an open-wire transmission line.

(v) Output power of a ratio transmitter.

# ELECTRONICS AND TELECOMMUNICATION ENGINEERING

## PAPER - II

*Time allowed: 3 hours* *Maximum marks: 200*

*Candidates should attempt five questions choosing not more than three from either 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) Draw the circuit of a Darlington pair using the common emitter configuration. Calculate the current gain and the input impedance of the circuit, if both the transistors have $\alpha_1=\alpha_2=0.98$, $h_{ie}$ = 1 kΩ and RL=100Ω.

10

(b) Distinguish between Class A, B and C power amplifiers. Draw the circuit of a Class B push-pull tuned amplifiers using valves/transistors. Calculate the, maximum efficiency of the amplifier. What are the advantages of Class B over Class A amplifiers?

15

(c) Draw the circuit of a series regulated Power Supply to give a load current of approximately 1 amp. at a nominal output voltage of 25 V. Indicate the unregulated input voltage required and calculate approximately the change in the output voltage due to a change to ±5 V at the input.

15

2. (a) Draw a Schmitt trigger circuit using transistors and explain its operation. How will you control the hysteresis between the turn-on and turn-off in the circuit? Sketch the output of the Circuit when the input is a sine wave having peak-to-peak amplitudes of (i) 2 V and (ii) 50 mV.

15

(b) Sketch the Outputs- of an RC differentiating circuit when. the input is (i) a square wave, (ii) a ramp and (iii) a trapezoidal waveform Show the relation between the RC time constant and the pulse widths of the output wave forms.

(c) Draw a crystal oscillator circuit using a transistor. What are the advantages of such oscillators? What is. the frequency of oscillation of the circuit with reference to the critical frequencies of the crystal ?

10

3. (a) A multi-vibrator giving a pulse output is coupled to a diode-clamping circuit, such that the output pulses are always positive. The waveform has a time period of 100 μs and duty ratio of 1/100. Draw the clamping circuit and calculate the location of the zero level of the output waveform. Given that: peak to-peak input = 10 V, source resistance = 0, R = 100 kΩ, C=.05 μF and forward resistance of the diode = 100Ω.

10

(b) Draw a typical scale of 16 Binary counter. Show how you will convert this to a scale-of-10-counter.

15

(c) Write the Truth table of a Full Adder. Draw the logic circuit of a 3-input Full Adder using two half adders.

4. (a) Using OP. AMP's, generate the transfer functions

(i) $G(s)=(1+s/2)$, (ii) $G(s)= 10^9/s$.

Assume that the feedback resistance of the OP-AMP is 1 MΩ.

10

(b) Draw an encoding Diode-matrix (BCD encoder) to convert a Decimal number into a Binary code.

15

(c) Develop an analog computer setup for solving (be differential equation

$$A\frac{d^2y}{dt^2}+B\frac{dy}{dt}+Cy=f(t)$$

Show how you will introduce the initial. condition in the simulation. What is the need of amplitude and time scaling in an analog computer setup. Give an example of such scaling of the problem.

10

5. (a) Explain the operation of Tachometers as velocity errors detectors. Obtain, using a block diagram, the transfer function of a Servo-integrator consisting of an amplifier, a motor and a tachometer.

10

(b) An instrument servo has the forward transfer function:

$$G(s)=\frac{K}{s(s\tau_1+1)(s\tau_2+1)},\ \tau_2<\tau_1$$

Using Nyquist criterion, determine if the system with unity feedback is stable or not for all values of K.

15

(c) If the above system is unstable for some values of K, then explain the use of phase lead networks to compensate the system.

15

## SECTION B

6. (a) Explain the technique of generating PCM signals. Draw schematically a PCM code. What is Quantizing noise? Explain its significance.

15

(b) A PCM-TDM multiplexed system is designed for 24 telephone channels, each having a bandwidth of 300-400 Hz, and 64 quantizing levels. The MUX output is transmitted through of VHF radio relay using PSK modulation. Draw the block diagram of the transmitter and indicate the band width required at each stage.

15

(c) Compare the above system with an SSB-FDM-FM multiplexed system in terms of the bandwidth required and the overall SNR improvement (above threshold) in the individual channels. Assume D = 4 for the FM modulation of the RF carrier.

10

7. (a) Explain, with diagrams, the operation of a CW Doppler radar using an IF in the receiver. Compare its merits and demerits with those of a Pulsed radar.

10

(b) A Doppler radar set. operating at 15 GHz, is used for traffic speed measurements. What will be the readings at the output frequency counter corresponding to the speeds of 10, 50 and 180 km/hr? On what factors does the accuracy of the readings depend? What will be the accuracy if the frequency stability of the IF is $10^{-4}$?

15

(c) Describe the working of a Cathode-ray Direction Finder. What are the different causes that give rise to errors in the DF readings? How are they eliminated?

15

8. (a) Define Mutual Information 1(x; y) and show that:

$$1(x; y)=H(x)-H(x/y);\ H\Delta \text{Entropy}$$

In a Binary communication channel, $p(x_i=0)=0.4$ and $p(x_i=1)=0.6$. For the given noise matrix of the channel, calculate the average information 1(x ; y) conveyed per symbol.

| $x_i$ \ $y_i$ | p(y/x) | |
|---|---|---|
| | 0 | 1 |
| 0 | .99 | .01 |
| 1 | 0 | 1 |

(b) Draw the block diagram of a typical triples detection type communication receiver Show the typical curves for sensitivity selectivity and fidelity of the receiver. Explain the operation of the delayed AVC as used in the above receiver.

15

(c) Explain, with reference to an FM transmitter how AFC is used to lock the mean carrier frequency to that of a crystal.

9. (a) Explain briefly the operation of the Reflect Klystron as a microwave signal source. Show the variation of its output power and frequency with the repeller voltage.

(b) Show a microwave bench setup suitable for Antenna measurements. Describe briefly how Antenna gain Antenna pattern and polarisation direction can be measured, in a laboratory. What are the special precautions necessary to minimize errors in the above measurements?

10

(c) A MW LOS link operates at a frequency of 2 6Hz with a repeater spacing of 50 km and requires –20 dbm of carrier power at the receiver input to avoid deterioration due to fading and noise. Calculate the transmitter carrier power required with the following parameters: Antenna gain = 34 db; coupling and waveguide loss in Tx = 10 db.

Due to operational reasons, the link is to be redesigned for operational at 8 GHz. Maintaining the same parabolic antenna and other losses, calculate the new transmitter power required to maintain the same received signal level.

15

10. Write short notes (indicating current practices) on any four of the following:

10 × 4

(a) Crossbar Exchanges.

(b) 60 channel MUX for carrier telephony.

(c) TWT amplifier.

(d) Ferrite-core memory.

(e) Diversity reception.

(f) Colour TV.