ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed: 3 hours *Maximum marks : 200*

Candidates should attempt question ***No. 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

Answers must be Written in English

1. (a) Calculate the following:

(i) The apparent capacitance of a mica capacitor of value 0.002μF whose equivalent series inductance of leads is 0.1μH, at an operating frequency of

$\sqrt{10^{15}} / 2\pi$ *Hz*.

(ii) The Common-Emitter Current gain of a pnp transistor whose Common-Base Current gain is 0.99.

(iii) The values of initial Current in a series RL circuit with R=100 Ω, L=10 H with a battery supply of 10 v, and final current at 0.1 sec after the battery circuit is broken.

(iv) The line length measured in wavelengths and the value of phase constant (β) of a RF transmission line with air dielectric of length 25 m at a frequency of 10 MHz.

(v) The field strength at a distance of 10 km from a 100 KW MW broadcast transmitter employing a short vertical antenna, assuming that the field strength value is 300 mv/m at a distance of 1 km from the transmitter for a radiated power of 1 kw.

(vi) The strength of the radiated field produced at a distance of 1 km by a vertical wire 1 m long in free space while carrying a current of 5A at frequency of 1 MHz.

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

(i) Transfer characteristic of a junction transistor and the calculation of its trans-conductance;

(ii) Impedance versus frequency characteristic of a piezo electric crystal and the evaluation of its Q;

(iii) Generation of a linear ramp voltage using an RC circuit and its use in timing applications;

(iv) Space wave propagation of EM waves over long distances, even beyond the horizon;

(v) Directional characteristics of a broadside array and its uses;

(vi) Measurement of frequency of an unknown signal with high accuracy.

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2. (a) Draw the high frequency equivalent circuit of a junction transistor and explain the significance of the different components used there in. Explain what you understand by the terms f_α, f_β, f_b and of the transistor.

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(b) Distinguish between Zener breakdown and avalanche breakdown at a semi-conductor pn junction. What tests will you carry out in the laboratory to determine the type of breakdown mechanism of a given semiconductor diode? Explain this.

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(c) An npn transistor having L_N=0.98, I_{CBO}=2μA. I_{EBO}=1.6μA is connected as a Common Emitter Switch with a V_{cc} = +12V and a Collector load of 4 KΩ. What are the magnitudes of the ON state and OFF state currents in the switch? What is the minimum base current required by the transistor to enter saturation? If the base signal is a rectangular pulse which can take the switch from deep OFF to deep ON, sketch the output waveform, across the transistor and explain its characteristics.

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3. (a) For an oscillatory decaying function $x(t)=Xe^{-\delta t}$ Sin $(\omega t+\theta)$, show that the ratio of successive amplitudes is given by $e^{-\delta\tau}$ where τ is the period corresponding to the ing to the frequency ω.

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(b) Distinguish between Therenin's theorem and Norton's theorem and explain their usefulness and importance in network analysis.

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(c) Two coils are connected in series across a 240 V, 50 Hz mains supply both the coils have the same voltage magnitudes across them. But, one coil has a resistance of 15 Ω and the other coil, 7 Ω . The total power taken by the coils is 550 W. What is the inductive, reactance of each coil?

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4. (a) Bring out the important differences between the following devices:

(i) Thermistor and Varistor

(ii) Fixed resistor and Variable resistor

(iii) Junction FET and MOS FET

(iv) Thyristor and Thyratron.

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(b) A turned circuit is required to have a parallel impedance of 6000 Ω and a Q of 12. If the resonant frequency is 300 KHz, evaluate all the components in the circuit.

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(c) Two identical circuits resonant at 1 MHz having Q=100 and inductances of 140 μH are coupled together. Calculate the critical co-efficient of coupling Also, calculate and plot the secondary current at the resonant frequency for 1 V applied to the primary, as the mutual inductance is varied from zero to twice the critical value.

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

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(b) Describe a method of spectral analysis of an unknown waveform. Draw a neat circuit/block diagram.

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(c) (i) Explain the principle of short-wave broadcasting and indicate the technique to be used for avoiding facting of the received signal.

(ii) Explain what you understand by the following relating to short wave communication:

(A) skip distance; (B) critical frequency, and (C) maximum usable frequency.

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6. (a) What are the characteristics to be satisfied by a transmitting antenna for MW broadcasting? Discuss different methods to improve the efficiency of radiation from such antennas.

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(b) A parabolic antenna having a circular mouth is to have a power gain of 1,000 at $\lambda = 10$ cm. Estimate the diameter of the mouth and the half-power beam width of the antenna.

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(i) Distinguish between:

(A) Galactic noise and Atmospheric noise.

(B) Ground wave propagation and Ionospheric propagation.

(C) E-layer and Spoladic E-layer.

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7. (a) Sketch a moving coil current meter and indicate its principle of operation. What factors decide the linearity and accuracy of this meter?

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(b) Compare the relative performance of wire strain guage, foil strain gauge and semi-conductor strain guage, and indicate typical uses of each of these.

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(c) Give the basic principles of the following measuring instruments and indicate their uses:

(A) Schering bridge

(B) Energy meter

(c) Frequency meter.

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time allowed: 3 hours *Maximum marks : 200*

Candidates should attempt five questions choosing not more them 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 hybrid-π equivalent circuit for a CE-transistor amplifier at high frequencies. Calculate the voltage gain-bandwidth product of the amplifier. in terms of the circuit constants.

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(b) Explain the method of shunt compensation for extending the bandwidth of a transistorized video amplifier. A video CE amplifier stage has a total shunt capacitance C of 25 pF. The stage is to be compensated at a frequency of 1 MHz by using an RL-combination as the load. The Q of the load at 1 MHz = 0.5. Calculate the values of RL and L.

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(c) What are the advantages of using negative feedback in a multistage amplifier? Draw a three-stage RC-coupled amplifier using parallel voltage feedback. If the output Impedance of the amplifier without feedback is Ro, what will be its value with feedback?

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2. Draw the circuit of a Monostable multivibrator using switching transistors. Show the waveforms at the collectors and bases. Express the output pulse width T in terms of RC constants. Calculate approximately the circuit constants of the MV for T = 10 μ sec; given that h_{fe} = 25, E_{fe} = 10 V. collector loads R_L = 1 KΩ each.

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(b) A pulse generator, for laboratory, use, is to be designed with the specifications Repetition frequency: 10 Hz. to 10^6 Hz; pulse width: 0.1 μs to 1 m sec; output: ±10V; output impedance: 50Ω. and with the facility for external synchronization. Draw the block diagram of the generator and show the waveforms at different stages.

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(c) Draw the circuit of a DC to AC Inverter, using SCR's. Explain its operation showing different waveforms. Name some applications for such inverters.

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3. (a) Simplify the Boolean functions:

(i) $f(x_1, x_2, x_3, x_4) = \Sigma (0, 1, 3, 4, 5, 6, 7, 9, 12, 13, 14)$

(ii) $\overline{ABC} + AD + \overline{R}(B + C) + \overline{AC} + \overline{AD}$

(iii) $f(ABC) = [A \oplus B \oplus AB]\ [A \oplus C \oplus AC]$

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(b) Draw the circuit of a switched-tail ring counter, using a 4-bit shift register. Sketch the voltage waveforms at the output of anyone of the flip-flops. Using the state table of the circuit, synthesize a repeated waveform given by (11000000).

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(c) Draw the logic diagram of a Serial Binary multiplier and explain the different operations required in multiplying the binary numbers 1001 and 1011.

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4. (a) What are the sources of errors in a DC amplifier as used in Analog computer set-ups? Explain with the help of a block diagram the operation of a Chopperstabilized DC amplifier.

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(b) Show an Analog computer set-up to solve the Lagrange's equation :

$$my + kay + mg = 0$$

with the initial conditions: $y(0) = 95$

$y(0) = 50$

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(c) What are the different types of multipliers used in Analog computers? Describe, with a diagram, the working of a Servo-multiplier.

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5. (a) Show the asymptotic Bode plot for the open- loop transfer function:

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

What are the gain and phase margins in the system? Is the system using unity feedback always stable.

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(b) Describe briefly a Relay servo-mechanism. What are the special properties of the servo and what is a limit cycle?

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(c) What are the different methods of controlling the speed of a DC motor? Describe one method using SCR's and AC power supply.

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SECTION B

6. (a) Show the Trunking diagram of a 5-digit Automatic exchange using Strowger switches. Explain 'Full Availability' and 'Grade of Service', as used in the design of the exchange.

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(b) Give a block diagram and the frequency assignment plan for the 12-channel FDM carrier system suitable for use in a cable circuit. Indicate how the carrier frequencies are generated. What is the Pilot-controlled AGC as used in the system?

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(c) An SSB communication link has a transmitter power of 20 watts, channel bandwidth of 4 KHz, and the receiver output SNR of 20 db. If the link is replaced by an FM transmitter and receiver, and if D=4, calculate the transmitter power and the channel bandwidth required for an output SNI of 40 db.

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7. (a) Explain the operation of a typical TV camera using a Vidicon tube.

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(b) Give the block schematic of a 10-channel Time-division multiplex system using PPM. Describe the modulator and demodulator for the PPM system.

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(c) Draw the circuit for an Adaptive Delta-modulation coder and decoder. Also draw approximately the S_{NR} and dynamic range characteristics of the ADM codec, for a bit Tate of 50 kb/s. If the output peak S_{NR} required for the codec is 30 db, calculate the bit rate required for the audio bandwidth of 4 KHz.

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8. (a) Explain, with diagrams, the working of:

(i) Ferrite isolator

(ii) Ferrite circulators.

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(b) Explain how long-distance communication is possible by using Geostationary Satellites. Give some important specifications regarding:

(i) the standard earth station and

(ii) the satellite transponder.

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(c) Explain briefly, how a loop antenna may be used as a Direction finder in the H.F. band.

A square-loop antenna has 200 turns and each arm of length 1 metre. This is connected to a receiver tuned to 10 MHz. Calculate the field strength in μ V/m required, so that the input to the receiver is 10 mV, while the loop is oriented at 60° from the direction of the transmitter. Q of the loop = 100.

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9. (a) Draw the block diagram of a Microwave receiver as used in a LOS MW system in 2 GHz band. What is the minimum carrier-to-noise ratio required in the receiver for an acceptable signal-to noise ratio at the output? Explain why?

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(b) Explain the operation of a Parametric amplifier using a Varactor diode. What are Manley-Rowe relations? Draw an up converter using a Varactor diode.

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(c) Define Noise Figure and Sensitivity of a Microwave receiver. If the receiver has a NF=14 db and the IFBW = 2 MHz, then calculate the sensitivity of the receiver. If the receiver uses a preamplifier with a gain of 13 db and a NF=3 db then what is the overall Noise Figure F_T of the preamplifier-receiver combination.

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10. Write short notes (explaining the operation and applications as welt) on any four of the following:

(a) Blocking oscillator.

(b) Ferrite core memory.

(c) Gunn oscillator.

(d) MTI radar.

(e) Fading and Diversity reception.

(f) Shannon's channel capacity theorem.

10×4