ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time allowed: 3 hours *Maximum marks: 200*

Candidates should attempt Question 1 (compulsory) and any four of the remaining questions.

1. (a) PROVE/ELABORATE the following: 30

(i) Volume element dv in spherical co-ordinates is given by

$$dv = r^2 \sin \theta .\ dr.d\theta.d\phi$$

(ii) Forces acting on a moving charge g in the presence of both electric and magnetic fields.

(iii) A half-wave rectifier feeds to a load, which is a series combination of R and L. The conduction period is less than/ equal to/more than 180^o. Give physical explanation.

(iv) Difference between turning off of a silicon controlled rectifier and a TRIAC.

(v) Cut-off voltages of a silicon transistor and a germanium transistor.

(vi) Terminating impedance for a distributed parameter transmission line for maximum power transfer.

(b) Explain or reason out the following: 30

(i) Which amongst the following three is a fundamental rule (Faraday's law of induction)? Derive the remaining two with assumptions, if any:

$$e(t) = N\frac{d\phi}{dt}, e(t) = \frac{d\phi}{dt}, e(t) = L\frac{di}{dt}$$

(ii) Necessity of phase and amplitude balance in an AC bridge.

(iii) Physical concepts to prove that the voltage across a condenser and current through an inductor cannot suddenly change.

(iv) Equivalent of a series combination of an ideal voltage source and an ideal current source.

(v) Wattmeter reading when its voltage circuit and current circuit are energised by dissimilar frequency sources.

(vi) In transducers/instrumentation application would you prefer a differentiator or an integrator? Give reasons.

2. (a) For silicon and germanium diode, state approximately the cut-in voltages. Also compare their reverse saturation current.

(b) Explain the difference between a rectifier diode and a switching diode, illustrating the difference with the help of waveforms, when the diodes are biased abruptly from forward to reverse.

(c) A ± 15 volts square-wave voltage source has finite internal resistance. Develop a simple circuit to clamp +15 volts/ to +5 volts and –15 volts to zero volt, with the help of idea dioder and batteries.

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3. (a) For a small-signal low-frequency operation, write down v, i equations in terms of h parameters for common emitter (CE) configuration of a transistor. Therefrom find out expressions for h parameters.

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(b) Draw an approximate h parameter model of a CE transistor configuration driven by voltage source $R_s = 0$, Ignore h_{re} and h_{oe}]. Consider RL and R_E as resistances in collector and emitter respectively.

Prove that

Current Gain= –ht.

Input Imedance = $ht_c[1 + hr_e]\ R_E$

Voltage Gain = $\dfrac{-ht_e RL}{ht_e + [1 + ht_e] R_E}$

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(c) The stability factor S for a transistor is defined as rate of change of collector current with respect to reverse saturation current. A CE configuration of a transistor utilizes self or emitter bias. Draw the circuit and derive the expression for the stability factor.

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4. (a) Write down the Laplace transforms for the following functions of time:

(i) Unit impulse. (ii) Unit step function. (iii) First derivative of f(t). (iv) Integral of f(t). (v)f(t–a).

(b) State, the initial and. final value theorems for Laplace transform applications. Can you apply these theorems to circuits with sinusoidal forcing functions?

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(c) A series R–L circuit [initially relaxed] is suddenly switched across a sinusoidal voltage source E sin (wt+ϕ) at t=0. Prove that if $\phi = \tan^{-1}\dfrac{wL}{R}$, there is no transient in the current.

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5. (a) State giving reasons, whether each of the following basic instruments can be used for DC alone/AC alone/ AC and DC both:

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(i) Permanent magnet moving coil type.

(ii) Moving iron type.

(iii) Dynamometer type.

(b) It is required to find phase-shift between two similar frequency sinusoidal voltages by Lissajous figures on a cathoderay oscilloscope. Discuss the method.

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(c) In a digital voltmeter an unsigned (No sign bit) 8-bit binary number 1111, 1111 [FF in Hex] represents 10 volts. Find the least count for the voltmeter and the binary number for 5 volts.

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6. (a) Define and name the realizable function used for driving point synthesis. Give its properties.

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(b) Test the function for realizability a driving point function:

$$\frac{s^2+2s+24}{s^2+5s+16}$$

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(c) Obtain a suitable Foster form realization of the function:

$$Y(s)=\frac{s.(s+2)}{(s+1)(s+3)}$$

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7. (a) The divergence theorem is given by the integral relationship:

$$\int_S \bar{D}.\bar{d}s = \int_{vol} \nabla.\bar{D}dv$$

Make a correct statement of the theorem represented in the given form.

(b) Evaluate both sides of the divergence theorem for the field $\bar{F}=2r^2\bar{a}_r$, for the volume of the sphere with r=3.

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(c) State conditions for "solenoidal" and "irrotational" fields.

Given the field $\bar{P}=\bar{a}_r\left[k/r^n\right]$, in which k is a constant, show that

$$\nabla\bar{P}=(2-n)k/r^{n+1}\text{(Excluding r = 0)}$$

What choice of n will provide a solenoidal field ? Prove whether field $\bar{P}$ is irrotational or not.

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PAPER - II

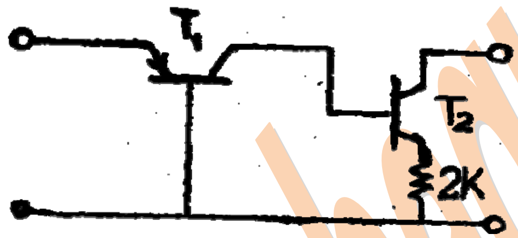
Time allowed: 3 hours *Maximum marks: 200*

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

SECTION A

1. (a) What are the charge control parameters of a transistor? How is the high frequency performance of transistors improved?

(b) What is the input impedence of the circuit given below? The transistors are identical and have a_{ib}=200 ohms, h_{rb}= 10^{-5}, h_{fb}=0.98 and h_{ob} = 2 millimhos.



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(c) How would you provide temperature compensation for the variations of V_{be} and current stabilisation of the operating point?

2. (a) How would you distinguish signals from noise?

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(b) A Gaussian signal has a power spectral density of 3μV^2/Hz for f≤1 kHz and zero elsewhere. What is the probability density of the noise and what is the effect of passing it through a low-pass filter with a cut-off frequency of 500 Hz?

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(c) What are the functions of preemphasis and deem phasis in an FM system? What is the improvement in the signal to noise ratio due to this?

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3. (a) How is the large input impedance needed for an operational amplifier obtained? What are the other features of amplifiers used in analog computers?

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(b) How would you

(i) generate any given arbitrary function for use in analog computers;

(ii) multiply two variables ?

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(c) Simulate the transfer function $T(s)=\frac{s+1}{(s+2)(s+4)}$ with the help of operational amplifiers.

How would you introduce initial conditions ?

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4. (a) Design a sequence detector which produces an output of 1 every time the sequence 0101 is detected and zero at all other times.

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(b) Give the diagram and explain the operation of a step wave generator of total duration 1 ms consisting of 4 steps of each IV.

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5. (a) How would you find whether a limit cycle exists for a given, functions ?

(b) How can you construct the time waveform from the phase plane diagram ?

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(c) List the steps in drawing the root locus.

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(d) Draw the root locus and test the stability of function with unity feedback:

$$G(s) = s(s+2)/s(s+1)(4s^2+s+1)$$

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SECTION B

6. (a) With a diagram explain the various parts of a subscriber telephone set connected to an automatic exchange. How is it different from an operator set?

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(b) Describe the differential duplex system of telegraph. A teleprinter with a margin of 40% is adjusted to sample each code element at the central position of a 50-band signal. What are the upper and lower limits of the r.p.m. of the transmitting shaft for which the receiver will function without error?

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(c) Describe the modulator used in carrier current working.

7. (a) What arc the dimensions of a waveguide with the following specifications ?

(i) At a frequency of 9959.5 MHz the guide wavelength for TE_{10} mode is 87.57% of the cut-off wavelength.

(ii) TE_{30} and TE_{12} modes have the same cut off frequency.

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(b) Deduce the expression for the attenuation produced by a piston attenuator.

(c) Explain the action of Magic-T. How are standing waves avoided in this?

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8. (a) A radar with a beam width of 1° scans a target of angular width 10^o at 10 r.p.m. Find the number of pulses received if the p.r.f is 500 pps. Compare pre-detection and post-detection integration of signals.

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(b) With a block diagram explain the operation of a mono-pulse radar. What type of antenna would you use for this?

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(c) Describe a Decca Navigation System.

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9. (a) How is the IF for sound IF amplifiers generated in an inter-carrier TV receiver ? What is its value ?

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(b) Explain the method of producing extra high tension in TV receiver? What is the function of the booster diode?

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(c) What is Hamming distance is codes? A message consists of five symbols A, B, C, D and E with probabilities 1/6, 1/4, 1/12, 1/8 and 3/8. Find the entropy and a code suitable for its transmission.

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10. Writes notes on any four:

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(a) Probability of false alarm in the presence of Gaussian noise in radar pulses. (b) Capture effect. (c) FDMA and TDMA. (a) Path loss in satellite transmission. (e) IMPATT diodes (f) Bootstrap circuits. (g) VOR. (h) Totem pole output stages. (i) Signal flow graphs. (j) Noise figure of cascaded stages.