SUBJECT: ELECTRONICS/ TELECOMMUNICATION ENGINEERING: PAPER – 2
SET-A

Time: 3 hours | Full Marks: 200

Note: Answer Question No. 1 and any four from the rest. All questions carry equal marks.

1. Attempt any 10 (ten). $10 \times 4 = 40$

(a) State how a non-symmetrical square wave can be generated using a comparator circuit.

(b) How will you draw the d.c. load line on the output characteristics of a transistor?

(c) Why is peak inverse voltage important in diode rectifier operations?

(d) What do you mean by a cyclic code? Give an example of a cyclic code.

(e) What do you mean by two-level logic? What is its main advantage?

(f) Define clock skew and time race in sequential circuits.

(g) What is the characteristic impedance of a transmission line? Draw the RF equivalent circuit representation of a transmission line.

(h) Explain Y, I and Q signals in color television.

(i) Distinguish between velocity and current modulations in the klystron amplifier.

(j) Describe the operation of the track-while-scan radar.

(k) Define entropy in information theory and give its mathematical expression.

(l) Define maximum frequency deviation in frequency modulation. How is it used to classify a signal into either a narrowband or a wideband frequency modulated signal?

2. Attempt any 8 (eight). $8 \times 5 = 40$

(a) Explain the principle of operation of fixed bias and self bias circuits using bipolar junction transistor in common emitter configuration.

(b) Determine R_C and R_B for fixed biasing circuit of a common emitter transistor if $V_{CC} = 12V$, $\beta = 50$, $I_C(Q) = 2.35$ mA, and $V_{CE}(Q) = 6.83V$.

(c) A 4-bit number is represented by ABCD with D as the LSB. Design a logic circuit that will produce a 1 whenever the input is greater than 0010 but less than 1000. Use minimum number of gates.

(d) Design an 8:1 multiplexer from a minimum number of 4:1 multiplexers.

(e) Explain Gain margin and Phase margin from the Nyquist plot.

(f) A unity feedback system has an open-loop transfer function

$$G(s) = \frac{10(s+1)}{s(s+2)(s+5)}$$

Determine the steady-state error for $r(t) = 3 + 10t$.

(g) A 10 MHz carrier is frequency modulated using a modulating signal $e_m = E_m \sin 10^3\ \pi t$. The resultant signal has a frequency deviation of 5 kHz. Calculate the modulation index and bandwidth of the modulated signal.

(h) Explain low and high level modulations in amplitude modulation.

(i) A microwave signal of 9.2 GHz is propagating in dominant mode through a rectangular waveguide filled with air. If inside dimensions of the waveguide are 2 cm × 1 cm, calculate

i) the cut-off frequency.

ii) the guide wavelength.

(j) Draw a sketch of electromagnetic wavefronts incident at an angle on a perfectly conducting plane surface.

3. Attempt any 5 (five). 5×8=40

(a) Draw two input OR gate and AND gate circuits using diodes and other components and explain their operations assuming approximate equivalent models for the diodes.

(b) Determine the value of gain K and velocity feedback constant k_v in Fig. 3 (b) so that the maximum overshoot in the unit step response is 0.2 and the peak time is 1 sec.

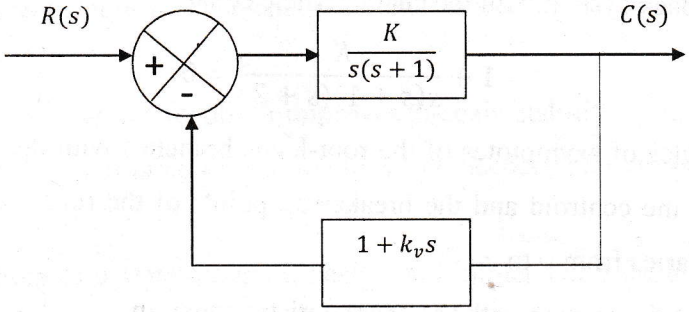

Fig. – 3 (b)

(c) Draw the block diagram of filtering method for generating a single sideband suppressed carrier modulated signal for an audio baseband signal. What are the frequency requirements of the filter used for generation of the modulated signal?

(d) Draw the block diagram of monochrome TV transmitter and explain in brief the functioning of the video amplifier and sound transmitter blocks.

(e) A reflex klystron is to be amplitude modulated only. Draw the necessary circuit diagram with the klystron to produce such modulation.

(f) A unity feedback system has a forward loop transfer function:

$$G(s) = \frac{K}{(s+1)^3(s+4)}$$

Determine:

i) the range of K for closed –loop system stability.

ii) the frequency of oscillations when the system is marginally stable.

(g) Draw the current mirror circuit using two back-to-back n-p-n transistors and write the equation of the mirror current from the circuit.

4. Attempt any 4 (four). 4×10=40

(a) Consider a discrete memoryless source with source alphabets $\{S_0, S_1, S_2,\}$ and corresponding source probabilities $P(s_0) = 0.7$, $P(s_1) = 0.15$, and $P(s_2) = 0.15$. Calculate:

i) the entropy of the source.

ii) the entropy of second order extension of the source.

(b) Consider a feedback system with the characteristic equation

$$1 + \frac{K}{s(s+1)(s+2)} = 0$$

Compute the angles of asymptotes of the root-locus branches with the real axis of the s-plane. Also find the centroid and the breakaway points of the root-locus of the system. Assume that K varies from 0 to ∞.

(c) Consider a third order system with the characteristic equation $s^3 + 3408.3\,s^2 + 1.204 \times 10^6\, s + 1.5 \times 10^7\, K = 0$. Find the critical value of K for stability using Routh-Hurwitz criterion.

(d) Explain the following parameters used to characterize a directional coupler:

i) Coupling coefficient.

ii) Directivity of an ideal directional coupler.

(e) A slotted line is terminated by different types of microwave loads. Draw the voltage standing wave within a rectangular waveguide when it is terminated by

i) sorted load

ii) matched load

Also determine the VSWRs for the sorted and matched loads.

5. Attempt any 2 (two). 2×20=40

(a) Discuss similarities and differences of the two major television systems of the world with respect to their standards required for transmission and reception.

(b) Describe the coherent detection process of double sideband suppressed carrier modulated signal and plot the spectrum of the detected signal.

(c) Give the schematic of a Magic Tee used in microwave measurements. Obtain the S parameters of the Magic Tee.

6. Attempt any 4 (four). 4×10=40

(a) Draw the bipolar junction transistor circuit for the common emitter configuration. Sketch the output characteristics of the circuit and hence indicate the active, saturation and cut-off regions on it.

(b) Draw different stages of a typical operational amplifier and briefly explain functioning of each stage.

(c) Show that the negative feedback improves the gain stability of an amplifier.

(d) Determine the truth table of a 3-line to 8-line decoder and draw the corresponding logic circuit.

(e) With the help of a state diagram, design and implement a BCD counter using J-K Flip-Flops.

7. Attempt any 2 (two). 2×20=40

(a) Draw the free-body diagram of the mechanical system shown in Fig. 7 (a) and write the force equation. What is the transfer function of the system? Write the parameters of an electrical system analogous to the above mechanical system using the Force-Current Analogy.

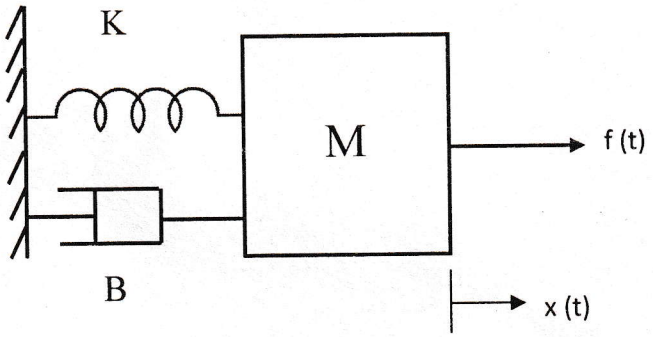

Fig. 7 (a)

(b) Explain the different types of errors in Delta modulator? How can these be removed? Explain with relevant diagrams.

(c) A non-inverting op-amp has got a gain of 10. The open-loop gain of the op-amp is 2×10^5. The output resistance of the op-amp without feedback is 75Ω. Draw the circuit diagram of the non-inverting amplifier and calculate the output resistance with feedback.

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