SEAL

I/LM/R-EXAM 2020

500010

ELECTRONICS AND COMMUNICATION ENGINEERING

Time : 3 hours] [Full Marks : 100

Notes : *(i)* Answer the questions as directed.

(ii) The figures in the right-hand margin indicate full marks for the questions.

(iii) Group—A is compulsory and attempt *any* **four** questions from Group—B.

GROUP—A

(Compulsory Group)

1. Attempt any *ten* from the following : 2×10=20

(a) How does the junction capacitance of a *p-n* diode depend on the depletion layer width and applied reverse bias?

(b) What is the basic difference between oscillator and amplifier in terms of feedback?

(c) What is the role of modulating frequency in frequency modulation?

(d) What is the significance of integral controller and derivative controller in a PID controller?

(e) What are the limitations of superposition theorem?

(f) What are causality and stability of a system?

(g) What are precision and sensitivity in measurement?

(h) What is physical significance of curl of a vector field?

(i) Prove $A + \bar{A}B + A\bar{B} = A + B$ using Boolean algebraic theorems.

(j) What is the minimum number of selection line required for selecting one out of n input lines in a multiplexer?

(k) What do you mean by band gap of a semiconductor?

(l) A doped semiconductor has 10 billion silicon atoms and 15 million pentavalent atoms. If the ambient temperature is 25 °C, how many free electrons and holes are there inside the semiconductor? Consider the carrier produced by the heat energy is zero.

SEAL

SEAL

GROUP—B

2. Attempt any *four* from the following : 5×4=20

(a) Design a full adder using 8 : 1 multiplexer ICs.

(b) Show that transconductance g_m of a JFET is related to drain current I_{ds} as $g_m = \frac{2}{|v_p|}\sqrt{I_{ds} \cdot I_{dss}}$, I_{dss} is saturation drain current when gate to source voltage is zero and v_p is the pinch of voltage.

(c) An amplitude modulated wave is represented by the expression

$$V = 5[1 + 0{\cdot}6\cos(6280t)]\sin(2\pi \times 10^4 t) \text{ volt}$$

Calculate—

(i) modulation depth;

(ii) modulating frequency;

(iii) period of carrier wave;

(iv) peak instantaneous value of modulated wave;

(v) total power if carrier power is 400 W.

(d) The input $-3e^{2t}u(t)$, where $u(t)$ is the unit step function applied to a system with a transfer function $(s-2)/(s+3)$. If the initial value of the output is –2, what will be the steady-state output?

(e) Describe the method of measurement of temperature using thermocouple transducers.

(f) What are the ideal characteristics of an operational amplifier?

3. Attempt any *four* from the following : 5×4=20

(a) Explain how type of material and mobility of semiconductor can be determined from Hall effect.

(b) Draw the three-dimensional radiation pattern for the half-wave dipole antenna and explain how it is developed.

(c) For the network shown in Fig. 1, determine the node voltage :

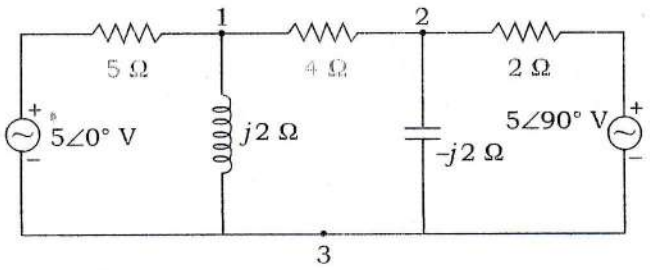

Fig. 1

(d) Derive equation for anode current of an SCR with the help of two-transistor model. What is regenerative action of SCR?

(e) Find the Fourier Transform of a Gaussian pulse signal $X(t) = e^{-at^2}$, $a > 0$.

(f) Three resistors having resistances 250 Ω, 500 Ω and 375 Ω respectively, are connected in parallel. The 250 Ω resistor has a +0·025 fractional error, the 500 Ω resistor has a −0·036 fractional error and the 375 Ω resistor has a +0·014 fractional error. Determine *(i)* total resistance considering the error of each resistor and *(ii)* the fractional error of the total resistance based upon rated values.

4. Attempt any *four* from the following : 5×4=20

(a) Distinguish between Zener diode with *(i)* ordinary diode and *(ii)* varactor diode.

(b) Given a binary memoryless source X with two symbols x_1 and x_2. Prove that $H(x)$ is maximum, when both x_1 and x_2 are equiprobable.

(c) Obtain the Norton equivalent circuit of Fig. 2 at terminals A and B :

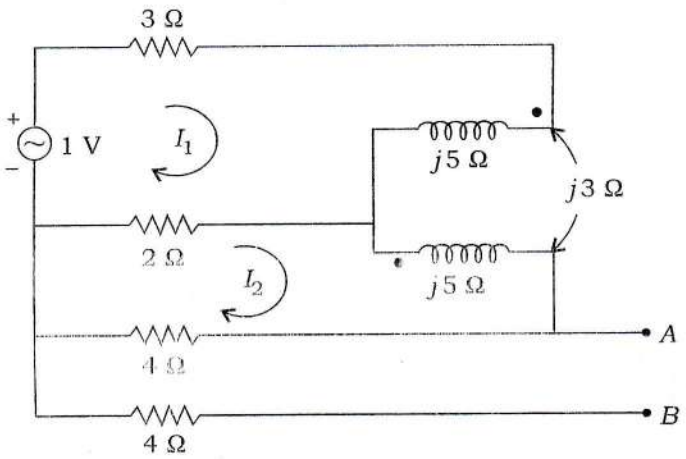

Fig. 2

(d) The load resistance of a centre-tapped full-wave rectifier is 500 Ω and the necessary voltage (end-to-end) is $60\sin(100\pi t)$. Calculate—

(i) peak, average and r.m.s. values of current;

(ii) ripple factor;

(iii) efficiency of the rectifier.

Each diode has an idealised *I-V* characteristics having slope corresponding to a resistance of 50 Ω.

(e) Find the Z transform of—

(i) $x[n] = -a^n u[-n-1]$;

(ii) $x[n] = a^{-n} u[-n-1]$.

5. Attempt any *four* from the following : 5×4=20

(a) A transistor is connected in CE configuration in which collector supply voltage is 8 V and the voltage drop across collector resistance is 0·5 V. The value of collector resistance is 800 Ω. If $\alpha = 0{\cdot}96$, determine (i) collector-emitter voltage and (ii) base current.

(b) A PCM system uses a uniform quantizer followed by a v bit encoder. Show that r.m.s. signal to quantization noise ratio is approximately given as $(1{\cdot}8 + 6v)$ dB.

(c) Consider the system shown in Fig. 3. Obtain the closed loop transfer function $H(s)/Q(s)$:

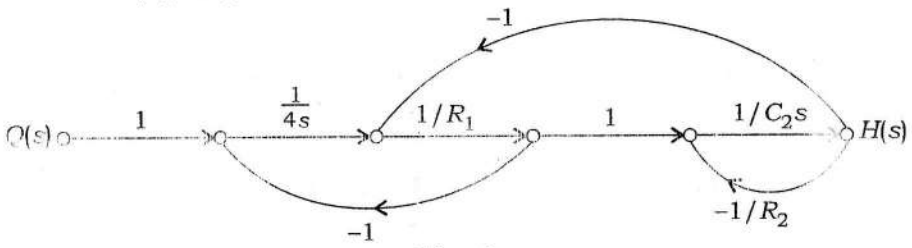

Fig. 3

(d) Given two positive 8-bit values X and Y. Write an assembly language subroutine program for 8085 microprocessor, which divides X and Y leaving the quotient A and remainder B. In case Y is zero, FFH is left in A and B registers.

(e) Explain the characteristics of good insulating material.

6. (a) Draw the state diagram of a modulo –4 UP/DOWN counter. Design the circuit using *J-K* flipflops.

(b) Design a first-order active Butterworth band-pass filter (with OPAMP) with a pass-band gain of 4. The pass-band frequency is from 1 kHz to 10 kHz. 10+10=20

7. (a) Draw the block diagram of superheterodyne receiver and explain the function of each block.

(b) Draw the circuit diagram of an *R-C* phase-shift oscillator using BJT and derive the equation for the frequency of oscillation and condition of oscillation. 10+10=20

8. *(a)* Consider the system shown in Fig. 4. Draw a root locus diagram. Determine the value of k such that the damping ratio of the dominant close loop pole is 0·4 :

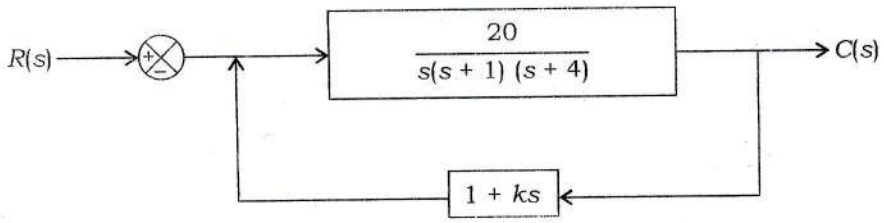

Fig. 4

(b) Draw and explain the Armstrong method for the generation of wideband frequency modulation. 10+10=20

★★★