ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper—II

(Conventional)

| Time Allowed : Three Hours | Maximum Marks : 200 |

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

Candidates should attempt FIVE questions in all.

Question No. 1 is compulsory.

Out of the remaining SIX questions, attempt any FOUR questions.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Assume suitable data, if necessary, and indicate the same clearly.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer-book.

Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer-book must be clearly struck off.

Answers must be written in ENGLISH only.

[P.T.O.

1. *(a)* An amplifier has a high frequency response given by

$$A = \frac{A_0}{1 + j\dfrac{\omega}{\omega_2}}$$

where $A_0 = 1000$ and $\omega_2 = 10^4$ rad/sec.

Find the −ve feedback factor β which will raise the upper corner frequency ω_2 to 10^5 rad/sec. What is the corresponding overall gain of the amplifier? Find also the gain-bandwidth product in each case.   5

(b) For the circuit shown in Fig. 1 *(b)*, show that the output v_o is given by a differential equation. The input is kept at constant V volts.   5
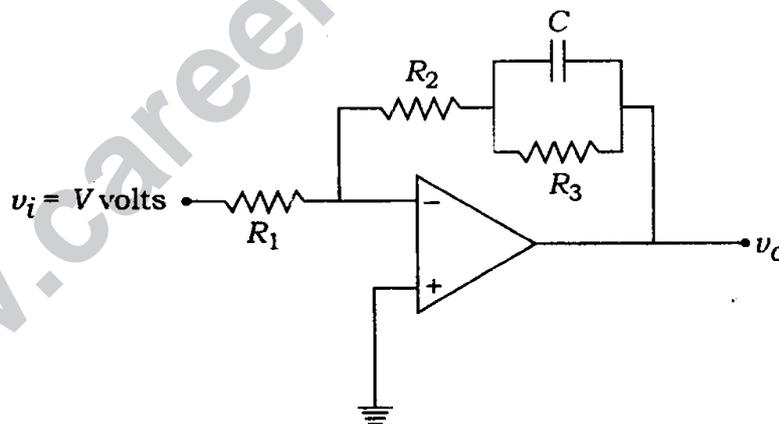

Fig. 1 *(b)*

(c) A digital logic has three inputs A, B and C. The output Y is equal to 1 if two or three inputs are 0.

   (i) Write the truth table.

   (ii) From the truth table, obtain the Boolean expression for Y.

   (iii) Minimize Y and draw the logic block diagram using NAND gates.   5

(d) Reduce the combinational logic circuit shown in Fig. 1 *(d)* such that the desired output can be obtained using only one gate.   5
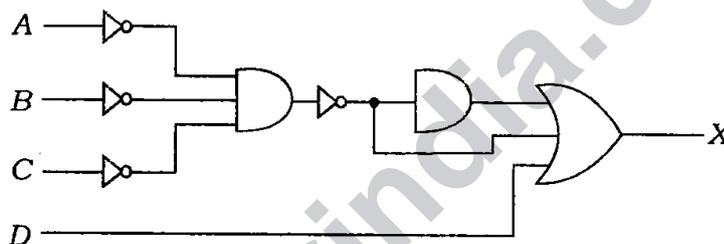

Fig. 1 *(d)*

(e) The transient test on a unity feedback second-order system gave the following data :

Settling time, $t_s = 0.8$ sec (2%)
Positional error constant, $K_p = 5.25$
Peak overshoot, $M_p(\%) = 16\%$

Find the transfer function of the system.   5

(f) Three students A, B and C are given a problem in Maths. The probabilities of their solving the problem are $\frac{3}{4}$, $\frac{2}{3}$ and $\frac{1}{4}$ respectively. Determine the probability that the problem is solved if all of them try to solve the problem.   5

(g) For a GaAs Gunn diode, following are the major specifications given :

Threshold field (E_{th}) = 2800 V/cm

Applied field (E) = 3200 V/cm

Frequency of operation (f) = 10 GHz

Doping concentration (n_0)
$$= 2 \times 10^{14}/cm^3$$

Length of Gunn device (L) = 10 μm

In the above case, compute—

(i) electron drift velocity;

(ii) current density;

(iii) negative electron mobility.   5

(h) What is the meaning of different parts of the address stored in a pointer under Windows environment?   5

2. *(a)* A common-emitter class–A power amplifier circuit is shown in Fig. 2 *(a)*, where $V_{CC} = 15\,V$, $R_L = 1\,K$ and $R_e = 0.5\,K$. Calculate the—

   (i) power supplied by the collector for symmetrical swing;

   (ii) power dissipated in the load and in the emitter resistor;

   (iii) power dissipated in the transistor;

   (iv) efficiency (η) of the operation.   10
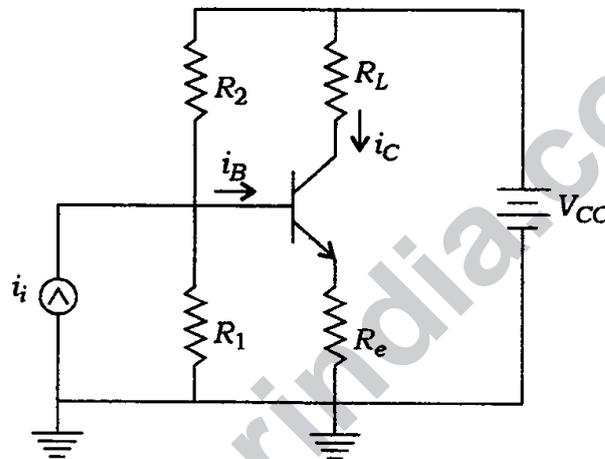

Fig. 2 *(a)*

(b) *(i)* Design a logic circuit to convert Excess-3 code to BCD.

   (ii) Draw the truth table.

   (iii) Consider "don't cares" in the simplification.

   (iv) Realize using discrete gates.   10

(c) *(i)* The antenna current of an AM broadcast transmitter, modulated to a depth of 40 percent by an audio sine wave, is 11 amperes. It increases to 12 amperes as a result of simultaneous modulation by another audio sine wave. What is the modulation index due to this second wave? 5

(ii) A certain transmitter radiates 9 kW with the carrier unmodulated and 10·125 kW when the carrier is simultaneously modulated. Estimate the modulation index. If another sine wave, corresponding to 40% modulation, is transmitted simultaneously, find out the total radiated power. 5

(d) Write an 8085 assembly language program to subtract two numbers of 16-bit data stored in memory from 4200 H to 4203 H. The data are stored such that low byte first and then high byte. Store the result in 4204 H and 4205 H. Draw also the flowchart for the program. 10

3. *(a)* Figure 3 *(a)* shows a two-transistor current source.

The circuit parameters are

$$V^+ = 5\,\text{V}, \ V^- = -5\,\text{V} \text{ and } R_1 = 9\cdot3 \ \text{k}\Omega$$

The transistor parameters are

$$\beta = 50, \ V_{BE\,(on)} = 0\cdot7 \ \text{V and } V_A = 80 \ \text{V}$$

Determine the change in load current I_O when V_{CE_2} changes from $0\cdot7$ V to 5 V.
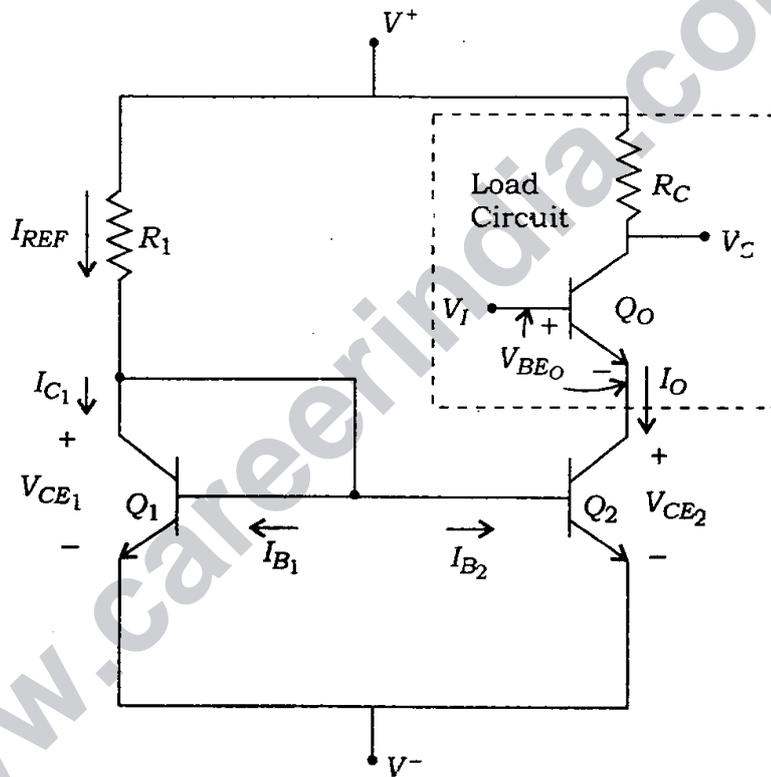

Fig. 3 *(a)*

(b) The truth table for *AB* flip-flop is shown below. Design this flip-flop using *J-K* flip-flops and additional logic gates.   10

Truth table

A_n	B_n	Q_{n+1}
0	0	$\overline{Q}_n$
0	1	Q_n
1	0	1
1	1	0

(c) Calculate the ratio of the cross-section of a circular waveguide to that of a rectangular one if each is to have the same cutoff wavelength for its dominant mode.   10

(d) (i) What is multiplexing and what is its advantage?   3

   (ii) How is clock signal generated in 8086? What is the maximum internal clock frequency of 8086?   5

   (iii) Write the flags of 8086.   2

4. *(a)* The open-loop transfer function of a feedback control system is given by

$$G(s)\,H(s) = \frac{K\,(s+8)\,(s+10)}{s\,(s+1)\,(s+2)}$$

(i) Using Routh-Hurwitz criterion, prove that the system is a conditionally stable system and determine the range of value of K for which the system is stable. 5

(ii) Determine the values of K which will cause sustained oscillations in the closed-loop system. What are the frequencies of oscillations? 5

(b) Construct the root locus for a feedback control system whose open-loop transfer function is given by

$$G(s)\,H(s) = \frac{K}{s\,(s+4)\,(s^2+4s+8)}$$

Show all the salient points in the sketch. 15

(c) The open-loop transfer function of a feedback control system is given by

$$G(s)\,H(s) = \frac{50}{s\,(1+0\cdot1\,s)\,(1+0\cdot2\,s)}$$

Determine stability using Nyquist plot. 15

5. *(a)* Obtain the mathematical expression for the output voltage v_o of the circuit shown in Fig. 5 *(a)*. Hence identify the function of the circuit.   1C
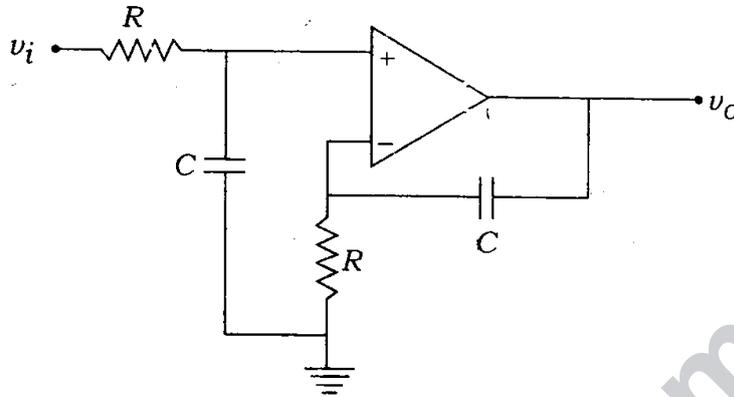

Fig. 5 *(a)*

(b) Design a logic circuit that controls an elevator door in a three-storied building. The circuit shown in Fig. 5 *(b)* has four inputs. M is a logic signal that indicates when the elevator is moving ($M = 1$) or stopped ($M = 0$). $F1$, $F2$ and $F3$ are floor indicator signals that are normally LOW, and they go HIGH only when the elevator is positioned at the level of that particular floor. For example, when the elevator is lined up with the second floor, $F2 = 1$ and $F1 = F3 = 0$. The circuit output is the OPEN signal which is

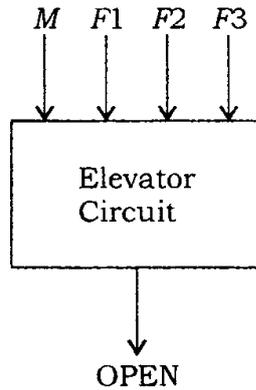normally LOW and is to go HIGH when the elevator door is to be opened. 10

M   F1   F2   F3

Elevator
Circuit

OPEN

Fig. 5 *(b)*

(c) A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of the system is equal to 50×10^6 bits/sec.

(i) What is the maximum message signal bandwidth for which the system operates satisfactorily? 5

(ii) Calculate the output signal to quantization noise ratio, when a full-load sinusoidal modulating wave of frequency 1 MHz is applied to the input. 5

(d) *(i)* What are the characteristics of EPROM? 2

(ii) Compare the memory mapped I/O and standard I/O mapped I/O. 5

(iii) What is masking and why is it required? 3

6. *(a)* The amplifier shown in Fig. 6 *(a)* utilizes an *n*-channel FET for which $V_p = -2 \cdot 0$ V and $I_{DSS} = 1 \cdot 65$ mA. It is required to bias the circuit at $I_{DS} = 0 \cdot 8$ mA using $V_{DD} = 24$ V. Assume $r_d \gg R_d$.

Find *(i)* V_{GS}, *(ii)* g_m, *(iii)* R_S and *(iv)* R_d such that the voltage gain is at least 20 dB with R_S bypassed with a very large capacitor C_S. 1C
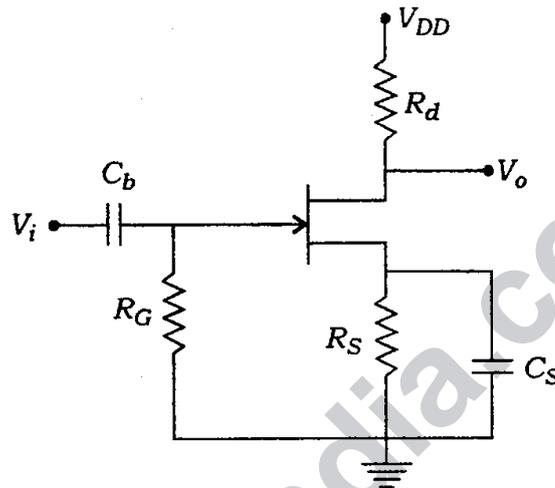

Fig. 6 *(a)*

(b) *(i)* Draw the circuit of MOD-6 Johnson counter (twisted ring counter) using *D* FFs.

(ii) Draw the waveform.

(iii) Write the sequence table.

(iv) Draw the state diagram.

(v) Develop the decoding circuit for MOD-6 Johnson counter using 2-input AND gates. 10

(c) When the mean optical power launched into an 8 km length of fibre is 120 μW, the mean optical power at the fibre output is 3 μW. Now evaluate the following :

   (i) Overall signal attenuation or loss in decibels through the fibre, assuming there are no connectors or splices   4

   (ii) Signal attenuation per kilometre for the fibre   2

   (iii) Overall signal attenuation for a 10 km optical link using the same fibre with splices at 1 km intervals, each giving an attenuation of 1 dB   4

(d) (i) What is RS–232 C standard? How is the RS–232 C serial bus interfaced to TTL logic device?   4

   (ii) Write the different operating modes of port–A of 8255 (PPI).   3

   (iii) Explain the working of handshake input port.   3

7. *(a)* A two-stage voltage series feedback amplifier circuit is shown in Fig. 7 *(a)*. The parameter values of the transistors used are

$$h_{fe} = 50, \quad h_{ie} = 1\cdot1\text{ K}, \quad h_{re} = h_{oe} = 0$$

Assume that $R_S = 0$. The values of the resistors and capacitors used are also shown in the figure. Calculate A_{vf}, R'_{of} and R_{if} for the feedback amplifier. **10**
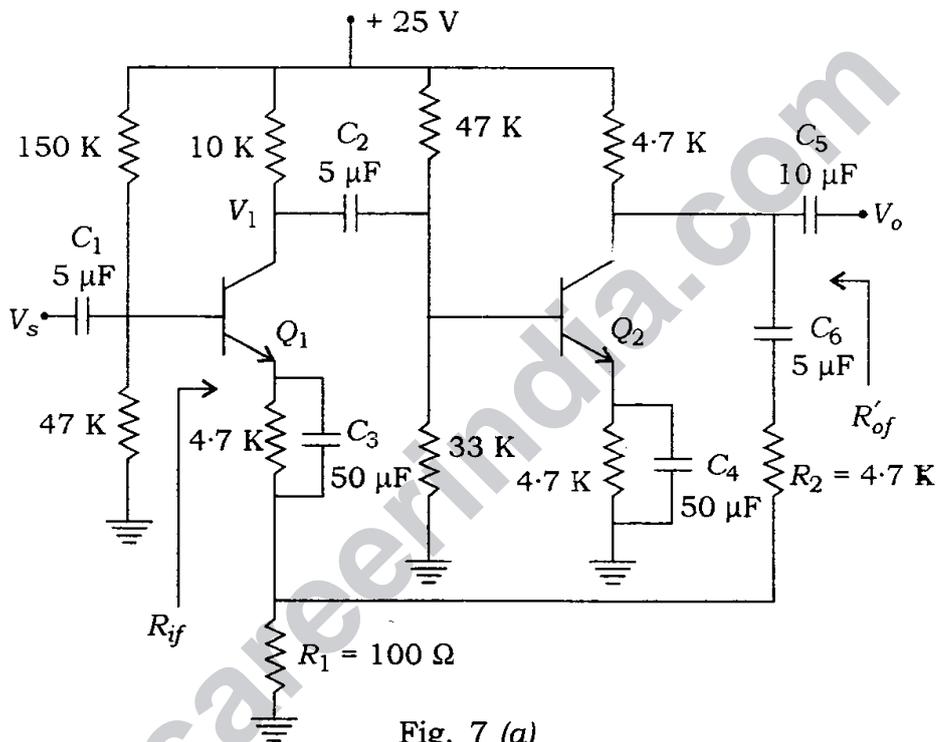

Fig. 7 *(a)*

(b) What is the 'magic' in a magic tee? How does a Faraday four-port circulator work? Why are slow-wave structures essential for the operation of TWT? Give sketches of three slow-wave structures. **10**

(c) (i) Draw an electronic circuit of a PID controller where the three different gains may be controlled independently. 5

    (ii) Explain the effect of different controllers (P, I and D) on the transient and steady-state performance of feedback control system. 5

(d) (i) A rectangular waveguide with a 5 cm × 2 cm cross-section is used to propagate TM_{11} mode at 10 GHz. Calculate the cutoff wavelength and the characteristic impedance. 5

    (ii) Sketch an experimental setup to measure the frequency of a microwave signal without using a frequency meter, and explain its measurement technique. 5

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