

- 8.✓ (a) Table 1, shows the marks scored by 229 students in a mathematics examination.

Table 1

Marks	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80
No. of students	12	30	a	65	b	25	18

Given that the median mark is 46, determine the:

12 18 25 30 65 95

- (i) values of a and b;
- (ii) mean;
- (iii) mode.

(10 marks)

- (b) Given that:

$$\begin{array}{lll} \Sigma x = 10 & \Sigma y = 15 & \Sigma xy = 38 \\ \Sigma x^2 = 50 & \Sigma y^2 = 86 & n = 15 \end{array}$$

Determine the:

- (i) Karl Pearson's correlation coefficient;
- (ii) least squares regression line of y on x;
- (iii) least squares regression line of x on y.

(10 marks)

- (b) An amplifier has a gain  $A = 100$ , input resistance  $R_i = 2\text{K}\Omega$  and output resistance  $R_o = 40\text{K}\Omega$ . Determine the following when it is connected as a voltage-series negative feedback amplifier with a feedback factor  $\beta = \frac{1}{10}$ :

- (i) gain;
- (ii) input resistance;
- (iii) output resistance;
- (iv) reduction in distortion;
- (v) percentage change in gain with feedback if the gain without feedback changes by 20%.

(10 marks)

3. (a) (i) Define the following with respect to operational amplifiers:

- (I) input offset voltage;
- (II) slew rate;
- (III) common-mode voltage gain.

- (ii) Figure 2 shows a circuit diagram of a first-order low-pass filter. Determine the:

- (I) voltage gain;
- (II) cutoff frequency.

(7 marks)

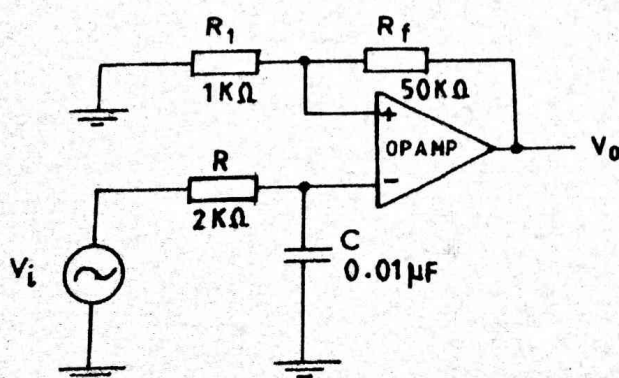


Fig. 2

- (b) Table 1 shows the data of the gain/frequency characteristic of a two-stage tuned radio frequency amplifier.

- (i) Plot, on the same axis, the gain/frequency curves for:

- (I) single stage;
- (II) two stages.

- (ii) From the curves, determine the bandwidth of the single stage and the two stage

(7 marks)



## SECTION A: ANALOGUE ELECTRONICS II

*Answer any TWO questions from this section.*

1. (a) (i) State **two** advantages of a silicon controlled switch (SCS) over a silicon controlled rectifier (SCR).
- (ii) Figure 1 shows a circuit diagram of an alarm system employing a silicon controlled switch. Describe its operation.

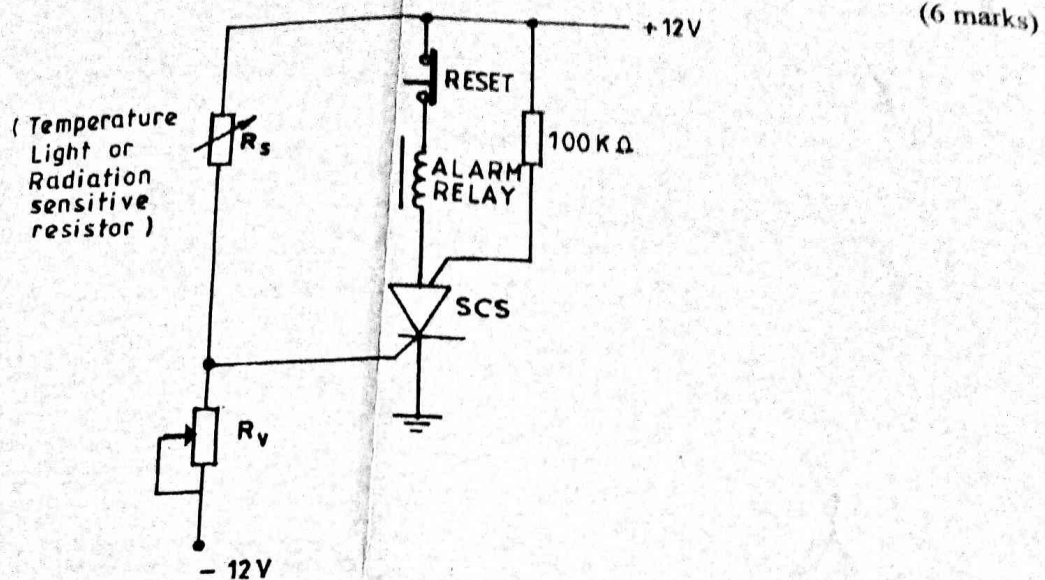


Fig. 1

- ✓(b) With the aid of a circuit diagram, describe the operation of a discrete-component bistable multivibrator. (8 marks)
- (c) An LED has the following ratings: power output  $P_o = 0.42 \text{ mW}$ , forward current  $I_F = 80 \text{ mA}$  and forward voltage  $V_F = 1.22 \text{ V}$ . It is connected in series with a current limiting resistor and supplied from a  $5 \text{ V}$  source. The light from the LED is projected onto a flat surface  $2.54 \text{ cm}$  away and forms a divergence angle of  $0.524 \text{ radians}$ . Determine the:

- (i) value of the current limiting resistor;
- (ii) area illuminated by the LED;
- (iii) incident irradiance at the flat surface.

(6 marks)

- (a) (i) State the **two** conditions necessary for oscillations to be sustained in a sinusoidal oscillator.
- (ii) With the aid of a circuit diagram, describe the operation of a blocking oscillator. (10 marks)

Table 1

Frequency	950	960	970	980	990	1000	1010	1020	1030	1040	1050
Gain of 1 stage	1.98	2.45	3.12	4.47	7.07	10	7.07	4.47	3.12	2.45	1.98
Gain of 2 stages	3.92	5.91	9.73	19.98	50	100	50	19.98	9.73	5.91	3.92

- (c) Show that the maximum theoretical efficiency of a class-B power amplifier is 78.54%.  
(6 marks)

### SECTION B: DIGITAL ELECTRONICS

Answer any **THREE** questions from this section.

4. (a) Perform the following number system conversion:

- (i)  $1011101001_2$  to decimal;  
(ii)  $EB4A_{16}$  to decimal

(6 marks)

- (b) Perform the following arithmetic operations in the given bases:

- (i)  $1011_2 \times 101_2$   
(ii)  $1A8_{16} + 67B_{16}$

- (c) (i) Table 2 shows the ASCII code for alphanumeric characters. Obtain the: (6 marks)
- (I) code for the letter  $e$ ;  
(II) decimal number represented by the code 0111001.

- (c) Figure 5 shows a circuit diagram of a weighted resistor digital-to-analog converter. Determine the value of the output voltage,  $V_o$ . (4 marks)

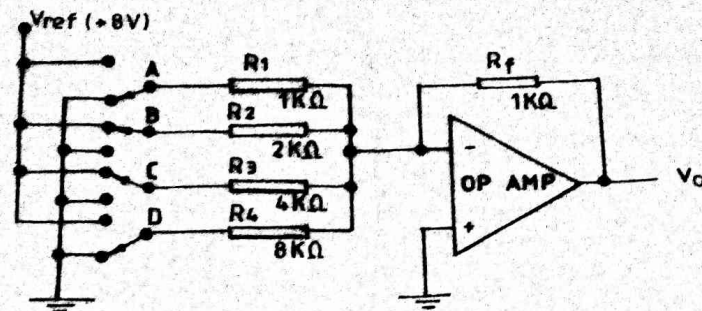


Fig. 5

8. (a) (i) State the packaging density of the following ICs:
- (I) medium scale integration;
  - (II) very large scale integration.
- (ii) With the aid of a circuit diagram, describe the operation of a two-input CMOS NOR gate. (10 marks)
- (b) Figure 6 shows a circuit diagram of a transistor switch. If  $V_{be} = 0.6V$ ,  $V_{ce(sat)} = 0.2V$  and  $\beta = 50$ ; determine the value of the base resistance at which the transistor will saturate. (10 marks)

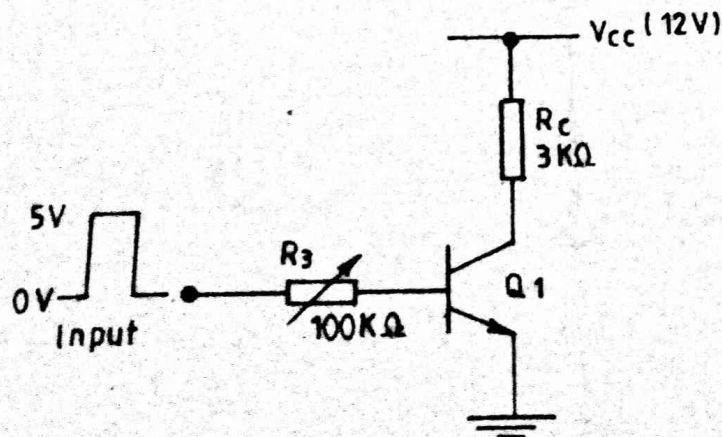


Fig. 6

**THIS IS THE LAST PRINTED PAGE.**



Table 2

	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P		p
1	SOH	DC1	!	1	A	Q	s	q
2	STX	DC2	"	2	B	R	b	r
3	ETX	DC3	#	3	C	S	c	s
4	EOT	DC4	\$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	.	:	J	Z	j	z
B	VT	ESC	*	;	K	[	k	{
C	FF	FS	,	<	L	\	l	
D	CR	GS	.	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	-	o	DEL

(ii) Add  $647_{10}$  to  $492_{10}$  in the 8421 BCD code.

(8 marks)

5. (a) (i) Define the following with respect to edge-triggered flip-flops:

- (I) set-up time;  
(II) hold-up time.

(ii) With the aid of a logic diagram, describe the operation of a master-slave JK flip-flop when the clock is at logic 1 and makes a transition to logic 0. Assume the circuit is initially reset and the inputs  $J = K = 1$ .

(9 marks)

(b) (i) State **two** applications of binary counters.

(ii) Figure 3 shows a logic diagram of a binary counter. Describe its operation for three clock pulses and draw the timing diagrams.

(8 marks)

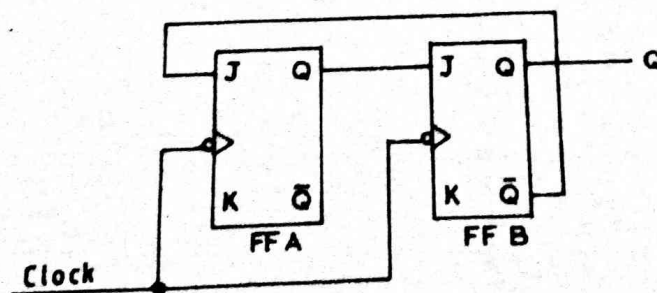


Fig. 3

(c) Draw the state diagram of a 4-bit Johnsons counter assuming that all the stages are in the '0' state.

(3 marks)

6. (a) Using Boolean algebra, simplify the equation

$$F = \overline{A} (B + \overline{C}) (A + \overline{B} + C) (\overline{A} \overline{B} \overline{C})$$

(5 marks)

- (b) A digital vending machine is to dispense beverage at a time as indicated:

- Tea and milk
- Coffee and milk
- Tea and sugar
- Coffee and sugar
- Tea, milk and sugar
- Coffee, milk and sugar

- (i) Draw the truth table for the vending machine operation.
- (ii) Obtain the logic expression from the truth table and simplify.
- (iii) Implement the simplified expression in b(ii).

(10 marks)

- (c) Figure 4 shows a logic diagram of a serial adder/subtractor connected to add two 4-bit binary numbers. Outline the sequence of adding the two numbers. (5 marks)

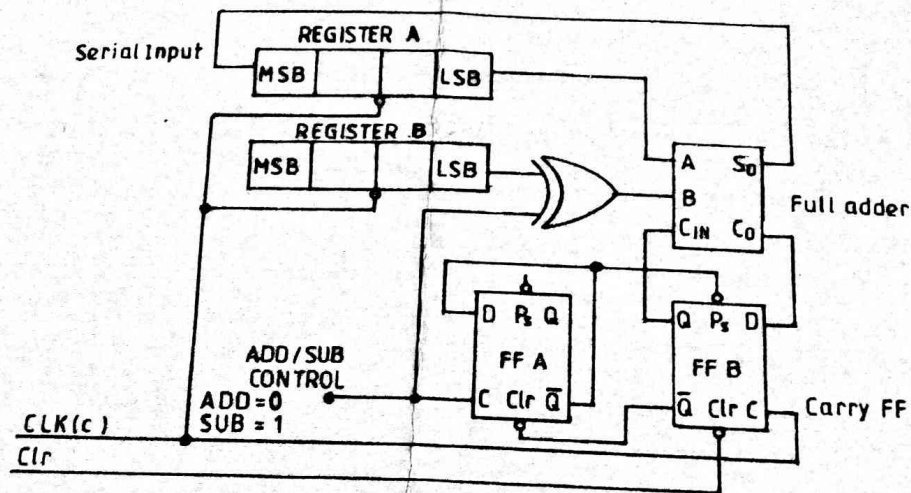


Fig. 4

7. (a) (i) Distinguish between random access memory (RAM) and read only memory (ROM).
- (ii) With the aid of a circuit diagram, explain how a programmable ROM is programmed.

(8 marks)

- (b) With the aid of a labelled block diagram, describe the operation of a ramp-type analog-to-digital converter.

(8 marks)