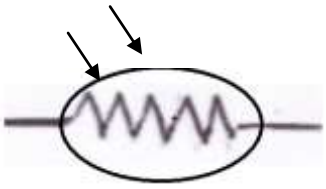
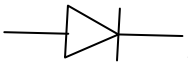
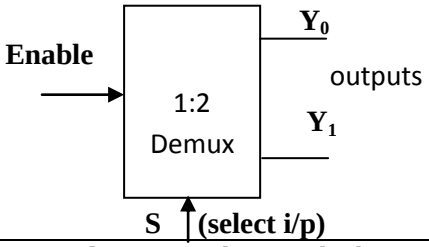
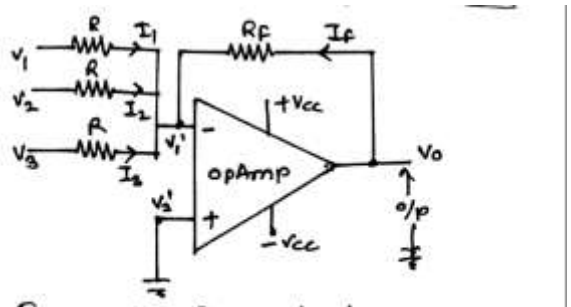
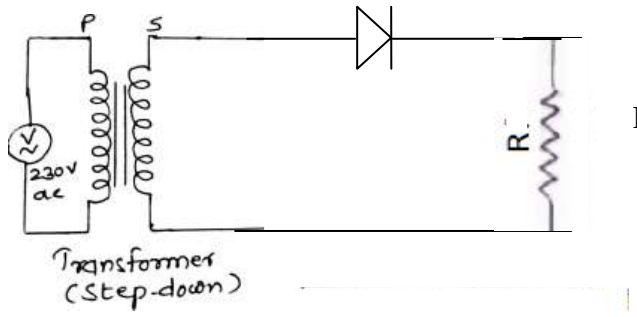
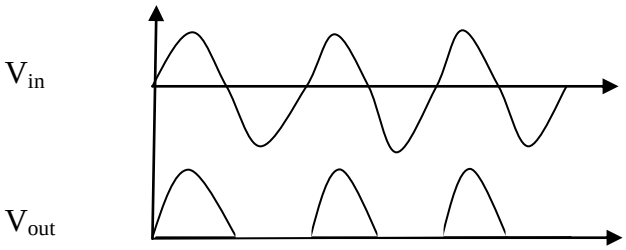
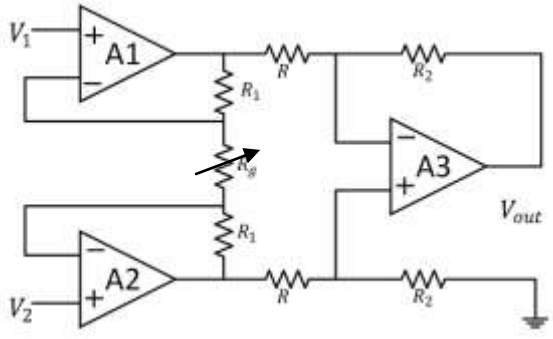
Important Instructions to examiners:

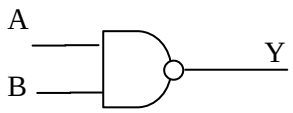
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No		Model Answer/Solution	Marks
1	A	**Attempt any SIX of the following:**	**12**
	i	Symbol of LDR and Diode   **A** **K**	01 M each
	ii	**Thermal runway:** The self-destruction of a transistor is known as thermal runway. It is the cyclic process, which destroys the transistor. As temperature increases, transistor leakage current I_{cbo} increases, which in turn increases the collector current I_c due to which again junction temperature increases and so on.	02M
	iii	**Barkhausen's Criteria :-** Barkhausen's criterion is applicable for oscillators. According to this criteria the circuit has to satisfy two conditions First:- the total phase shift given by the circuit should be **360^0 or 0^0**. and Second :- The factor **A□ should be less than equal to one**.	02M
	iv	**Logical symbol of 1:2 De-multiplexer and its truth table**  <table><tr><th>S</th><th>Y_0</th><th>Y_1</th></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td></tr></table>	01M 01M
	v	**Transducer :-** A device which converts one form of energy to other form. OR A device that converts physical energy into electrical energy. **Classification of Transducer:- (Any one may be given marks)** **Mechanical and Electrical** **Primary and Secondary** **Active and Passive** **Analog and Digital** **Temperature, Pressure, Humidity, Level, Thickness, Sound, Speed……**	01M 01M
	vi	**Mechatronics**: - It is a multidisciplinary approach to product and manufacturing system design. Mechatronics is the synergistic integration of mechanical engineering with electronics and intelligent computer control in designing, manufacturing process and production. It helps develop atomized and efficient manufacturing/production systems to produce high quality products.	02M
	vii	**Symbol of BJT** 	01 M each

1	viii	**Types of ADC: (Any two may be given 1 mark)** - Flash type - Tracking or servo type - Single Slop - Counter Type - Successive Approximation - Dual Slope **Types of DAC:** - Binary weighted register R-2R ladder	01M 01M
1	**B**	**ATTEMPT ANY TWO**	**08M**
	i	**LINE AND LOAD REGULATION** **Load regulation** is the capability to maintain a constant output voltage despite of changes in the load current from no load (NL) to full load(FL). $\%Load\,\text{Re}\,gulation = \left(\frac{V_{FL} - V_{NL}}{V_{FL}}\right) \times 100$ **Line regulation** It is the change in the regulated load voltage due to change in line voltage in a specified range. % Line regulation $= (V_{LH} - V_{LL} / V_{nom}) \times 100$	**01M** **01M** **01M** **01M**
	ii	**OPAMP AS ADDER**  Expression for output. By KCL, $I_1 + I_2 + I_3 + I_f = I_B$ But $I_B = 0$ $\therefore I_1 + I_2 + I_3 = -I_f$ $I_1 = \frac{V_1}{R}$, $I_2 = \frac{V_2}{R}$, $I_3 = \frac{V_3}{R}$, $I_f = \frac{V_o}{R_f}$ $\therefore \frac{V_1}{R} + \frac{V_2}{R} + \frac{V_3}{R} = -\frac{V_o}{R_f}$ $\therefore \boxed{V_o = -\frac{R_f}{R}(V_1 + V_2 + V_3)}$ **Student may explain with two inputs V1 and V2 only.**	**02M** **02M**

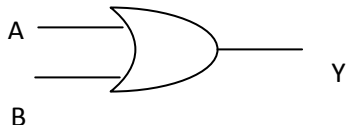
Q.No		Model Answer/Solution	Marks
1B	iii	**SELECTION CRITERIA FOR PLC** a) Type of PLC: Analog or Digital b) Number of inputs and outputs to PLC c) Operating voltage and operating current range d) Scan time of PLC e) Memory size of PLC f) Type of memory of PLC g) Type of programming h) Reliability of PLC i) Flexibility of PLC { any other relevant and appropriate criteria may also considered}	**1/2*8 = 04**
2		**ATTEMPT ANY FOUR**	**16M**
	a	Circuit diagram of Half wave Rectifier with input and output waveforms **Half wave rectifier and its waveforms**   	02M 01M 01M
	b	Instrumentation Amplifier with 3opamps and its output voltage equation  Vo = (1+2R1/Rg)(R2/R) (V2-V1) OR $V_{out} = (V_2 - V_1)(1 + \frac{2R_1}{R_g})(\frac{R_2}{R})$	03M 01M

Q.No		Model Answer/Solution	Marks
2	c	**Symbol of OR gate and NAND gate** Symbol and truth table of **NAND gate**	02M



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

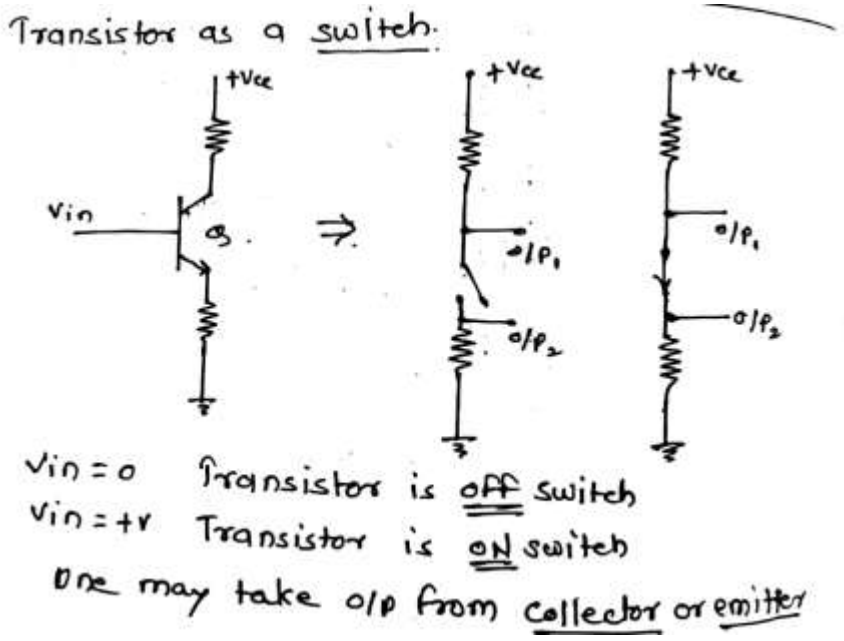
OR gate



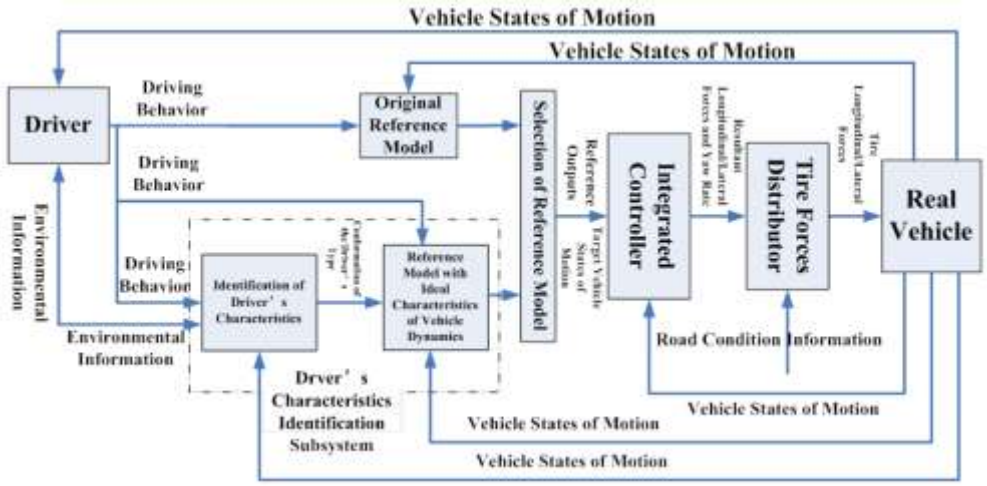
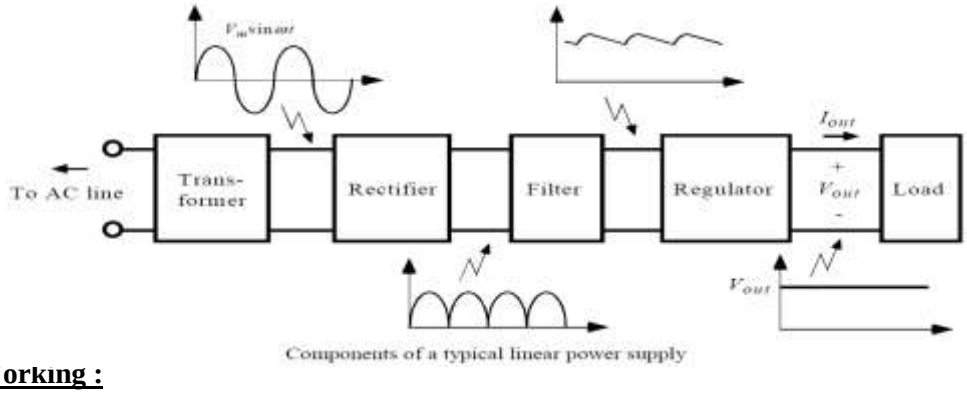
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

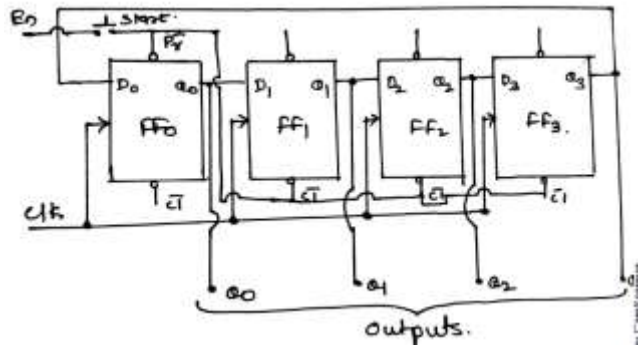
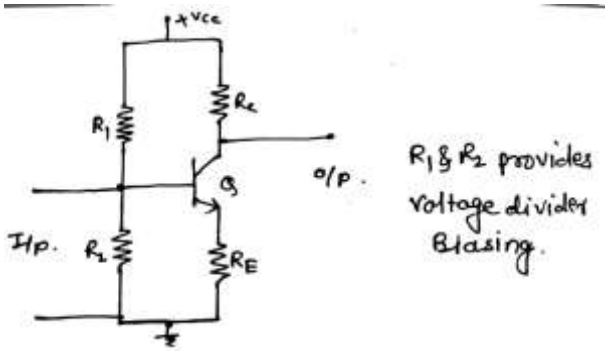
02M

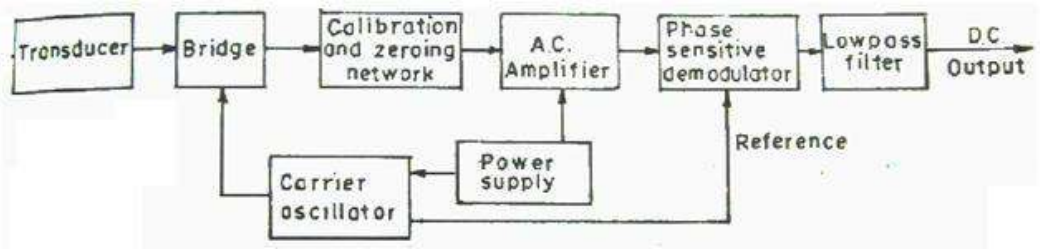
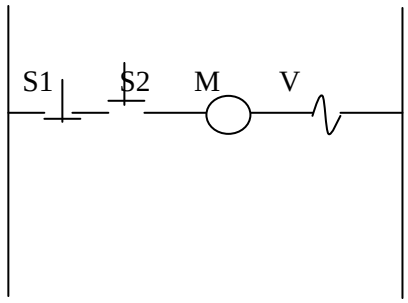
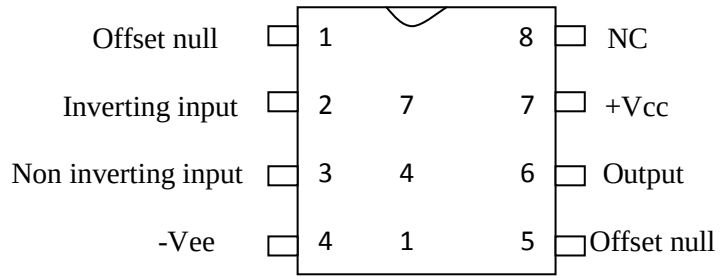
	d	Trasistor as a switch	04M



	e	DAS and its Applications **DAS**-Data Acquisition System:- The function of DAS is to collect the input data efficiently, accurately, simultaneously to store and display the data. It consists of sensor or transducer associated with signal conditioning element, multiplexer circuit, data conversion, data transmission and final storage element and display unit. **Application of DAS** In instrumentation system of various industries like paper, sugar, steel etc., for measurement of Temperature, pressure, velocity, thickness etc.	02M 02M

Q.No		Model Answer/Solution	Marks
2	f	**Functional block diagram of AVCS** 	04M
3		**Attempt any Four**	**16M**
	a	Block diagram of Regulated power supply  Components of a typical linear power supply	02M
		Working : **Step Down Transformer**: A step down transformer will step down the voltage from the ac mains to the required voltage level. The turn's ratio of the transformer is so adjusted such as to obtain the required voltage value. The output of the transformer is given as an input to the rectifier circuit. **Rectification:** Rectifier is an electronic circuit consisting of diodes which carries out the rectification process. Rectification is the process of converting an alternating voltage or current into corresponding direct (dc) quantity. The input to a rectifier is ac whereas its output is unidirectional pulsating dc. Usually a full wave rectifier or a bridge rectifier is used to rectify both the half cycles of the ac supply (full wave rectification). **Filter** : The rectified voltage from the rectifier is a pulsating dc voltage having very high ripple content. But this is not we want, we want a pure ripple free dc waveform. Hence a filter is used. Different types of filters are used such as capacitor filter, LC filter, Choke input filter, π type filter.	02M

Q.No		Model Answer/Solution	Marks
	a	**Continued….** **Regulator** : This is the last block in a regulated DC power supply. The output voltage or current will change or fluctuate when there is change in the input from ac mains or due to change in load current at the output of the regulated power supply or due to other factors like temperature changes. This problem can be eliminated by using a regulator. A regulator will maintain the output constant even when changes at the input or any other changes occur.	
	b	4 bit ring counter  Clock Count / Output bit Pattern Q0 Q1 Q2 Q3 1 1 0 0 0 2 0 1 0 0 3 0 0 1 0 4 0 0 0 1 5 1 0 0 0	02M 02M
	c	**Biasing**:- It the process of selecting the value of collector current I_C and Collector to emitter voltage V_{ce}. (selecting position of operating point of transistor on DC load line) To use transistor as an amplifier it should be always operated in active region so we have to provide proper biasing to the transistor. **Voltage divider biasing for BJT**  	02M 02M

		Model Answer/Solution	Marks
3	d	**Signal conditioning and AC signal conditioner** **Need of signal Conditioning:** It is the process used in instrumentation and measurement system to modify or improve output of the various transducers. Improvement of signal is necessary so as to make them useful and compatible with the measuring system. It consists of number of circuits or blocks. **Types of circuits used in AC signal Conditioning** a) Calibration and zeroing network (offset nullifying circuit) b) AC amplifier c) Phase detector d) Low pass filter e) Power supply 	02M 02M
	e	**Ladder diagram** Ladder diagram for start stop logic with one input push button for start and one push button for stop and output motor to activate solenoid valve.  S1 – Stop button S2 – Start button M- motor V- Solenoid valve Student may draw different ladder diagram as per his logic, if logic is correct it may also be considered	04M
	F	**Pin diagram of IC 741 Op-amp**  1 and 5 Offset null, to make output offset voltage to zero. 10k pot is connected between	02M

pin 1 and pin 5 and variable terminal is connected to –Vee supply.

2 Inverting input, input applied to this terminal is 180^0 phase shifted at output or inverted

3 Non inverting input, input applied to this terminal is in phase (no phase shift)

4 -Vee, negative voltage is applied to this pin

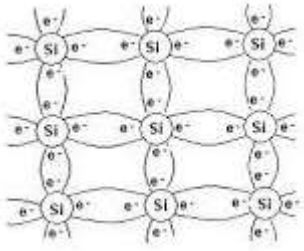
6 Output, output of IC 741 is available at this pin which is measured w.r.t. ground

7+Vcc, positive voltage is applied to this pin

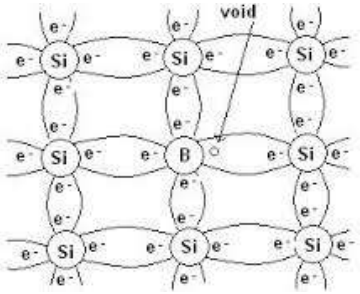
8 Not Connected

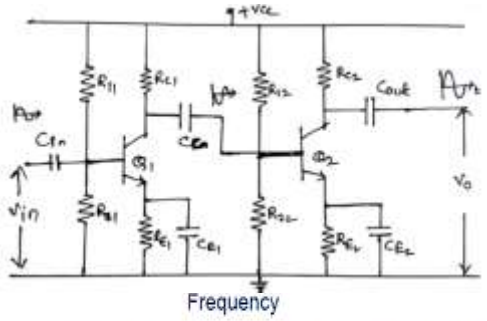
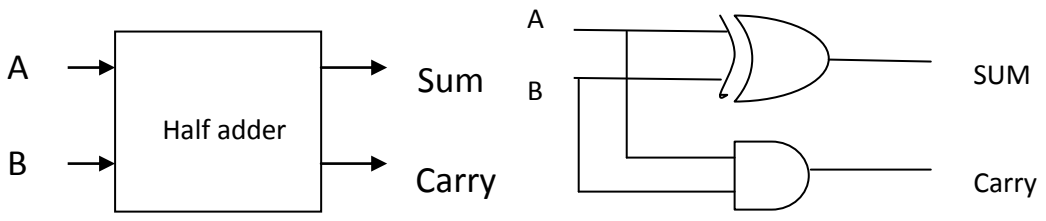
4 a.

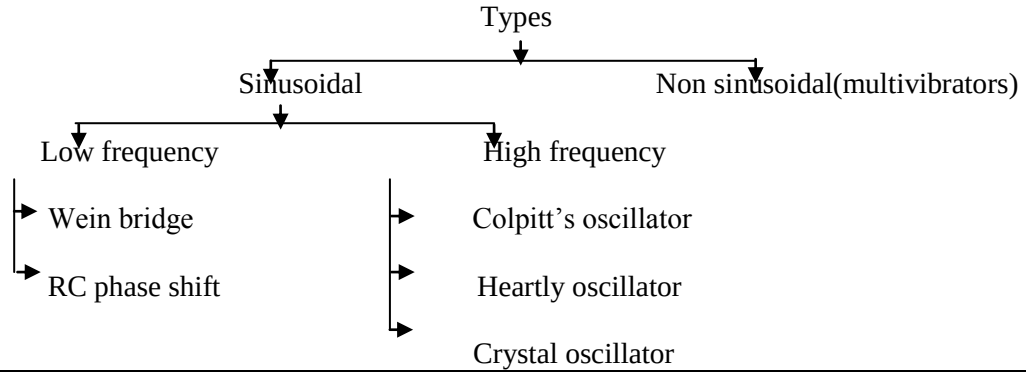
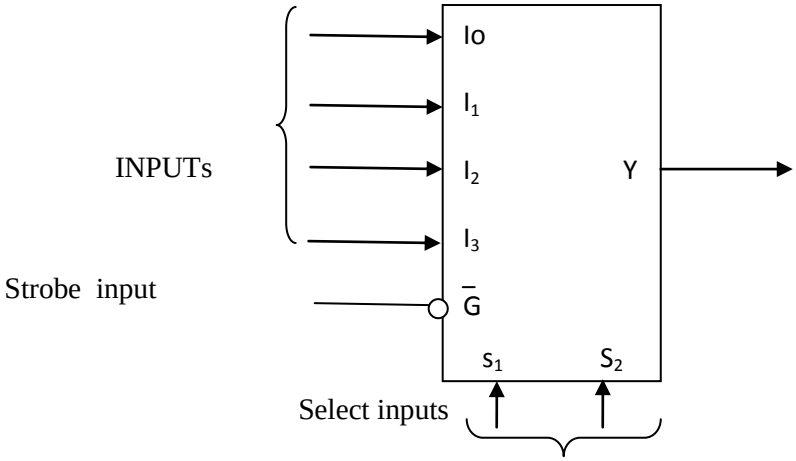
Intrinsic semiconductor :- These is a pure form of semiconductors available in nature. It has high resistivity silicon and germanium is the most popularly used semiconductors. Each atom of semiconductor forms a covalent bond with neighbouring atom and completes its octet. **Fig. silicon structure** — 2Marks



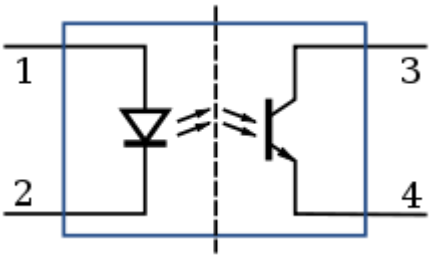
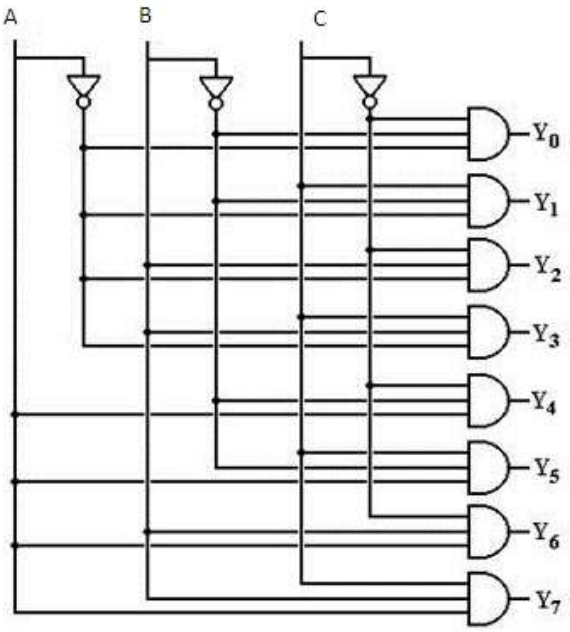
Extrinsic semiconductor :- when some impurity is added to a pure semiconductor, the resultant semiconductor is known as Extrinsic semiconductor. The process of adding impurity is called as Doping. Generally trivalent and pentavalent impurities are used to get p-type and n-type semiconductors respectively. **Fig. p type semiconductor** — 2 Marks



Q.No		Model Answer/Solution	Marks
4	b	Two stage RC coupled amplifier and its frequency response  Frequency Response Curve of a RC Coupled Amplifier	02M Circuit diagram 02M Frequency response
	c	**Real time Mechatronics systems and its advantages and disadvantages** A mechatronic system which performs various functions or operations with respect to time is referred as real time Mechatronics system. e.g. PLC,SCADA,HMI etc… **Advantages: -** 1. Fast speed of response 2. High accuracy 3. More flexible 4. Overall cost is low **Disadvantages:-** 1. More complex 2. Need of expert 3. Difficult to maintain 4.Due to mechanical parts more Noisy system (Any suitable and relevant point may also be considered above)	02M 01M (Any 2) 01M (Any 2)
	d	**Half adder circuit** **Half Adder –** A combinational circuit used to perform addition of two binary bits and produces Sum and Carry bits as a result. **Logical Circuit diagram-**  **A** **B** **Sum** **Carry** 0 0 0 0 0 1 1 0 1 0 1 0 1 1 0 1	01 M 02M 01 M.

Q.No		Model Answer/Solution	Marks
4	e	**Oscillator**:- A circuit which produces continuous oscillations at output is known as Oscillator. **Positive Feedback** is required for oscillators  	01M 01M 02M (Types)
	f	**For 4:1 multiplexer , it requires 2 select inputs.**  Truth table	02M 02M

G_bar	S_2	S_1	Y
1	X	X	0
0	0	0	I_0
0	0	1	I_1
0	1	0	I_2
0	1	1	I_3

Q.No		Model Answer/Solution	Marks
5	a	**Opto coupler**: a device containing light-emitting and light-sensitive components, used to couple isolated circuits.  **Isolation** : opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light. Intensity of light is proportional to current flowing through LED. A photosensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply. The sensor can be a photoresistor, a photodiode, a phototransistor. In this way opt coupler provides electrical isolation and couple the input signal to the output without any physical contact.	01 03
	b	**Decoder :** It is a combination logic circuit used to select a device or decode. Decoders consist of number of inputs (N) and number of output(M) and both are related as $2^N >= M$ The standard decoders are 1:2,2:4,3:8 and so on……  **Logic Diagram**	01 02

Truth Table

Inputs				Outputs							
EN	A	B	C	Y_7	Y_6	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0
0	×	×	×	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	1
1	0	0	1	0	0	0	0	0	0	1	0
1	0	1	0	0	0	0	0	0	1	0	0
1	0	1	1	0	0	0	0	1	0	0	0
1	1	0	0	0	0	0	1	0	0	0	0
1	1	0	1	0	0	1	0	0	0	0	0
1	1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	1	0	0	0	0	0	0	0

01

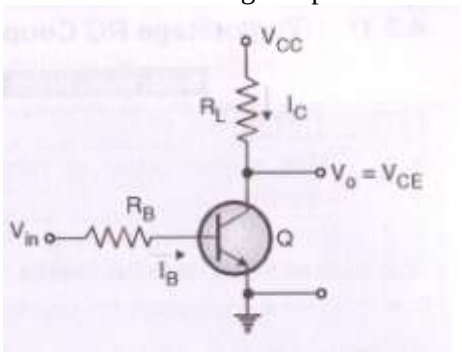
c Explanation :

Transistor as current amplifier:

Current gain of CE configuration is given as $Ic/I_B = \beta$

As the value of β is much higher than 1, we can say that the current gain is large and transistor acts as current amplifier.

Transistor as a voltage amplifier:



02

From fig.we can say that, small change in input there is small change in I_B

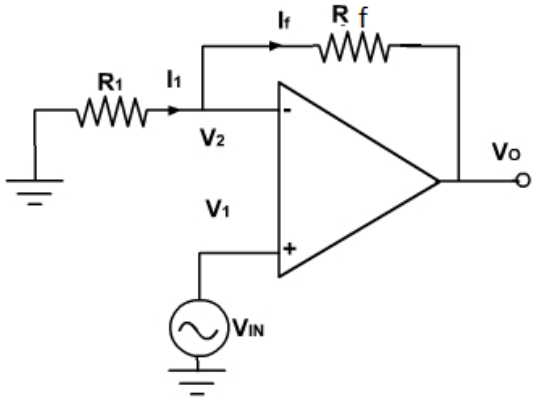
Hence, $\Delta I_B = \Delta Vin/R_B$ ------- 1

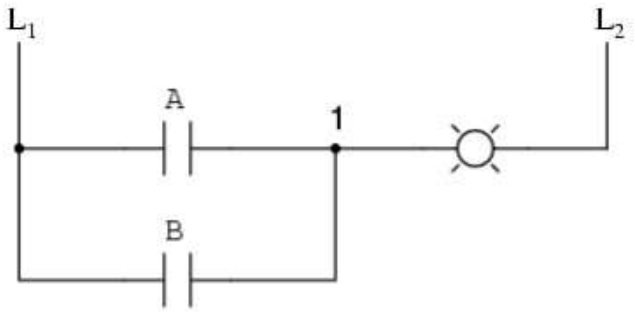
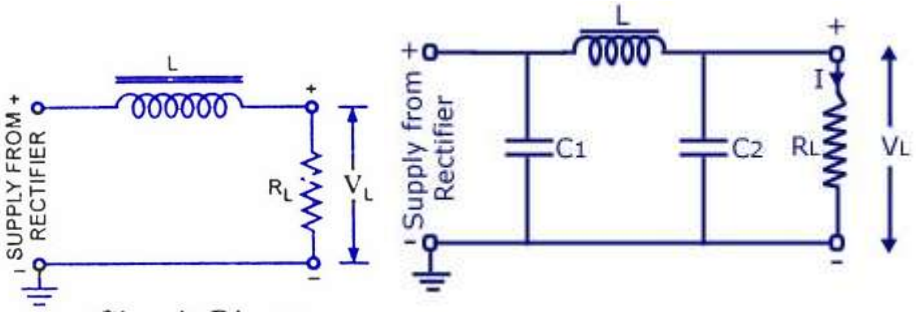
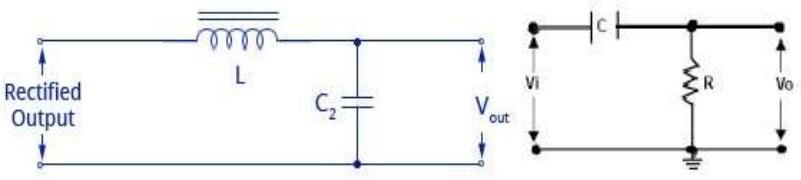
Therefore corrosponding change in collector current is given by,

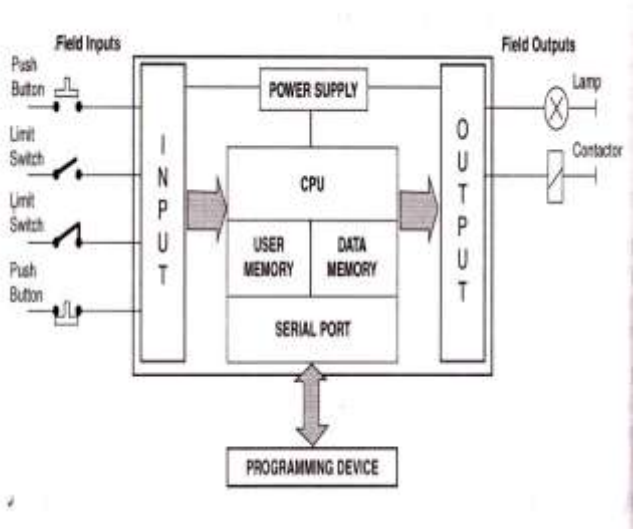
$\Delta Ic = \beta \Delta I_B$ ------- 2

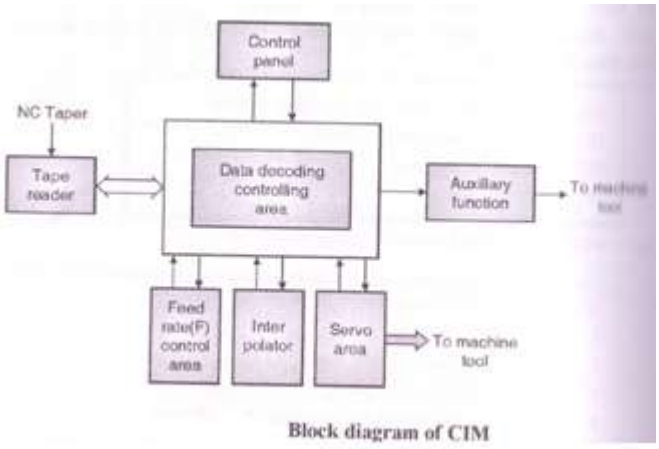
Therefore corrosponding change in output voltage is given by,

02

		$\Delta V0 = \Delta Ic\ R_L$ ---------- 3 From equation 1, 2 & 3 $\Delta V0 = \beta\ \Delta Vin/R_B\ x\ R_L$ $\Delta V0 = \beta\ R_L/ R_{B\ x}\ \Delta Vin$ Thus for small change in Vin e get lage change in V0and voltage amplification takes place.	
	d	Selection criteria (1 mark each for any four relevant criteria) 1. Operating range: - It should be as per requirement of application. 2. Sensitivity: - It should be high in order to produce sufficient output for even small change in quantity to be measured. 3. Frequency response: It should be flat over entire operating frequency. 4. Accuracy: It should be high to minimize the error. 5. Usage & ruggedness: Transducer should be rugged and work without any wear and tear over its life span. 6. Electrical aspects : Type of excitation (AC or DC), type of output impedance, amplification etc. 7. Loading effects : Transducer should not load the source physical quantity to be measured . 8. Compatibility: Transducer should be compatible with the measuring system.	01 each
	e	 Gain Av = 1+(Rf/R1) = 1+(21K/3K) **= 8**	02 02

	f	Ladder diagrams are specialized schematics commonly used to document industrial control logic systems. They are called "ladder" diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent.  **Explanation :** The lamp will come on if either contact A or contact B is actuated, because all it takes for the lamp to be energized is to have at least one path for current from wire L1 to wire L2. It is a simple OR logic function, implemented with nothing more than contacts and a lamp. (Student may draw different ladder diagram as per their logic, if logic is correct it may also be considered)	04
6	a	**Filter:** A filter is electronic circuit which is used to remove ripple contents (ac variations) from the rectified voltage. **Types of filter** - Series Inductor filter (L) - Parallel capacitor filter (C) - LC filter - C-L-C filter (π)  L-C Filter - Inductor input L Section Filter  Any one diagram can be considered	01 02 01

	b	"Programmable logic controller is defined as a sequential logic device that generates output signals" according to the logic operations performed on the input signals." or PLC is a digitally operated electronic system which used programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic sequencing, timing counting and arithmetic to control through analog inputs and outputs, various types of machines or processes  	02 02
	c.	<table><tr><th>Parameter</th><th>RC oscillator</th><th>LC Oscillator</th></tr><tr><td>component used</td><td>Resistor (R) and Capacitor (C)</td><td>Inductor (L) and Capacitor (C)</td></tr><tr><td>frequency range</td><td>Low and medium</td><td>high</td></tr><tr><td>frequency stability</td><td>poor</td><td>poor</td></tr><tr><td>application</td><td>low and medium frequency signal generator</td><td>in radio, TV, frequency synthesizers</td></tr></table>	01 mark to each correct point
	d	**Data Logger** : A data logger, " is an electronic instrument that records measurements of the instruments located at different parts of plant at set intervals over a period of time. Data logger measure and record data effortlessly as quickly, as often and as accurately desired. **Applications: (any four)** - power plant - Petrochemical plant - cement plant - AVCS - fertilizer industries - oil refinery - engine testing	02 ½ mark each
	e	- It is an 8 bit microprocessor - It is manufactured with N-MOS technology implemented with 6200 transistors. - It has 16-bit address lines - A0-A15 - The first 8 lines of address bus and 8 lines of data bus are multiplexed AD0-AD7. Data bus is	½ mark each to any correct 8

		a group of 8 lines D0-D7. - It provides 5 level interrupts and supports external interrupt request. - A 16 bit program counters (PC). - A 16 bit stack pointer (SP). - It consists of 74 instruction sets. - It requires a signal +5V power supply - operates at 3.2 MHZ single phase clock with maximum clock frequency 6 MHz and minimum clock frequency 500 kHz. - It provides 1 accumulator, 2 flag register, six 8-bit general purpose register arranged in pairs: BC, DE, HL and 2special purpose registers. - It performs arithmetic and logical operations. - 8085 microprocessor requires two phase, 50% duty cycle, TTL clock. These clock signals are generated by an internal clock generator - It generates 8 bit I/O address, hence it can access 2^8 = 256 input ports and 256 output ports. - 8085 microprocessor can be used to implement three chip microcomputer (8085, 8155, 8355)	points
	f	Computer-integrated manufacturing (CIM) is the manufacturing approach of using computers to control the entire production process. This integration allows individual processes to exchange information with each other and initiate actions. It consist of 4 basic components : 1) Machine tool & related equipment 2) Material handling system 3) Computer system 4) Human labour  Block diagram of CIM	02 02