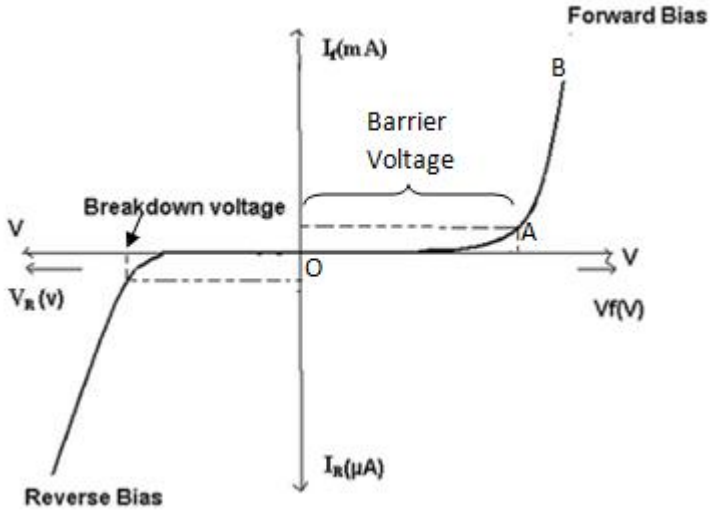
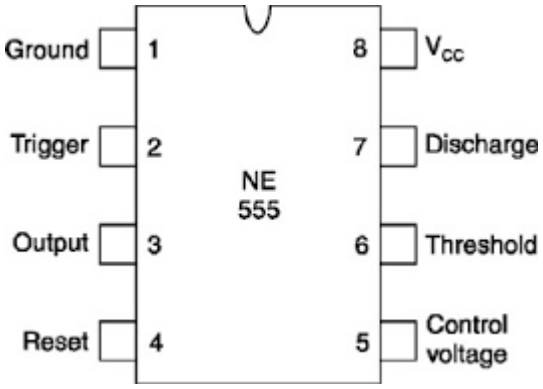
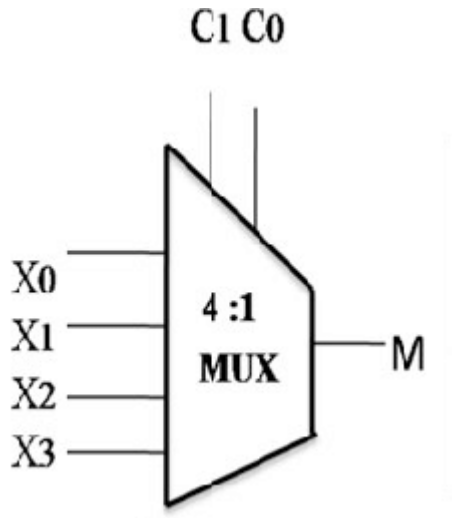
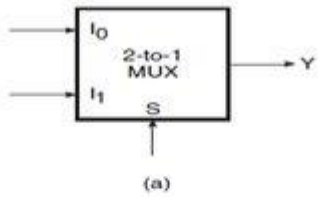
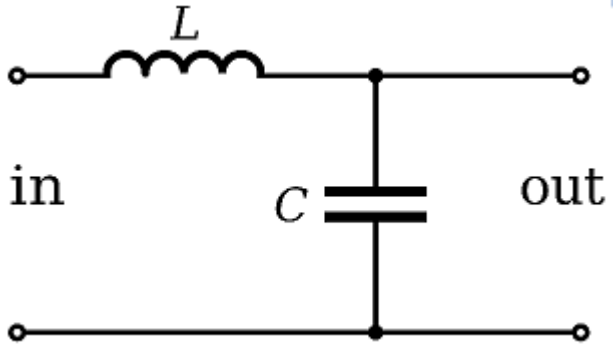
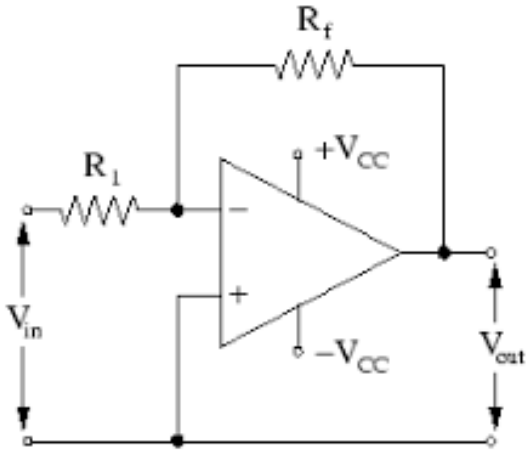
Important Instructions to examiners:

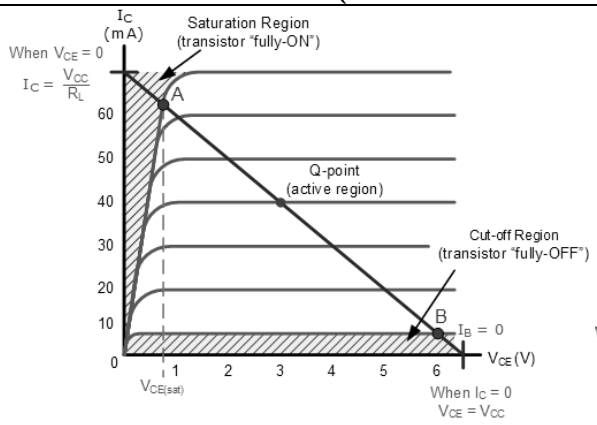
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

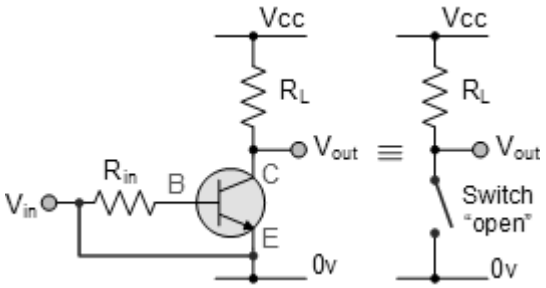
Q.1.		Attempt any SIX of the following:	12 Marks
a)	i)	**Draw V-I characteristic of P-N junction diode**	
	Sol.		02 marks
	ii)	**State types of real time mechatronics system.**	
	Sol.	**Hard real-time**: meeting deadlines may cause catastrophic consequences Examples: Airbags, ABS **Soft real-time:** meeting deadlines is desirable for performance reasons, but missing them is not critical. Examples: command interpreter of the user interface	01 mark 01 mark
	iii)	**What is rectifier? How are they classified**	
	Sol.	It is a circuit which converts AC voltage into DC voltage. **Classification**	01 mark

		Half wave rectifer Full wave rectifier Bridge rectifier.	**01 mark**
	iv)	**Sketch pin diagram of IC555 and label all pins.**	
	Sol.		**02 mark**
	v)	**Draw the logical symbol of 4:1 multiplexer.**	
	Sol.		**02 mark**
	vi)	**What is mechatronics?**	
	Sol.	**Mechatronics** is a branch of engineering that focuses on designing, manufacturing and maintaining products that have both mechanical and electronic components.	**02 mark**
	vii)	**List any four applications of Op-amp.**	
	Sol.	- Adder - Subtractor - Current to voltage converter -Voltage to current converter - Voltage follower - Integrator -Differentiator -Active Filter	**1/ 2 mark each**

		-Voltage comparator	
	viii)	**Draw logical symbol of 2:1 multiplexer and write its truth table.**	
	Sol.	 (a) S | Y 0 | I_0 1 | I_1 (b)	**01 mark** **01 mark**
b)		**Attempt any <u>TWO</u> of the following:**	**08 Marks**
	i)	**What is filter? List types of filter. Draw circuit diagram of any one type.**	
	Sol.	**Rectifier filter** is an electronic circuit that removes ripple or unwanted AC signal components from the output of a **Rectifier**. **Types -** Series Inductor filter Shunt capacitor filter L-C type filter Π - type filter **Circuit - LC type filter** 	**01 mark** **01 mark** **02 Mark**
	ii)	**Why multistage amplifier circuit is used? List out any two coupling methods used for multistage amplifier.**	
	Sol.	**The multistage amplifier is used for** - To achieve higher input impedance - To achieve higher Gain - To achieve Low output impedance **Coupling**	**02 marks**

		Direct coupling RC coupling Transformer coupling	**02 marks**
	iii)	**Draw the circuit diagram of inverting amplifier. Calculate RF if gain is 10 and R1 = 1.5 KΩ**	
	Sol.	 A = RF / R1 RF = A . R1 = 10 x 1.5 KΩ **RF = 15 KΩ**	**02 mark** **02 mark**
Q.2.		**Attempt any <u>FOUR</u> of the following:**	**16 Marks**
	a)	**Compare HWR and FWR with respect to ripple factor efficiency.**	
	Sol.	HWR - Ripple factor - 1.21 Efficiency - 40.6% FWR - Ripple factor - 0.48 Efficiency - 81.2%	**02 marks** **02 marks**
	b)	**How BJT works as a switch?**	
	Sol.	In Bipolar Transistor as a Switch the biasing of the transistor, either NPN or PNP is arranged to operate the transistor at both sides of the " I-V " characteristics curves. The areas of operation for a transistor switch are known as the Saturation Region and the Cut-off Region**.** This means then that we can ignore the operating Q-point biasing and voltage divider circuitry required for amplification, and use the transistor as a switch by driving it back and forth between its "fully-OFF" (cut-off) and "fully-ON" (saturation) regions as shown below.	**02 mark for diagram** **2**





1. Cut-off Region
Here the operating conditions of the transistor are zero input base current (I_B), zero output collector current (I_C) and maximum collector voltage (V_{CE}) which results in a large depletion layer and no current flowing through the device. Therefore the transistor is switched "Fully-OFF".
2. Saturation Region
Here the transistor will be biased so that the maximum amount of base current is applied, resulting in maximum collector current resulting in the minimum collector emitter voltage drop which results in the depletion layer being as small as possible and maximum current flowing through the transistor. Therefore the transistor is switched "Fully-ON".

marks for explanation

c) Define oscillator. State barkhausens criteria for oscillation

Sol.

Definition -

Oscillator is an amplifier which does not have any input but it operates on the principle of positive feedback to generate an AC signal at its output.

02 mark

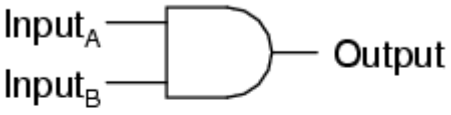
Barkhausen's Criteria - To obtain sustain oscillation the loop gain AB = 1 and phase shift of feedback signal should be 0^0 or 360^0 of an amplifier. it is called as barkshausen's criteria.

02 mark

d) Draw the logical symbol and write truth table for (a) AND (b) NOR gate.

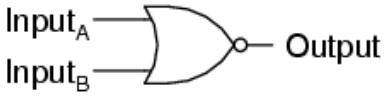
Sol.

2-input AND gate



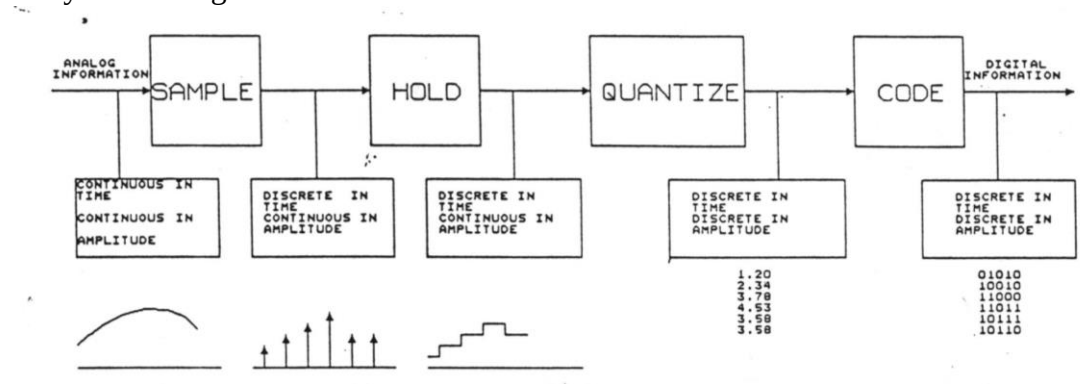
A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

2-input NOR gate

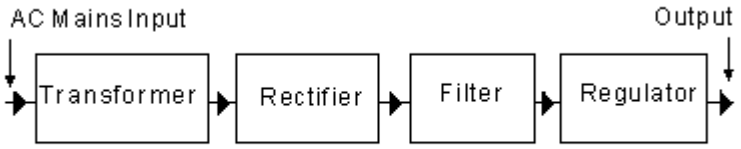


A	B	Output
0	0	1
0	1	0
1	0	0
1	1	0

01 mark each

	e)	**Draw block diagram of ADC and write function of each block**	
	Sol.	***Sample*** The **sample** block function is to sample the input analog signal at a specific time interval. The samples are taken in **continuous amplitude** & possess real value but they are **discrete** with respect to **time**. The sampling frequency plays important role in the conversion. So it is maintained at a specific rate. The sampling rate is set according to the requirement of the system. ***Hold*** The second block used in ADC is the '**Hold'** block. It has no function. It only holds the sample amplitude until the next sample is taken. The hold value remains unchanged till the next sample. ***Quantize*** This block is used for **quantization**. It converts the analog or continuous amplitude into discrete amplitude. The on hold continuous amplitude value in hold block goes through '**quantize'** block & becomes **discrete** in **amplitude**. The signal is now in digital form as it has **discrete time** & **discrete amplitude**. ***Encoder*** The **encoder** block converts the digital signal into **binary form** i.e. into bits. As we know that the digital devices operate on binary signals so it is necessary to convert the digital signal into the binary form using the Encoder. 	**02 mark** **2 mark**
	f)	**Explain the criteria for the selection of PLC for an application.**	
	Sol.	PLC selection criteria consists of: * System (task) requirements. * Application requirements. * What input/output capacity is required? * What type of inputs/outputs are required? * What size of memory is required? * What speed is required of the CPU? * Electrical requirements. * Speed of operation. * Communication requirements. * Software. * Operator interface. * Physical environments. **System requirements** * The starting point in determining any solution must be to understand what is to be achieved.	**04 mark**

		* The program design starts with breaking down the task into a number of simple understandable elements, each of which can be easily described. **Application requirements** * Input and output device requirements. After determining the operation of the system, the next step is to determine what input and output devices the system requires. * List the function required and identify a specific type of device. * The need for special operations in addition to discrete (On/Off) logic. * List the advanced functions required beside simple discrete logic. **Electrical Requirements** The electrical requirements for inputs, outputs, and system power; When determining the electrical requirements of a system, consider three items: • Incoming power (power for the control system); • Input device voltage; and • Output voltage and current. **Speed of Operation** How fast the control system must operate (speed of operation). When determining speed of operation, consider these points: – How fast does the process occur or machine operate? – Are there "time critical" operations or events that must be detected? – In what time frame must the fastest action occur (input device detection to output device activation)? – Does the control system need to count pulses from an encoder or flow-meter and respond quickly? **Communication** If the application requires sharing data outside the process, i.e. communication. Communication involves sharing application data or status with another electronic device, such as a computer or a monitor in an operator's station. Communication can take place locally through a twisted-pair wire, or remotely via telephone or radio modem. **Operator Interface** If the system needs operator control or interaction. In order to convey information about machine or process status, or to allow an operator to input data, many applications require operator interfaces. Traditional operator interfaces include pushbuttons, pilot lights and LED numeric display. Electronic operator interface devices display messages about machine status in descriptive text, display part count and track alarms. Also, they can be used for data input. **Physical Environment** The physical environment in which the control system will be located. Consider the environment where the control system will be located. In harsh environments, house the control system in an appropriate IP-rated enclosure. Remember to consider accessibility for maintenance, troubleshooting or reprogramming.	
Q.3.		**Attempt any <u>FOUR</u> of the following:**	**16 Marks**
	a)	**Draw block diagram of regulated power supply and give function of each block.**	
Sol.		A fluctuating DC voltage may result in an erratic operation of electronic devices and circuits. In order to avoid poor voltage regulation due to fluctuation in DC voltage, it is necessary to use a voltage regulator circuit in DC power supply.	**04 mark**

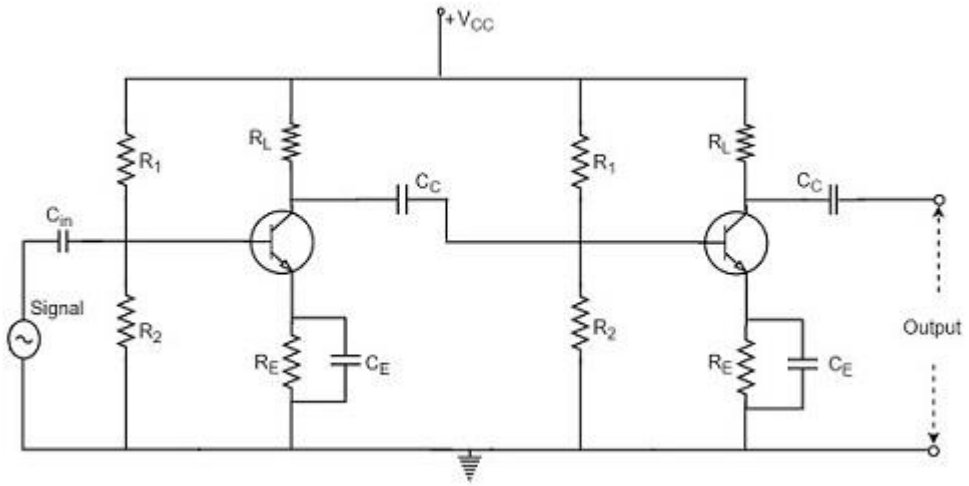


Regulated Power Supply

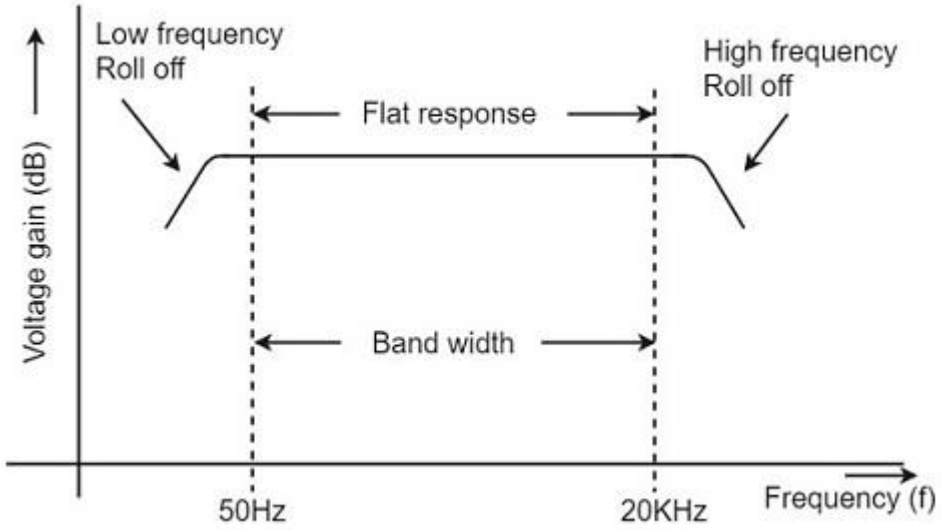
- The regulated DC power defines a DC power supply which maintains the DC voltage constant irrespective of AC input fluctuations in load resistance values.
- The block diagram of a regulated DC power supply is shown in above figure. It consists of rectifier, filter and voltage regulator circuits. The load may be connected across the voltage regulator.
- Commonly the bridge rectifier is used in regulated power supply. Its function is to convert the AC mains voltage to the rectified DC voltage.
- The voltage contains small amount of ripple the pulsating voltage is passed through the filter circuit. Its function is to bypass the filter.
- The pulsating opposes the AC fluctuations. This voltage is applied to the voltage regulator. Its function is to maintain the output DC voltage constant irrespective of fluctuations in AC mains voltage and variations in currents load. Thus, the regulated power supply gives the stable DC voltage across the load.

b) Draw two stage RC coupled amplifier and its frequency response.

Sol.



02 marks



02 marks

c) How Op-amp offers high input impedance? List out any four specifications of ideal Op-amp.

Sol.

Infinite – Input impedance is the ratio of input voltage to input current and is assumed to be infinite to prevent any current flowing from the source supply into the amplifiers input circuitry ($I_{IN} = 0$). Real op-amps have input leakage currents from a few pico-amps to a few milli-amps. **2 mark**

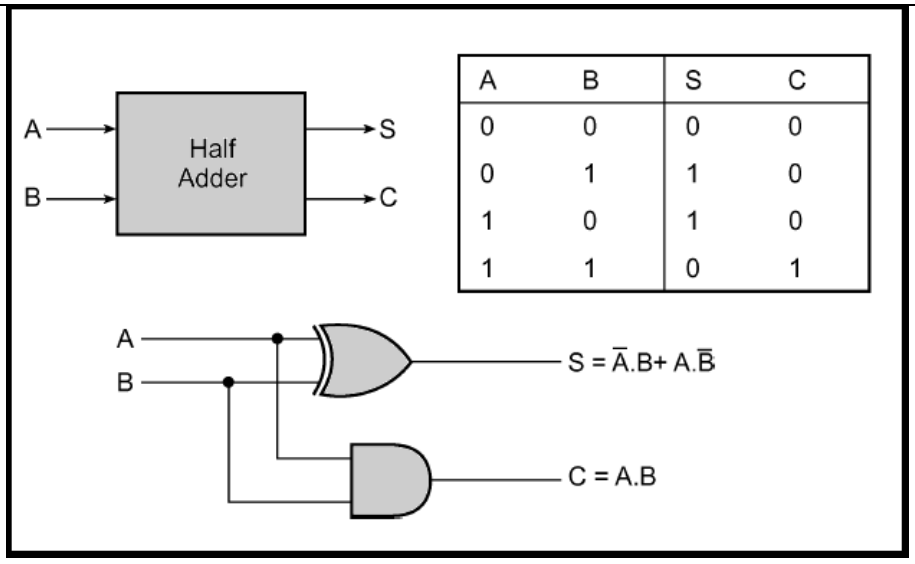
Specification

Infinite open-loop voltage gain
Infinite input impedance
Zero output impedance
Zero noise contribution
Zero DC output offset
Infinite bandwidth
Differential inputs that stick together

2 mark

d) Draw the half adder circuit. Also write its truth table.

Sol.



A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

02 marks for ckt.

02 marks of TT

e) Draw single channel DAS (Data Acquisition System). Give function of each block.

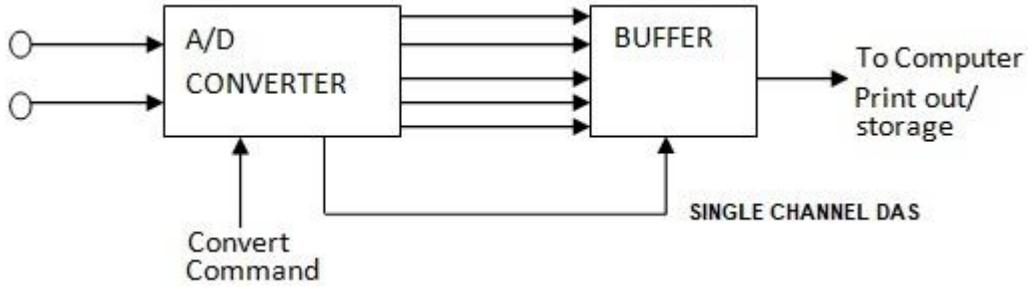
Sol.

Single Channel Data Acquisition System:

The block diagram of a single channel DAS is shown in Figure. It consists of a signal conditioner, analog to digital converter. The output of the signal conditioner is given to to the A/D converter. This circuit performs repetitive conversions at a free running rate.

02 marks diagram

The rate of conversion is internally determined. The digital outputs from the buffer are fed to a storage system or a printer or to a computer for further analysis.



Block Diagram of Single Channel DAS

02 marks explain

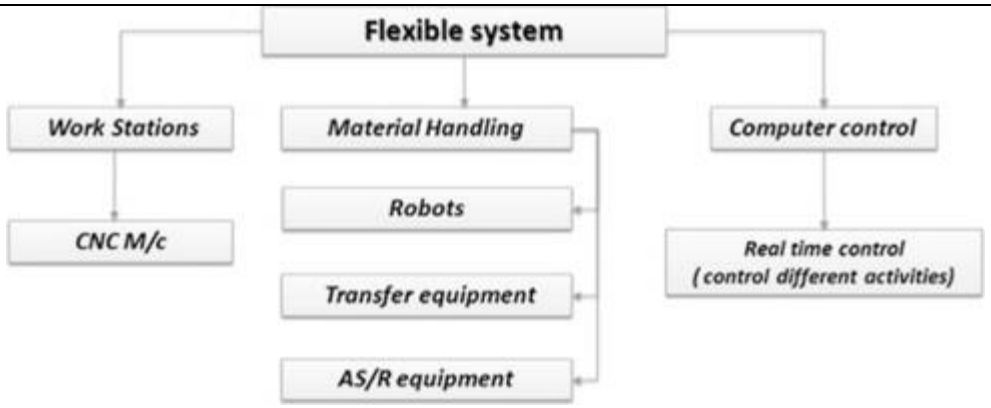
A known example of the single channel DAS is the digital panel meter [DPM]. There are two disadvantages in using a DPM as a DAS. They are:
It is slow and if the output is to be professed by digital equipment the BCD has to be changed into binary coding.
While it is free running the data from the A/D converter is transferred to the interface register. This is done at a rate determined by the DPM itself, than the commands beginning from the external interface.

Preamplification and Filtering:
Mostly low resolution [8/10 bit] A/D converters are manufactured with a single ended input. They have a normalized analog input range of the order of 5 -10 V, bipolar or unipolar. Amplifiers are used for signal levels which are low compared to the input requirement.
Amplifiers can be used to improve the level of the input signal to match the converter input. This provides optimum accuracy and resolution. An arrangement for preamplification is shown in Figure.
Differential amplifiers are necessary when the input signal levels are below one tenth of a mV, or when resolution of 14 bits or 16 bits. Instrumentation amplifiers are used when differential output is to be handled from a bridge network.

f) Draw the block diagram of FMS and explain the function of each block.

Sol.

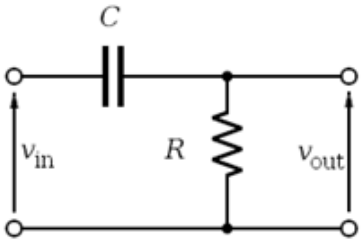
02 marks

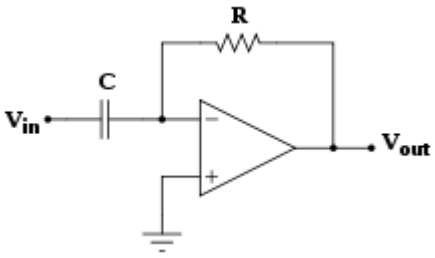
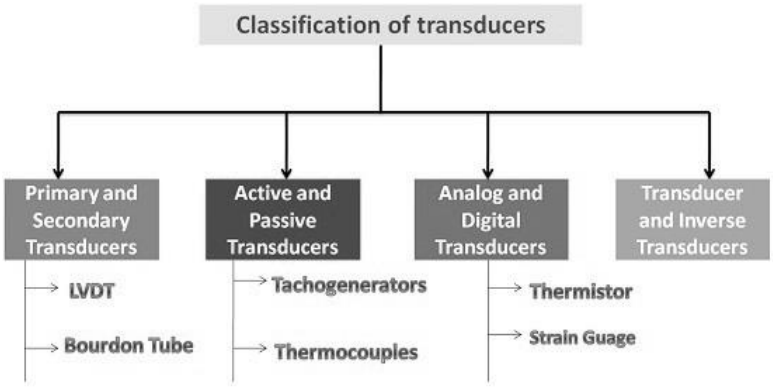


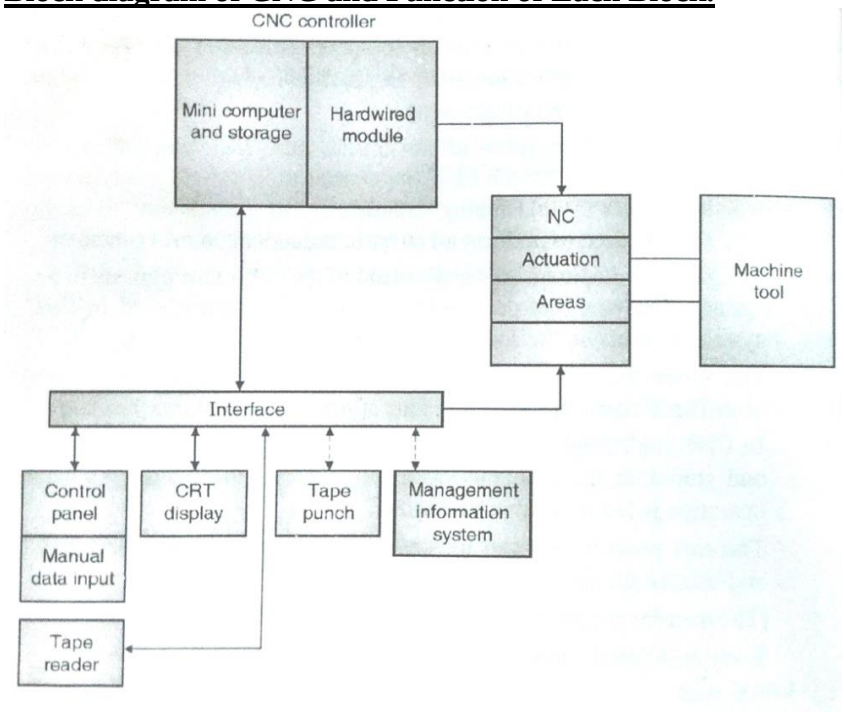
Flexible system

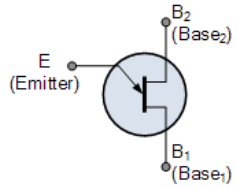
Flexible Manufacturing System (FMS) could be defined as a set of machines in which parts are automatically transported under computer control from one machine to another for processing.

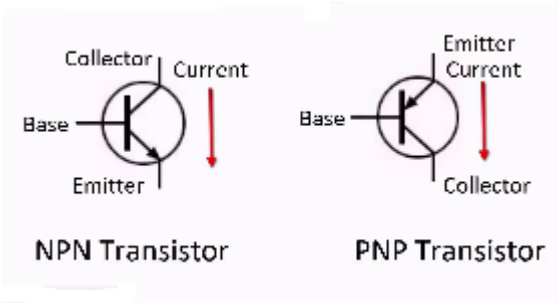
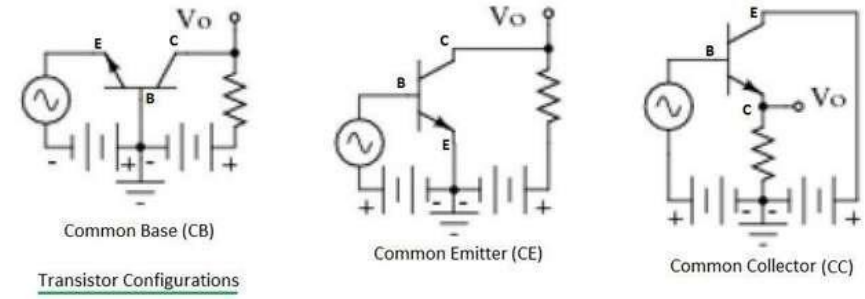
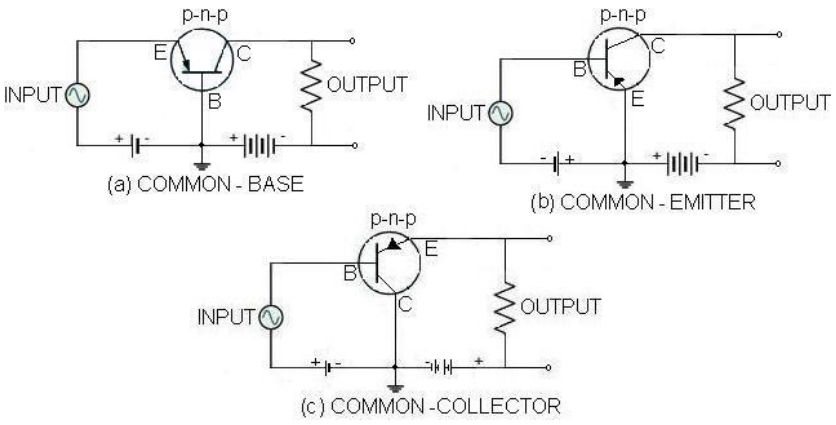
	Flexibility refers to the ability to respond effectively to changing circumstances. A flexible system is one which is able to respond to change. A flexible manufacturing system (FMS) should be capable of coping with both external changes (i.e. changes in the type, mix, processing requirements and quantity of job allocated to the system, changes in the training and skill of operators assigned to the system), as well as internal changes or disturbances (i.e. machine and material handling system breakdowns, variability in processing time, operator absences, quality problems, etc.). It mainly consist of three major parts Work station - The work station are used to manufacture actual job by using CNC machine. Material handling - robotics system is used to handle material and manufacturing, also to transfer equipments. Computer control - to control the overall operation computer based system is used which works in real time.	**02 marks**

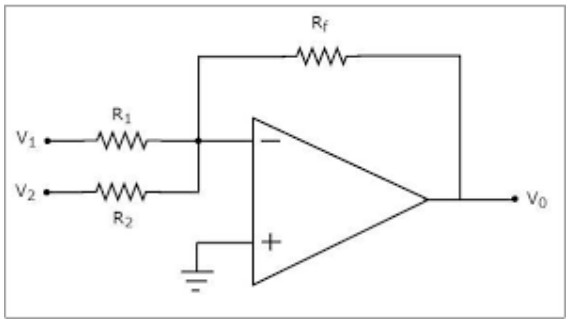
Q.No		Model Answer/Solution	Marks
4		**Attempt any FOUR of the following:**	**16**
	i)	Load Regulation and Line Regulation **Load regulation**:- It is the change in output voltage with respect to change in load Resistance. Ideally output voltage of regulator should be independent on load resistance but practically when load resistance changes output voltage is also changes. Load regulation always calculated in %. % Load Regulation $=(V_{NL}-V_{FL}/V_{NL})*100$ Where , V_{NL}= No load voltage and V_{FL}= full load voltage **Line regulation**:- It is the change in output voltage with respect to change in Input voltage. Ideally output voltage of regulator should be independent on load resistance but practically when input voltage changes output voltage is also changes. Load regulation always calculated in %. % Line Regulation = $(V_{O2}-V_{O1}/V_{IN2}- V_{IN1})*100$ Where , $V_{O2} - V_{O1}$ = Change in output voltage and $V_{IN2} - V_{IN1}$= Change in input voltage	02 02
	ii)	Thermal Runway and Use of Heatsink **Thermal Runway**:- It is process of self destruction of a transistor In a BJT when due to overheating or improper circuit design the collector current increases due to increase of beta value of transistor because beta increases with temperature the maximum collector current range of the transistor is exceeded and the transistor is damaged. It is the cyclic process. **USE OF HEAT SINK**:- To prevent transistor from damage heat sinks are used. Heat sinks are made up from metal(Aluminium), which dissipate the excessive heat of transistor.	02 02
	iii)	**Logic circuit of Differentiator:-** **Passive differentiator**  **Vout = d/dt (Vin)** **OR**	02 + 02

Q.No		Model Answer/Solution	Marks
4	**iii)**	**Continue..** **Active Differentiator**  **Vout = - RC d/dt (Vin)** **Student may draw any one Type.**	
	iv)	**Comparison Microprocessor with Microcontroller** Microprocessor: 1. Contains only CPU; RAM, ROM, I/O, timer are separately interfaced. 2. Designer decides on the amount of ROM, RAM and I/O ports. 3. High cost 4. General-purpose 5. High speed 6. Higher Power Consumption. ex – 8085, 8086 Microcontroller: 1. CPU, RAM, ROM, I/O and timer are all on a single chip 2. Fix amount of on-chip ROM, RAM, I/O ports 3. Low cost 4. Single-purpose 5. Low speed 6. Low Power Consumption. ex – 8051,AVR Any other suitable and relavent point may also considered.	01 * 4 = 04
	v)	**Classification of Transducers on the basis of signals:-** Transducers are classified as  	04

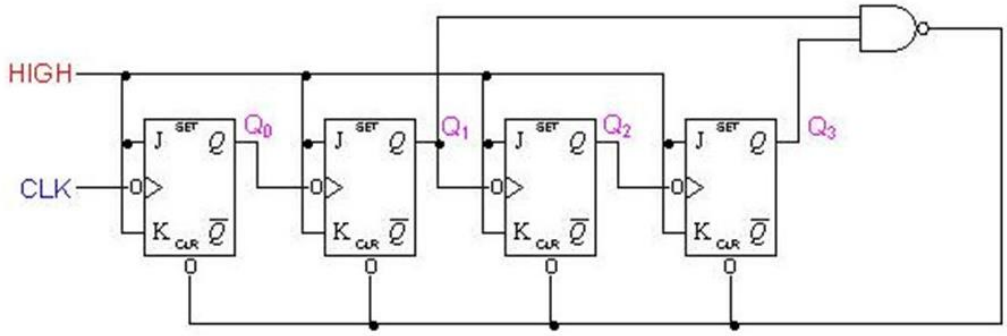
Q.No		Model Answer/Solution	Marks
4			
	vi)	**Block diagram of CNC and Function of Each Block.**  **Student may draw another suitable and relevant diagram, so if logic is correct then it is also considered.** **Explanation should be brief description of all blocks**	02 + 02
5		ATTEMPT ANY **FOUR** OF THE FOLLOWING.	16
	i)	Symbol and applications of UJT and ZENER diode	

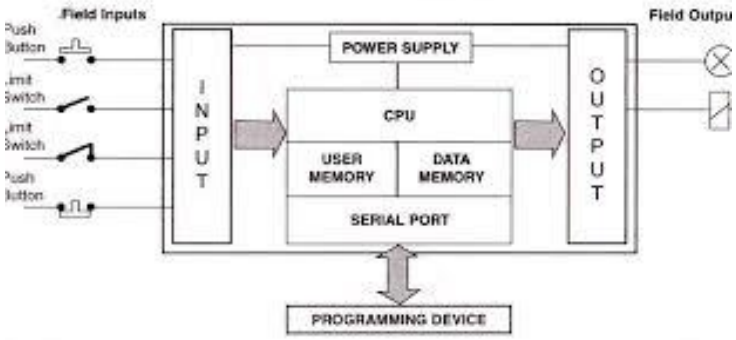
Symbol	Applications	
UJT  	1) Used to generate Saw tooth waveforms 2) Used to provide triggering pulses to SCR. Any other suitable and relevant application may also consider.	01 + 01
ZENER DIODE  	1) as a voltage regulator 2) as reference voltage source. Any other suitable and relevant application may also consider.	01 + 01

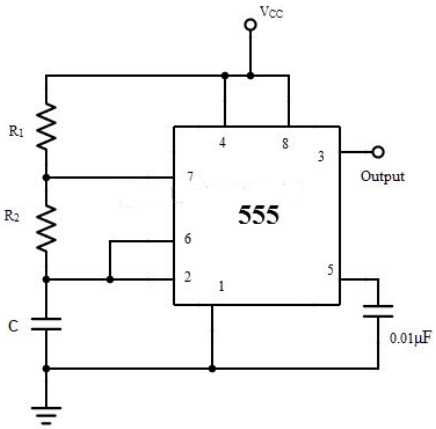
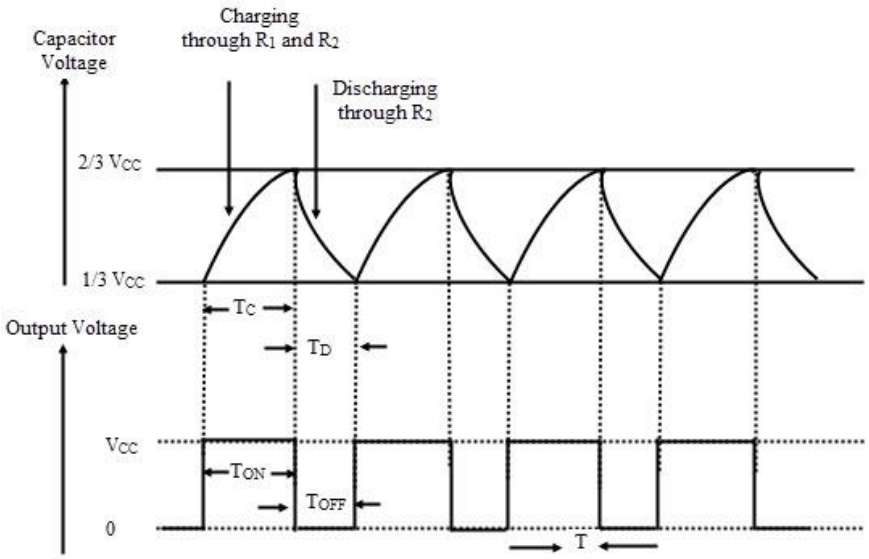
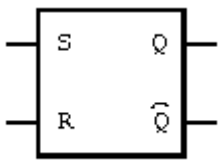
Q.No		Model Answer/Solution	Marks
5			
	ii)	**Symbol of NPN and PNP transistor:-** 	01
		Configuration of NPN and PNP transistor. 1) Common Base configuration (CB) 2) Common Emitter configuration (CE) 3) Common Collector configuration (CC)	+ 01
		NPN Configurations  Transistor Configurations	+ 01
		PNP Configurations 	+ 01
		The question is asked is quit confusing to the students because there are 2 types of transistor and each has 3 configurations, so total combination becomes 6 diagrams. So depending upon student approach provide marks uniformly.	

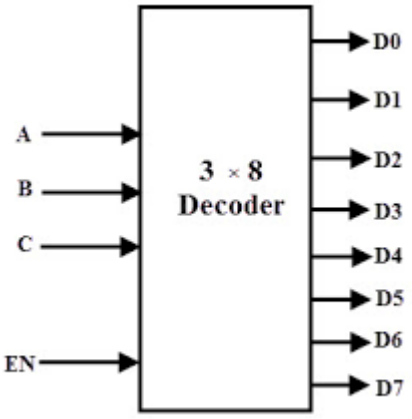
Q.No		Model Answer/Solution	Marks
5			
	iii)	**Op-Amp as an Adder with Waveforms**  **Consider $R_f = R_1 = R_2$** $Vo = -(R_f/R_1)V_1-(R_f/R_2)V_2$ $Vo = -(V_1 + V_2)$ **Note:-**Waveforms are asked in the question, but input signal is not mentioned whether AC (sine wave) or DC. So students may draw as per their understanding with Sine wave, square wave, triangular wave or DC signal. Only while assessing please check logic and output must be in negative side (below 0 level) because opamp is operated in inverting mode. Students may draw adder using Non inverting configuration so at that time output is in positive side(above 0 level)	02 01 01 (W/F)
	iv)	**Construction of Decade counter using T Flipflop** **Decade counter:-** Will count 10 clock pulses. So no. of flip-flops required are $2^N >= 10$ Therefore no. of flip-flops are = 4 (four) But 4 flip-flops will count total 2^4 =16 clock pulses so we required external logic circuit to eliminate remaining 6 clock pulses. Count sequence **clk 0-9 total 10 clock pulses.**	

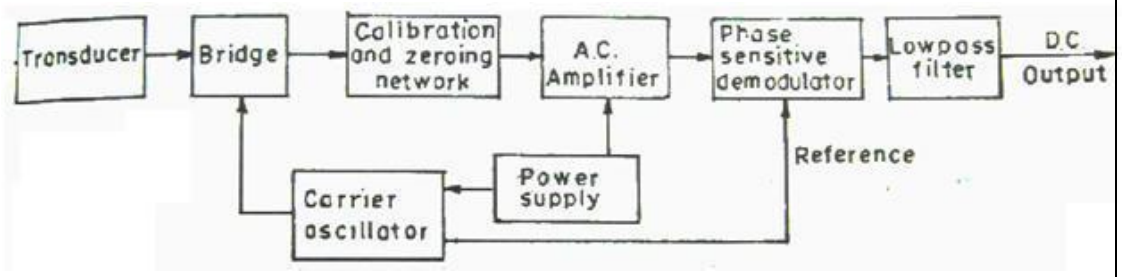
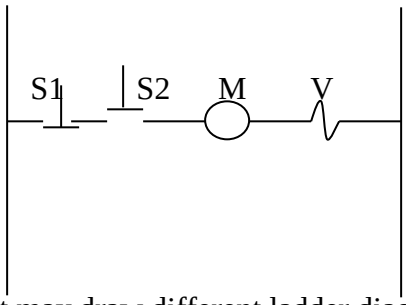
Clk	Q_3	Q_2	Q_1	Q_0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0

Q.No		Model Answer/Solution	Marks
5		**continue**	
	iv)	**Continue……** **One NAND gate is used with input 'Q_3' and 'Q_1' and output connected to Clear input of all Flip-flops and flip-flops are reset and again start counting from 0000.** 	04
	v)	**Data logger and its Applications:-** A **data logger** (also **datalogger** or **data** recorder) is an electronic device that records **data** over time or in relation to location either with a built in instrument or sensor or via external instruments and sensors. Increasingly, but not entirely, they are based on a digital processor (or computer). **Applications of Data logger:-** **Applications of data logging include: (any 4)** . ➢ Unattended gas pressure recording. ➢ Road traffic counting. ➢ Measure temperatures (humidity, etc.) of perishables during shipments: Cold chain.[1] ➢ Measure variations in light intensity. ➢ Process monitoring for maintenance and troubleshooting applications. ➢ Process monitoring to verify warranty conditions ➢ Wildlife research with pop-up archival tags ➢ Tank level monitoring. ➢ Environmental monitoring. ➢ Vehicle Testing (including crash testing) ➢ Motor Racing ➢ Monitoring of relay status in railway signalling. ➢ Temperature, humidity and power use for heating and air conditioning efficiency studies. ➢ Water level monitoring for groundwater studies. ➢ Digital electronic bus sniffer for debug and validation	02 ½*4 = 02

Q.No		Model Answer/Solution	Marks
5		**continue**	
	vi)	**PLC and its Architecture:-** PLC:- means programmable logic control. or PLC:-Programmable Logic Controller (PLC) is a digital computer used for the automation of various electro-mechanical processes in industries. These controllers are specially designed to survive in harsh situations and shielded from heat, cold, dust, and moisture etc. PLC consists of a microprocessor which is programmed using the computer language. **Architecture of PLC:-**  	(01) or 02 (03) or 02
6		ATTEMPT ANY **FOUR** OF THE FOLLOWING.	16
	i)	**Applications of Seven Segment display and Opto-coupler.** **Applications of Seven Segment display.** ➢ Bank token Counters ➢ Counting System ➢ Digital Clock ➢ Digital Stop Watches. ➢ Sensor controlled counters. ➢ Object counter Any other suitable and relevant point may also considered. **Applications of Opto-coupler.** ➢ To provide isolation between high power and low power circuits. ➢ Opto-couplers include microprocessor input/output switching, ➢ DC and AC power control. ➢ PC communications. ➢ Signal isolation. ➢ Power supply regulation which suffer from current ground loops. Any other suitable and relevant point may also considered	02 02

Q.No		Model Answer/Solution	Marks
6			
	ii)	**Astble multivibrator using IC 555 and its waveforms:-**	
			02
			02
	iii)	**Block diagram of SR flipflop and its Truth table:-**	
			02
		S R Q $\overline{Q}$ 0 0 no change 0 1 0 1 1 0 1 0 1 1 undefined	02

Q.No		Model Answer/Solution	Marks
6			
	iv)	**Decoder and 3:8 decoder with its Truth table:-** A **decoder** is a circuit that changes a code into a set of signals. It is called a decoder because it does the reverse of encoder.	01
		3:8 Decoder  	02
		Truth Table of 3:8 Decoder **Truth Table of a 3-to-8-Line Decoder** Inputs: x y z; Outputs: D_0 D_1 D_2 D_3 D_4 D_5 D_6 D_7 0 0 0 1 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 1 0 0 0 1 0 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 1 0 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 0 0 0 0 0 1 0	01
	v)	**Signal Conditioing and AC signal conditioner** **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.	01

Q.No		Model Answer/Solution	Marks
6			
	v)	**Continue,,,** **Block Diagram of AC signal Conditioning**  Student may draw other relevant block diagram and explain. So explanation of each block is expected.	02 01
	vi)	**Ladder diagram of start-stop logic with one input push buttonfor start and one push button for stop and one output for motor to activat 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	04

End of model solution