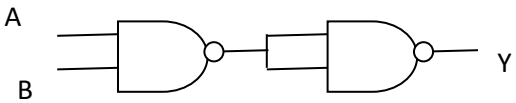
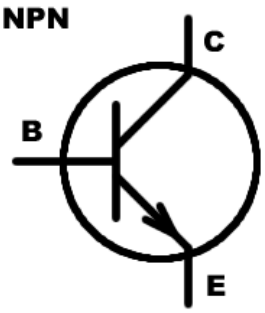
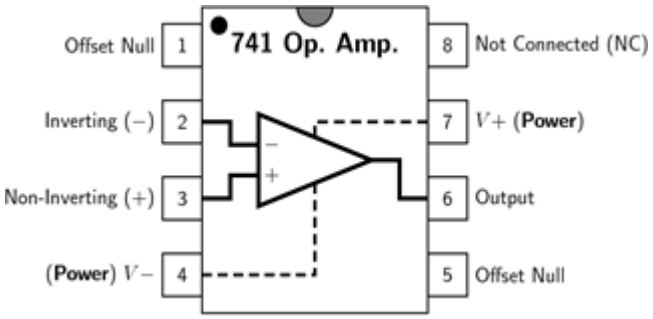
WINTER – 19 EXAMINATION

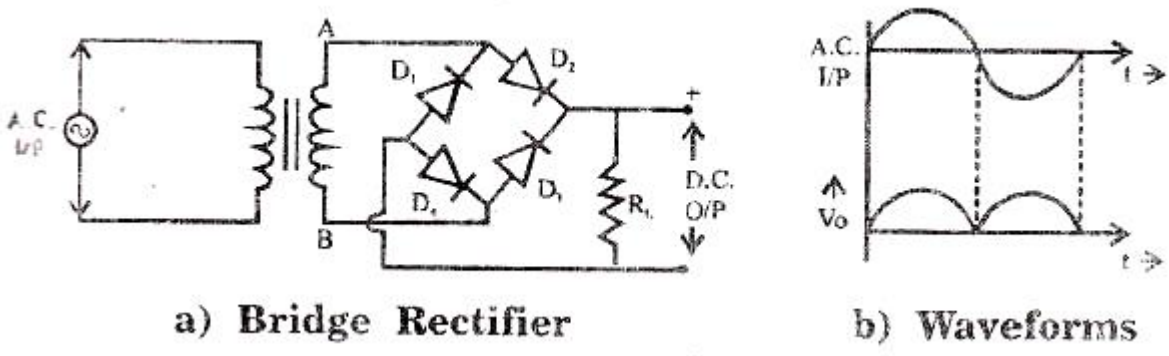
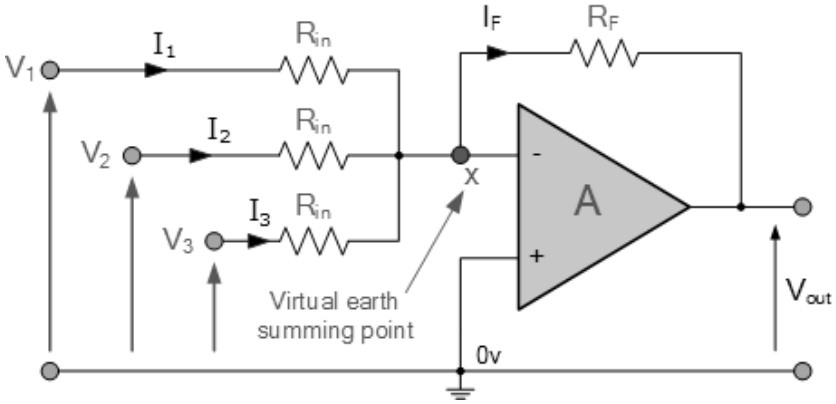
Subject Name:Basic Electronics & Mechatronics **Model Answer** Subject Code: 17302

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.	Sub Q. N.	Answer	Marking Scheme
1A	**a**	**Give the speciality of zener diode. State its 2-3 applications** **Speciality -** This diode can keep breakdown voltage constant across it. It is used in reverse bias. **Applications - Zener diodes** voltage regulation as reference elements surge suppressors switching applications clipper circuits.	**1 M each**
	B	**Why NAND and NOR gate are called as universal gate? Draw AND gate using NAND gate only.** **Universal gate -** All basic gates functionality can be implemented using NAND and NOR gate hence these gates are called as universal gates. AND gate using NAND gate  	**1 m** **1 m**
	C	**Draw symbol of NPN transistor and state three configurations of transistor (BJT)**	**1 mark**

		 **Configuration -** Common Emitter Common Collector Common Base	**1 mark**
	d	**Define counter. State four applications of counter.** **Counter -** The circuit which counts number of clock pulses is called as counter. **Applications -** Processor Real time clock Calculator Batch counter	**1 mark** **1 mark**
	e	**Draw pin diagram of Op-Amp IC-741.** 	**2 marks**
	f	**Give two examples of :** **(i) Electrical transducer** Voltage measurement Temperature measurement Strain measurement **(ii) Mechanical Transducer** Pressure measurement Force measurement Velocity measurement	**1 mark** **1 mark**
	g	**State important specification parameters of ADC (any two)** Accuracy Resolution	

		Linearity Conversion time Settling time stability	**2 marks**
	h	**List various types of CNC machine** • CNC **Plasma Cutting** Machine. • CNC **Laser** Cutting Machine. • CNC Milling Machine. • CNC Router Machine. • CNC Lathe Machine.	**2 marks**
1 B	**a**	**Define rectifier. Draw circuit diagram and input-output waveforms of bridge type full wave rectifier** **Rectifier - This circuit convert AC signal into DC.**  **a) Bridge Rectifier** **b) Waveforms**	**Def - 1 m** **Ckt - 2m** **Wf - 1m**
	b	**Describe how Op-Amp is used as adder using circuit diagram and output voltage equation.** **Summing Amplifier Circuit**  In this simple summing amplifier circuit, the output voltage, (Vout) now becomes proportional to the sum of the input voltages, V_1, V_2, V_3, etc. Then we can modify the original equation for the inverting amplifier to take account of these new inputs thus:	**Dia - 2 mark** **Exp- 1 mark** **Equation- 1 mark**

$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{V2}{Rin} + \frac{V3}{Rin}\right]$$

$$\text{Inverting Equation: } Vout = -\frac{Rf}{Rin} \times Vin$$

$$\text{then, } -Vout = \left[\frac{R_F}{Rin}V1 + \frac{R_F}{Rin}V2 + \frac{R_F}{Rin}V3\right]$$

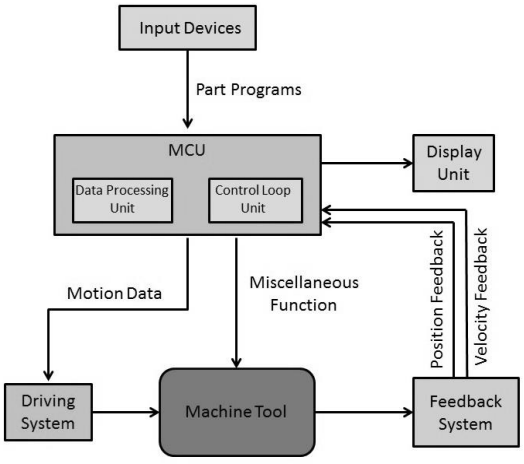
However, if all the input impedances, (R_{IN}) are equal in value, we can simplify the above equation to give an output voltage of:

Summing Amplifier Equation

$$-Vout = \frac{R_F}{R_{IN}}\left(V1 + V2 + V3 \ldots . etc\right)$$

We now have an operational amplifier circuit that will amplify each individual input voltage and produce an output voltage signal that is proportional to the algebraic "SUM" of the three individual input voltages V_1, V_2 and V_3. We can also add more inputs if required as each individual input "see's" their respective resistance, Rin as the only input impedance.
This is because the input signals are effectively isolated from each other by the "virtual earth" node at the inverting input of the op-amp. A direct voltage addition can also be obtained when all the resistances are of equal value and R*f* is equal to Rin.
Note that when the summing point is connected to the inverting input of the op-amp the circuit will produce the negative sum of any number of input voltages. Likewise, when the summing point is connected to the non-inverting input of the op-amp, it will produce the positive sum of the input voltages.

c **Draw simple block diagram of CNC machine and describe in short.**



Dia - 2marks

Exp- 2 marks

(i) Input Devices: These are the devices which are used to input the part program in the CNC machine. There are three commonly used input devices and these are punch tape reader,

magnetic tape reader and computer via RS-232-C communication.

(ii) Machine Control Unit (MCU): It is the heart of the CNC machine. It performs all the controlling action of the CNC machine, the various functions performed by the MCU are

- It reads the coded instructions fed into it.
- It decodes the coded instruction.
- It implements interpolation (linear, circular and helical) to generate axis motion commands.
- It feeds the axis motion commands to the amplifier circuits for driving the axis mechanisms.
- It receives the feedback signals of position and speed for each drive axis.
- It implements the auxiliary control functions such as coolant or spindle on/off and tool change.

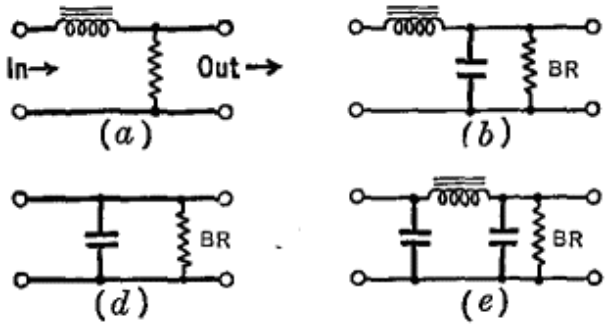
(iii) Machine Tool: A CNC machine tool always has a slide table and a spindle to control of the position and speed. The machine table is controlled in X and Y axis direction and the spindle is controlled in the Z axis direction.

(iv) Driving System: The driving system of a CNC machine consists of amplifier circuits, drive motors and ball lead screw. The MCU feeds the signals (i.e. of position and speed) of each axis to the amplifier circuits. The control signals are than augmented (increased) to actuate the drive motors. And the actuated drive motors rotate the ball lead screw to position the machine table.

(v) Feedback System: This system consists of transducers that acts like sensors. It is also called as measuring system. It contains position and speed transducers that continuously monitor the position and speed of the cutting tool located at any instant. The MCU receives the signals from these transducers and it uses the difference between the reference signals and feedback signals to generate the control signals for correcting the position and speed errors.

(vi) Display Unit: A monitor is used to display the programs, commands and other useful data of CNC machine.

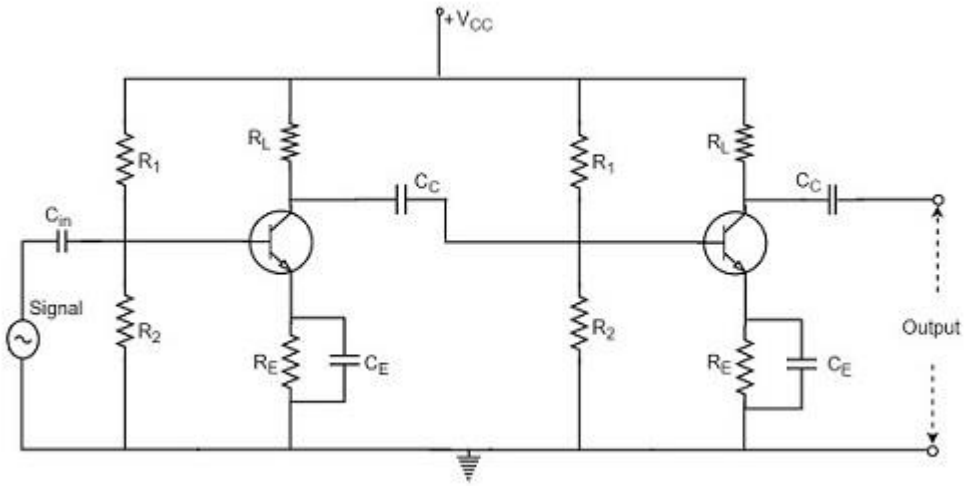
2	**a**	**Name the circuit used in rectifier to minimize ripple. List the types of this circuit with simple circuit diagram.**	**Def- 1 mark**
		Rectifier filter is an electronic circuit that removes ripple or unwanted AC signal components from the output of a **Rectifier**.	**Types - 3 makrs**
		Types -	
		(a) Series Inductor filter (d) Shunt capacitor filter (b) L-C type filter (e) Π - type filter	



b **Compare LED and Photo diode with four points** — **4 marks**

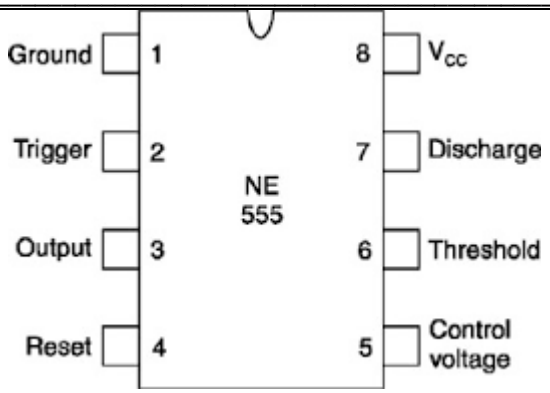
Sr. No.	Parameters	LED (Light Emitting Diode)	Photodiode
1	Definition	Two terminal device which converts electrical energy into light energy.	Two Terminal Device which converts light energy into electrical energy.
2	Working Principle	Works on the principle of Electro-luminance.	Works on the principle of Photoconduction.
3	Semiconductor used	Gallium Arsenide Phosphide (GaAsP) or Gallium Phosphide (GaP)	Germanium and Silicon
4	Biasing Mode	Forward Biased Only	Reversed Biased Only
5	Problem of Leakage Current	No leakage current	Reverse saturation current is significant. Dark current flows when no light rays are incident on it.
6	Applications	Indicator in AC circuit, Alphanumeric and Numeric display etc.	Switching, high speed counting, ac coupled signaling etc.

c **Draw circuit diagram of two stage RC coupled amplifier using BJT and state function of each component in short** — **Dia - 2marks** — **Function- 2 marks**



BJT - To amplify input signal.
R1 & R2 = Biasing resistor to provide DC biasing voltage
RE = Emitter resistor to control gain
RL = Load resistor to carry load current
Cin = Cout = Coupling capacitors to block DC
CE = emitter bypass resistor

d **Draw a labelled pin diagram of IC-555 and state function of each pin in short** — **Dia- 2 marks**



Pin	Name	Purpose
1	GND	Ground reference voltage, low level (0 V)
2	TRIG	The OUT pin goes high and a timing interval starts when this input falls below 1/2 of CTRL voltage (which is typically 1/3 *V*cc, CTRL being 2/3 *V*cc by default if CTRL is left open). In other words, OUT is high as long as the trigger low. Output of the timer totally depends upon the amplitude of the external trigger voltage applied to this pin.
3	OUT	This output is driven to approximately 1.7 V below +*V*cc, or to GND.
4	RESET	A timing interval may be reset by driving this input to GND, but the timing does not begin again until RESET rises above approximately 0.7 volts. Overrides TRIG which overrides threshold.
5	CTRL	Provides "control" access to the internal voltage divider (by default, 2/3 *V*cc).
6	THR	The timing (OUT high) interval ends when the voltage at threshold is greater than that at CTRL (2/3 *V*cc if CTRL is open).
7	DIS	Open collector output which may discharge a capacitor between intervals. In phase with output.
8	*V*cc	Positive supply voltage, which is usually between 3 and 15 V depending on the variation.

Function- 2 marks

e **Compare microprocessor and microcontroller with help of four points. Give two application of each.**

Compare - 3 marks

Application

Microprocessor - Computer, Mobile phone, calculator

Microcontroller - washing machine, microwave oven

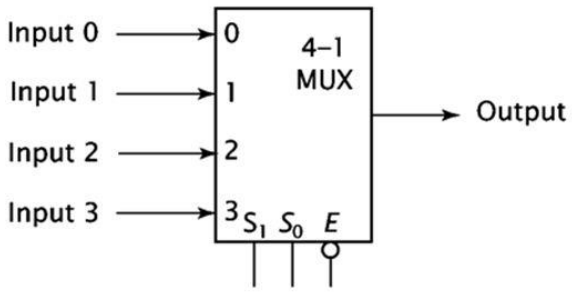
Application - 1 mark

Microprocessor	Microcontroller
Do not have inbuilt RAM or ROM	Inbuilt RAM or ROM
Do not have inbuilt Timer	Inbuilt Timer
I/O Ports are not available, it required 8255 for interfacing	I/O Ports are available
Do not have inbuilt serial port, it required extra devices like 8251.	Inbuilt serial port
Program and data are stored in same	Separate memory to store

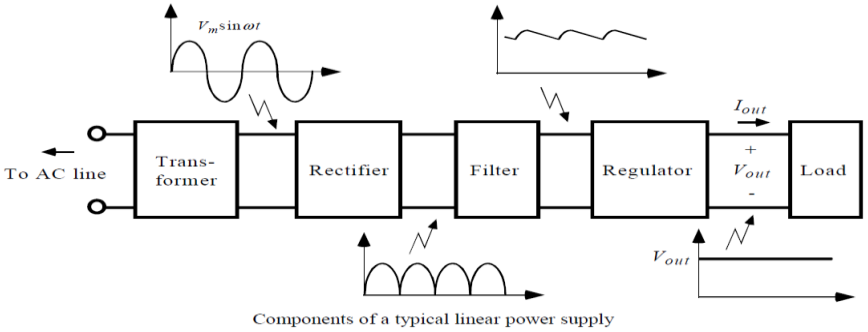
			memory.	program and data	
			Boolean operation is not possible directly	Boolean operation is possible	
			Many instruction to access external memory access.	Few instructions for external memory access	
			Less multifunction pins on the IC	Many multifunction pins on the IC	
	f	**Describe ADC and DAC w.r.t. their needs and list two applications of each.** ADC An analog to digital converter (**ADC**), converts any analog signal into quantifiable data, which makes it easier to process and store, as well as more accurate and reliable by minimizing errors. Application - Digital multimeter, Digital oscilloscope DAC Digital to analog converter, converts Digital signal into equivalent analog signal, hence any analog circuit can work with digital system Application - Microcontroller, washing machine			**2 marks each**
3	**a**	**Compare intrinsic and extrinsic semiconductor with the help of four important points.**			**4 marks**

S.No	Intrinsic Semiconductor	Extrinsic Semiconductor
1.	Semiconductor in a pure form is called intrinsic semiconductor.	Semiconductor which are doped with impurity is called extrinsic semiconductor
2.	Here the change carriers are produced only due to thermal agitation.	Here the change carriers are produced due to impurities and may also be produced due to thermal agitation.
3.	They have low electrical conductivity.	They have high electrical conductivity.
4.	They have low operating temperature.	They have high operating temperature.
5.	At 0K, Fermi level exactly lies between conduction band and valence band.	At 0K, Fermi level exactly lies closer to conduction band in "n" type semiconductor and lies near valence band in "p" type semiconductor.
	Examples: Si,Ge,etc.	**Examples:** Si and Ge doped with Al, In,P,As etc

	b	**State the need of multistage amplifier. List the types of multistage amplifier and give two advantages of each type.** **The multistage amplifiers are needed for**	

		- To achieve higher input impedance - To achieve higher Gain - To achieve Low output impedance **Coupling** Direct coupling - Less complex, used for load which is in series. RC coupling - Noise free, High gain Transformer coupling - Good isolation, Good impedance matching	**2 marks** **2 marks**
	c	**State Barkhausen criteria for oscillations. List types of oscillator.** 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. Types - RC oscillator RC-Phase shift oscillator Wien bridge oscillator LC Oscillator Hartley oscilator Colpitts oscillator Crystal oscillator	**2 marks** **2 marks**
	d	**Define multiplexer. Draw logical symbol of 4:1 multiplexer with truth table and output logical equation** Multiplexer - it is a combinational circuit which selects one input from several inputs and connects it to the output. It is a circuit which has N-input and single output is called as multiplexer.  S_1 S_0 E | Output X X 1 | Z 0 0 0 | Input 0 0 1 0 | Input 1 1 0 0 | Input 2 1 1 0 | Input 3 Output = (s1'.s0'.Input0)+(s1'.s0.input1)+(s1.s0'.input2)+(s1.s0.input3)	**Def- 1m** **Symbol - 1m** **TT - 1marks** **Equ - 1mark**
	e	**Define transducer. State factors which are considered while selecting transducer for a particular application.**	**Def - 1mark**

		Transducer - It converts one form of signal into another form. A transducer is a device that is used to convert a physical quantity into its corresponding electrical signal. **Selection factors** • **Operating Principle :** The transducers are selected on the basis of operating principle it may be resistive, inductive, capacitive, optical etc. • **Operating range :** The range of transducer should be appropriate for measurement to get a good resolution. • **Accuracy :** The accuracy should be as high as possible or as per the measurement. • **Range :** The transducer can give good result within its specified range, so select transducer as per the operating range. • **Sensitivity :** The transducer should be more sensitive to produce the output or sensitivity should be as per requirement. • **Loading effect :** The transducer's input impedance should be high and output impedance should be low to avoid loading effect. • **Errors :** The error produced by the transducer should be low as possible. • **Environmental compatibility :** The transducer should maintain input and output characteristic for the selected environmental condition.	**Factors - 3 marks**
	f	**List various elements of mechatronic system and state 4-5 applications.** **Elements** • Sensors. • Actuators (Hydraulics, Phnumetics) • PLC, Micro controllers. • Electrical Motors. • Mechanical Couplings, Assembly & Gears. • Control Panel. **Applications** digitally controlled combustion engines, robots, automated guided vehicles home appliances such as dish washer and washing machines. automatic air conditioning systems unmanned aerial vehicles and automatic pilots.	**Elements - 2 marks** **Application 2 marks**
4		**ATTEMPT ANY FOUR**	**16**
	(a)	**Block diagram of regulated power supply and function of each block** **Figure shows block diagram of Regulated power supply**	



Components of a typical linear power supply

02

Function of each block:

1)Transformer: - converts higher as voltage to lower ac voltage with same frequency.

2)Rectifier: - converts ac signal into dc signal. Rectifiers are of different types.

i) Half wave rectifier

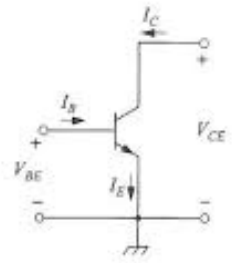
ii) full wave rectifier

3) Filter- filter is used to remove unwanted signals. Ac signal is removes and pure dc signal is passed to regulator block. **02**

4) Regulator: -used to provide constant output.

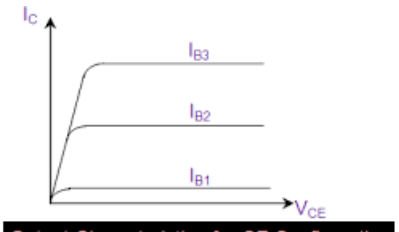
(b) **Circuit diagram of CE configuration for NPN transistor and its characteristic's.**

Circuit Diagram of CE configuration: -



02

Output characteristic's: -



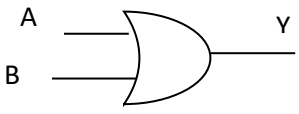
Output Characteristics for CE Configuration

02

(c) **Function of OR Gate its logical symbol and truth table.**

Function: - OR gate is used to perform logical addition. So used in adder subtractor and logic circuits where logical Oring is required. Used to implement SOP form equations. Also used in PLA logic. **01**

Logical symbol of OR gate :-



01

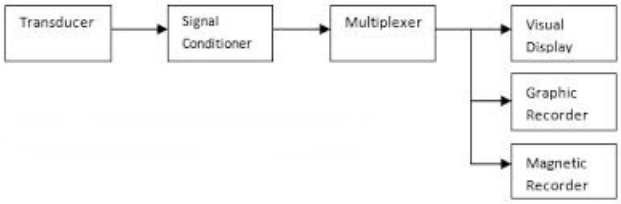
Truth table:-

Inputs		O/P
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

02

(d) **Data Acquisition System(DAS) : - (**Definition) - 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. **01**

Block Diagram of DAS : - **01**



Function of each block: -

Transducer – converts input physical quantity into required form.

Signal conditioner – Brings the signal into proper condition and provides signal to multiplexer.

Multiplexer – DAS may be of Singla Channel or Multi channel. For multi channel DAS mux is required to select the input.

Output – to output od DAS is provided in the form of display or plot or recoded in recorder. **02**

(e) **Any four selection Criteria of PLC and explanation of any one**

Selection criteria :-

To select PLC for any particular application following points are to be considered. **02**

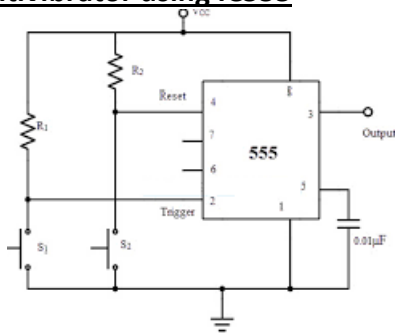
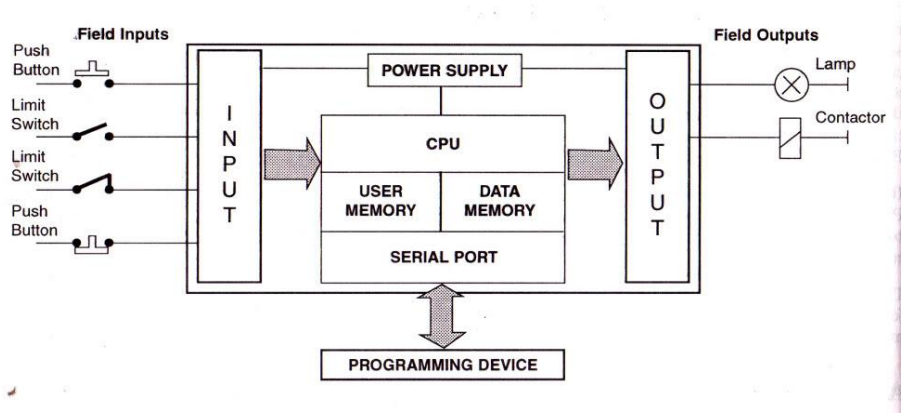
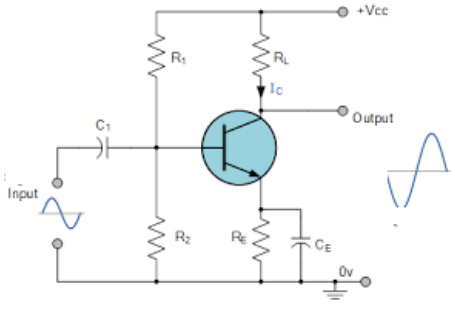
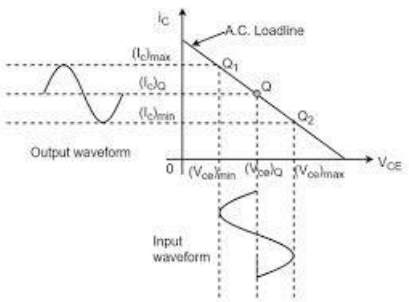
a) Type of PLC: Analog or Digital
b) Number of inputs and outputs to PLC
c) Operating voltage and operating current range
d) Scan time of PLC
e) Memory size of PLC
f) Type of memory of PLC
g) Type of programming
h) Reliability of PLC
i) Flexibility of PLC

(any other relevant and appropriate criteria may also considered)

Explanation of any one criterion – different Examinee may explain different criteria so if provide marks if explanation is suitable and relevant to that particular criteria. **02**

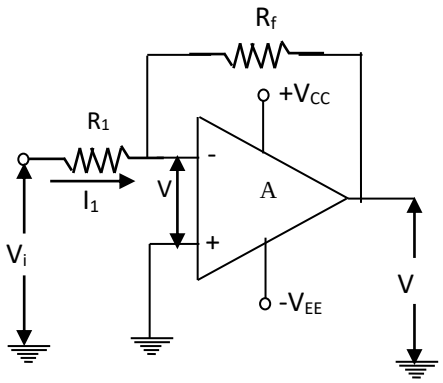
(f) **Definition of Bistable multivibrator and circuit of bistable multivibrator using IC555**

Definition – A multivibrator which has two stable states, one can be change to other when

		trigger pulse is applied, known as bistable multivibrator. **Circuit diagram of Bistable multivibrator using IC555** 	02 02
5		**ATTEMPT ANY FOUR**	16
	(a)	**Block diagram of PLC and input/output devices used for PLC**  **Input/output devices –** The input module has bank of terminals for physically connecting input devices, like push buttons, limit switches etc. to a PLC. the role of an input module is to translate signals from input devices into a form that the PLC's CPU can understand. The Output module also has bank of terminals that physically connect output devices like solenoids, motor starters, indicating lamps etc. to a PLC. The role of an output module is to translate signals from the PLC's CPU into a form that the output device can use.	02 01 01
	(b)	**BJT acts as an amplifier.**   Fig.shows BJT acts as an amplifier. When BJT is operated in CE configuration it will act as amplifer. The amplification factor is denoted by β (beta). Base is at input side and collector is at output side. Input current is very less and output current is high so transistor acts as an amplifier. In CE configuration transistor provides 180^0 phase shift between input and output	02 01 01

as shown in graph.

(c) **Circuit of inverting amplifier using opamp.** **02**



Inverting

Gain of Inverting amplifier with R_f =12Kohm and R_i=3Kohm

For inverting amplifier

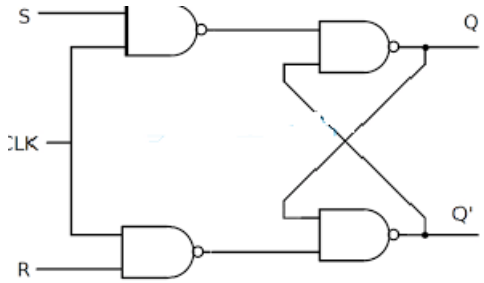
Gain = - R_f/R_i

Gain = - 12K/3K **02**

Gain = -4

-ve Sign indicated inverting mode.

(d) **Basic SR Flipflop using NAND gates.** **02**



Truth Table

Clk	R	S	Q	Q`	comments
0	X	X	0	1	FF NOT FUNCTIONING
1	0	0	0	1	NO CHANGE IN STATE
1	0	1	1	0	FF IS SET
1	1	0	0	1	FF IS RESET
1	1	1	1	1	ILLIGAL CONDITION NOT ALLOWED

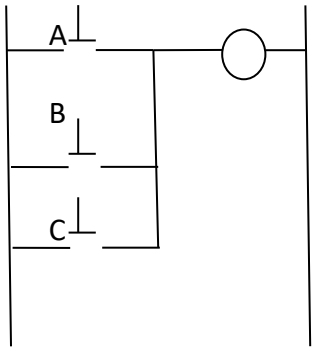
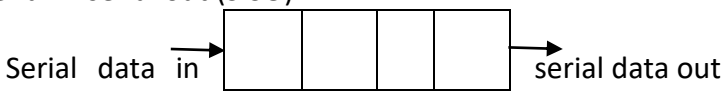
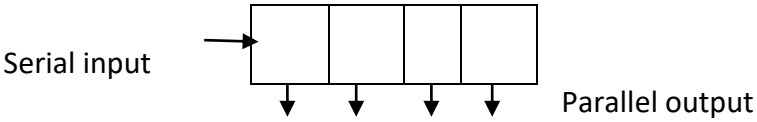
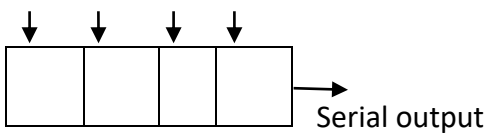
02

(e) **Comparison of BJT and FET**

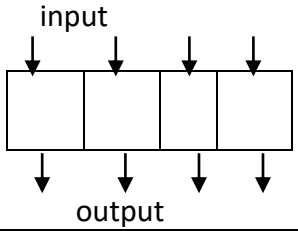
Parameter	BJT	FET
Control parameter	Current control device	Voltage control device
Input junction	Always forward biased	Always reversed biased
charge carriers	Electrons and holes both are carrying current	Either electrons or holes carry currents.
Noise	More noise	less noise
Terminals	Emitter, base collector	Source, Gate Drain
Any other suitable and relevant point		

01*4

=4

	(f)	**Active and Passive transducers with examples** **Active Transducer:-** A transducer which do not requires external energy source to convert signal from one form to another. Active transducers passes gain. e.g. Thermometer,Thermocuople, bourdon tubes, piezoelectric transducer etc… **Passive Transducer:-** A transducer which requires external energy sources while converting signal from one form to other form. Passive transducer passes loss. e.g. Thermistor, strain gauges, LVDT etc….	**01** **01** **01** **01**
6		**ATTEMPT ANY FOUR**	**16**
	(a)	**Ladder diagram for output Q to be ON when button A is ON or either button B or button C is ON** Output -Q, Input -A,B,C Output is high when any one switch is ON means OR operation. 	**04**
	(b)	**Shift Register:-** Shift Register is a group of flipflops used to shift data from one side to other side or to convert serial data into parallel or vice versa. Shift registers are of following types i) Serial in serial out (SISO)  ii) Serial in parallel out (SIPO)  iii) Parallel in serial out(PISO) Parallel input 	**04**

iv) Parallel in parallel out(PIPO)



(c) **Piezo-electric effect:-**

Piezoelectric Effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. The word Piezoelectric is derived from the Greek piezein, which means to squeeze or press, and piezo, which is Greek for "push"

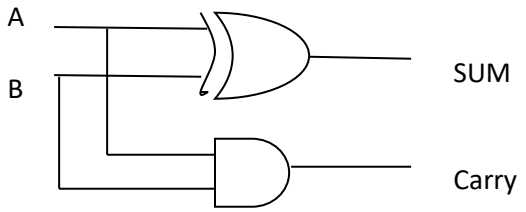
Features of Crystal Oscillator:- **02**

- 18pF of Load Capacitance
- Frequency Tolerance(Ɛf/f) range is ± 30ppm
- Frequency Temperature Stability range is ±50ppm
- Resonance Resistance 40ohms (max)
- Oscillation mode: Fundamental mode
- Shunt Capacitance less than 7pF
- Drive Level less than 100µW **02(any 4)**
- Operating Temperature Range: -20 to + 70°C
- Operable Temperature Range: -25 to + 85°C
- Storage Temperature Range: -55 to + 125°C
- Insulation Resistance: 500 M ohms

(d) **Half adder**

Half adder is an adder which performs addition of two bits.

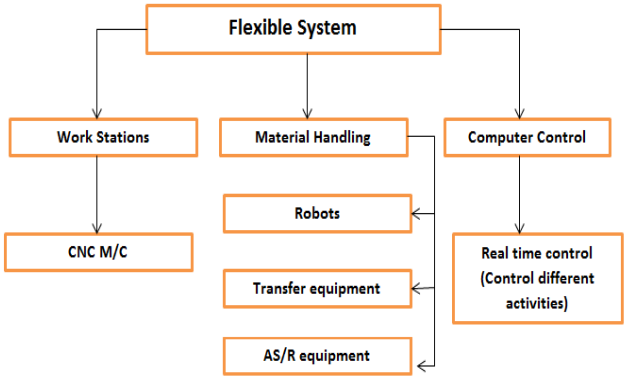
Logic circuit of Half adder **02**



Truth table- **02**

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

(e) **FMS-**



02

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**

(f) **Comparison of three configuration of BJT**

Parameter	Common Base(CB)	Common Emitter (CE)	Common collector (CC)
Input terminal	Emitter	Base	Base
Common terminal	Base	Emitter	collector
Output terminal	Collector	Collector	Emitter
Gain factor	Alpha(Ic/Ie)	Beta(Ic/Ib)	Gamma(Ie/Ib)

01*4

=04

Any other relevant point may also considered.

End