MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2005 Certified)
WINTER– 16 EXAMINATION
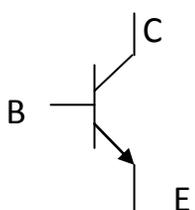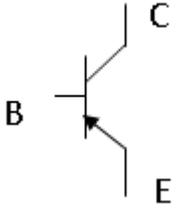**Model Answer**   Subject Code: | 17302

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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
1 a)	i)	**Semiconductor: -** A type of material whose resistivity lies in between conductor and insulator. Examples: Silicon, Germanium (½ mark for each example)	(1 Mark each for definition) & examples)
	ii)	Rectifier: A rectifier is an electronic circuit that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. Classification of rectifier: • Half wave rectifier • Full wave rectifier : Center tapped & Bridge rectifier	(1 Mark definition) (1 Mark Classification)
	iii)	**Symbol of NPN and PNP Transistor** NPN Transistor PNP Transistor	1 Mark for each symbol
	iv)	**Four Applications of Op-Amp** a) Adder b) Subtractor c) Integrator d) Differentiator e) Converters (Voltage-to-Current and Current-to Voltage) (Any other appropriate and relevant applications may also be considered to award the marks)	1 Mark for each application

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1a)	v)	**Logical symbol of 4:1 multiplexer**	2 Marks

	vii)	a) **Active Transducer:** The transducer which does not require external power supply for its operation is called as active transducer. (These transducers are self-powered.) b) **Passive Transducer:** The transducer which requires external power supply for its operation is called as active transducer. (These transducers are externally powered.)	1 Mark for each Definition
	vii)	**Definition of Mechatronics :** Mechatronics is a synergistic combination of precision engineering, electronic control and mechanic systems. It is the science, that exists at the interface among the other five disciplines:	2 Mark for Definition

	viii)	**Advantages of Mechatronics Any four**
		    1. Fast speed of response
		    2. High accuracy
		    3. More flexible
		    4. Overall cost is low
		(Any other appropriate and relevant advantages may also be considered to award the marks)
			1 /2 Mark for each advantage

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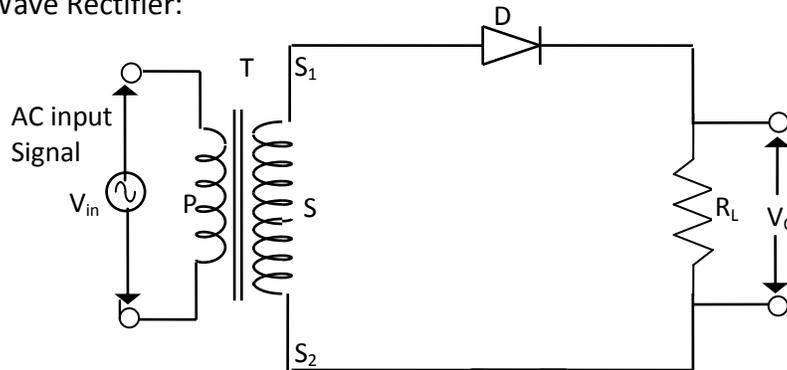| 1b)	i)	Half Wave Rectifier:	1Mark circuit diagram

Figure shows the circuit diagram of Half wave rectifier

Working of Half Wave Rectifer

Case I) During positive half cycle of input signal, secondary winding terminal S_1 becomes positive and S_2 negative. Hence diode D becomes forward biased and it conducts resulting to flow the current. Thus output voltage drops across load resistance R_L.

Case II) During negative half cycle of input signal, secondary winding terminal S_2 becomes positive and S_1 negative. In this case diode D becomes reverse biased and it do not conduct resulting to no flow of current.

In half wave rectifier diode D conducts only in positive half cycle.

Input-Output Waveforms of half wave rectifier

Marks column for the above section:
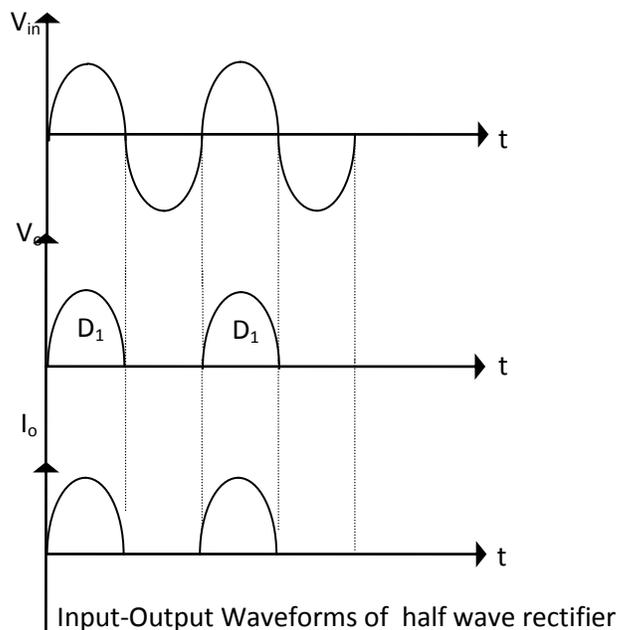
2Marks for circuit operation

I Mark for Waveforms

1b)	ii)	Features of ideal op-amp	1 mark for each feature with

1) The voltage gain A_v (open loop voltage gain) should be infinite (∞).
2) Input resistance R_i should be infinite (∞).
3) Output resistance R_o should be infinite (0).

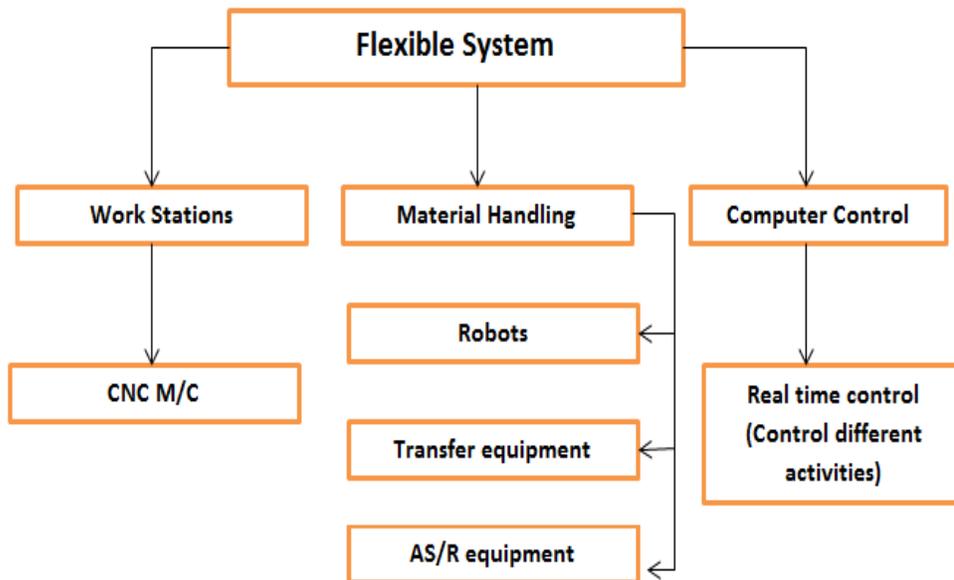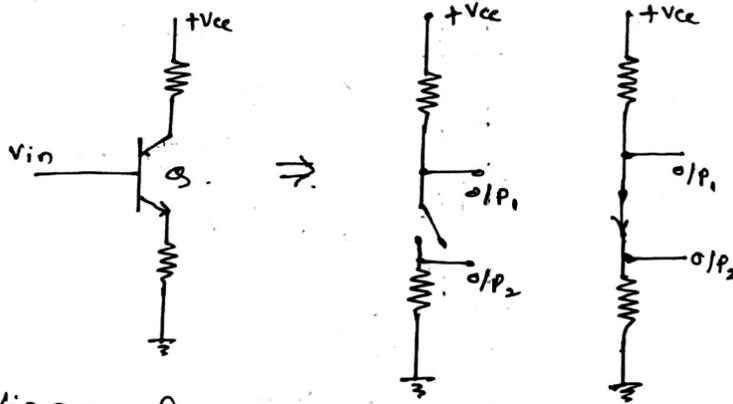|			
		4) Infinite bandwidth. 5) If $V_1 = V_2$ then $V_0 = 0$ i.e. zero offset. 6) High common mode rejection ratio i.e. CMRR should be infinite. 7) Infinite slew rate so that the changes in output voltage should occur simultaneously with change in input voltage. 8) Zero output voltage when input voltage is zero.	explanation
	iii)	Block diagram of FMS 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	2 Marks for Block diagram and 2 Marks for explanation
2	a)	**Need of Biasing Circuit** 1. to fix the operating point of the transistor. 2. To set proper value the zero signal collector current Ic 3. To set proper value of collector to emitter voltage Vce Biasing circuit required for faithful amplification. **Types of biasing circuits for Transistors** Base biasing [fixed bias] Base bias with collector feedback Base bias with Emitter feedback	2 Marks for need and 2Marks for types

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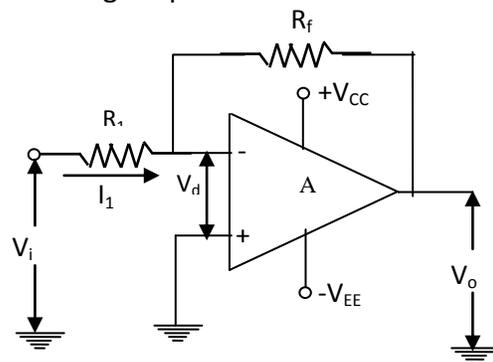|			
	b)	Voltage divider biasing Emitter bias BJT as Switch Transistor as a switch. $V_{in} = 0$ Transistor is off switch $V_{in} = +v$ Transistor is ON switch One may take o/p from collector or emitter	2 Marks for Circuit diagram and 2 Marks for explanation
2	c)	Circuit Diagram of Inverting Amplifier Inverting amplifier **Calculations of Rf:** Given: Gain $A_v = 10$; $R_1 = 1k\Omega$; Rf= ?	2 Mark for circuit diagram 2 Mark for calculations

The closed loop gain of inverting amplifier is given by;

$$A_v = \frac{V_o}{Vi} = -\frac{R_f}{R_1}$$ R_f = 10 kΩ; The negative sign indicates Inverting configuration
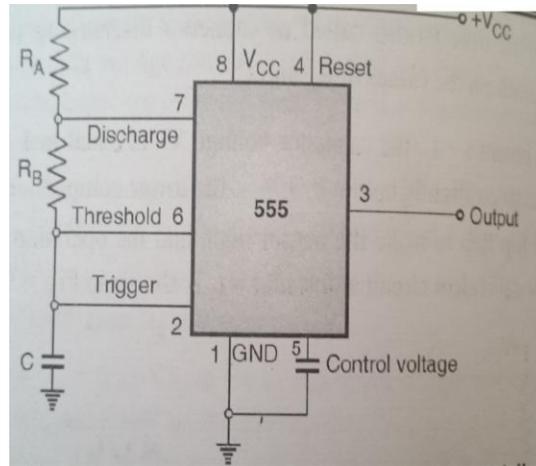
d) **Astable Multivibrator**

Fig. shows the circuit diagram of Astable Multivibrator using IC 555 Timer.
Explanation should be brief working of circuit diagram

2 Marks for circuit diagram and 2 Marks for working

e) **Oscillator:**
Oscillator is a circuit that generates alternating voltage of desired shape at desired frequency. The output voltage and frequency of an oscillator can be variable. The oscillator operates on dc supply and produces alternating output voltage without any alternating input voltage.

Barkhausen criteria for oscillation:

Basic Oscillator Block Diagram

(2 Marks for definition)

(2 Marks for criterion)
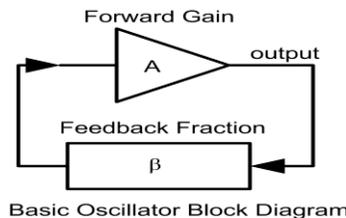
Barkhausen criteria states that:
- An oscillator will operate at that frequency for which the total phase shift introduced, as the signal proceeds from the input terminals, through the amplifier and feedback network and back again to the input is precisely 0 degree or 360 degree.
- At the oscillator frequency, the magnitude of the product of open loop gain of amplifier (A) and the feedback factor (β) is equal to or greater than unity
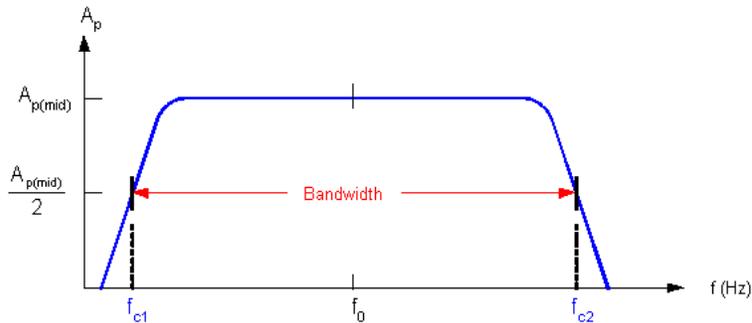**Aβ ≥ 1**

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2	f)	Half Adder Circuit	2marks for Circuit Diagram

Truth Table of Half Adder

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

2marks for Truth Table

3		Attempt any four	16
	a)	Circuit Diagram of RC coupled amplifier	02 + 01(1/2) + (½)

Stage-1   Stage-2

Fig shows two stage RC coupled amplifier, coupling capacitor C_C is used to couple stage 1 and stage 2.

Total phase shift to the signal is $180^0 + 180^0 = 360^0$

Resister R1 and R2 provides voltage divider biasing,

Rc- load resister

Re- emitter resister to provide –ve feedback

Ce- bypass capacitor

		Frequency response is	
	b	Logical symbol of AND gate and NOR gate with Truth Table AND GATE 	01+01
		NOR GATE 	01+01
	c)	Comparison of Microprocessor and Microcontroller(any 4 points)	01*4

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Microprocessor	Microcontroller
1. Contains only CPU; RAM, ROM, I/O, timer are separately interfaced.	1. CPU, RAM, ROM, I/O and timer are all on a single chip
2. Designer decides on the amount of ROM, RAM and I/O ports.	2. Fix amount of on-chip ROM, RAM, I/O ports
3. High cost	3. Low cost
4. General-purpose	4. Single-purpose
5. High speed	5. Low speed
6. Higher Power Consumption	6. Low Power Consumption
ex – 8085, 8086	ex – 8051,AVR

d)   Decoder and Encoder

Decoder:- A binary code of n bits is capable of representing up to 2^n distinct elements of coded information. A decoder is a combinational circuit that converts binary information from n input lines to a maximum of 2^n unique output lines.

01
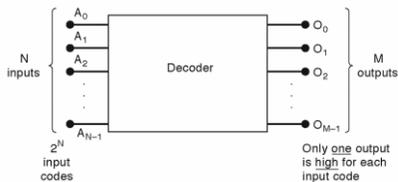
Applications:- 1) to generate a chip select logic in microprocessor applications 2) to convert binary numbers into BCD format 3) designing of adders, sub tractors etc.. (any 2 application, other suitable and relevant application is also considered)

Encoder:- An encoder performs the inverse operation of a decoder, It has 2_m inputs, and n output lines

(1/2)*2
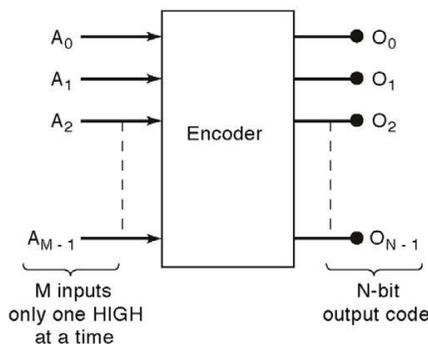
Applications- 1) in puzzle game combinational logic circuitry 2) in priority input logic 3) interrupt control logic (any 2 application, other suitable and relevant application is also considered)
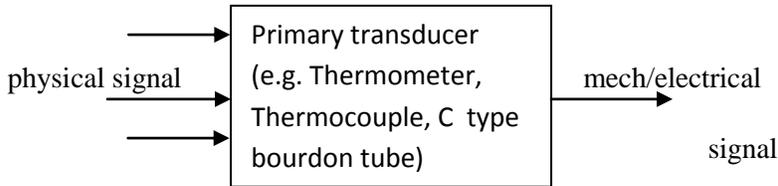
01

(1/2)*2

e)   Concept of primary and secondary transducers:-

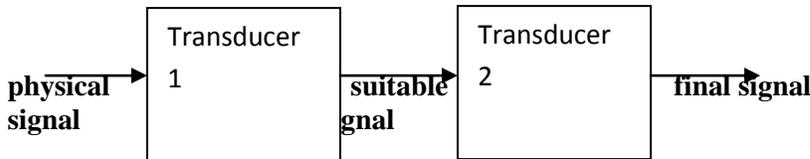MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
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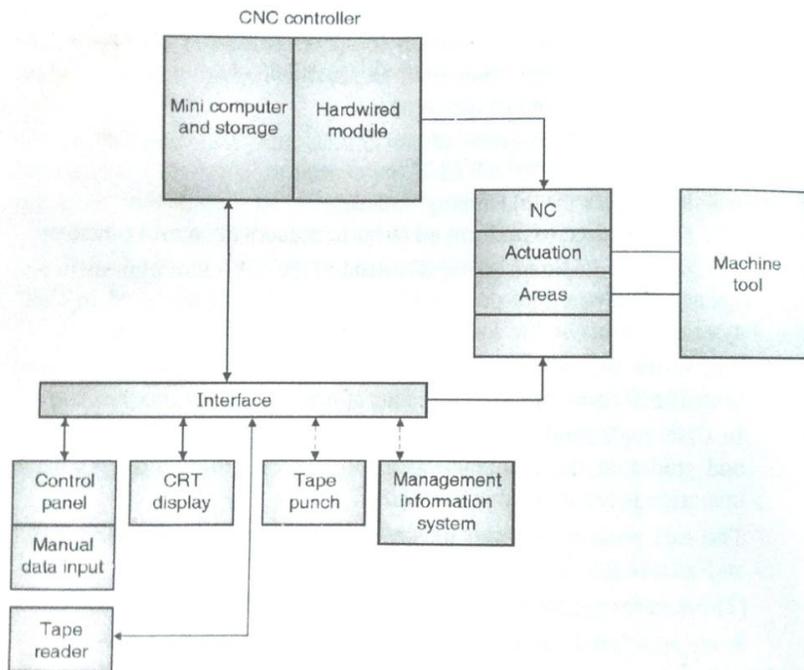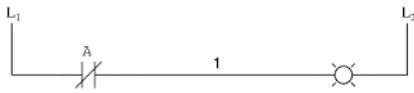|			
		Primary transducer:- In this type of transducer the there is only one time conversion of signal. Means physical signal is directly converted into final mechanical or electrical form. physical signal → Primary transducer (e.g. Thermometer, Thermocouple, C type bourdon tube) → mech/electrical signal	01+01
		Secondary Transducer:- In this type of transducer the there is two times conversion of signal. Means physical signal is converted into suitable form and again that suitable form is converted into final mechanical or electrical form. physical signal → Transducer 1 → suitable signal → Transducer 2 → final signal **e.g. LVDT to measure pressure, thermister etc...**	01+01
3	f)	Block diagram of CNC machine- 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
4		ATTEMPT ANY FOUR	16
	a)	Ladder diagram for NOT and OR gate	

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NOT Gate;-

A	Output
0	1
1	0

02

OR gate:-
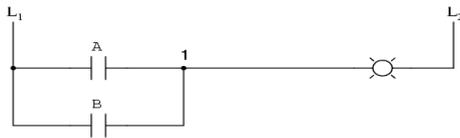
A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

02

4	b)	Direct coupled amplifier:-	
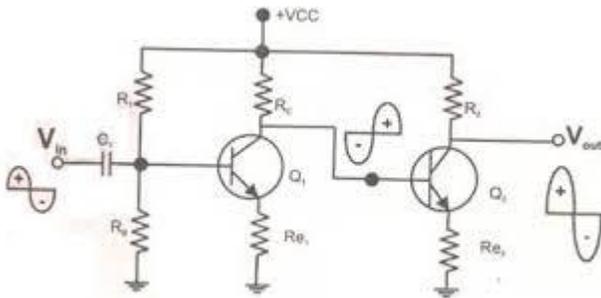
02

Applications:- 1) for low frequency amplification signal 2) for coupling and bypass applications (other suitable and relevant applications may also considered, any 2)

01*2

c) Selection criteria for PLC:- (Any four)

1.Number of inputs and number of outputs of PLC.

2. Nature of input and output i.e. Analog or Digital.

3. Speed of operation

4. Programming Flexibility

5. Power consumption.

6. Cost of PLC

01*4

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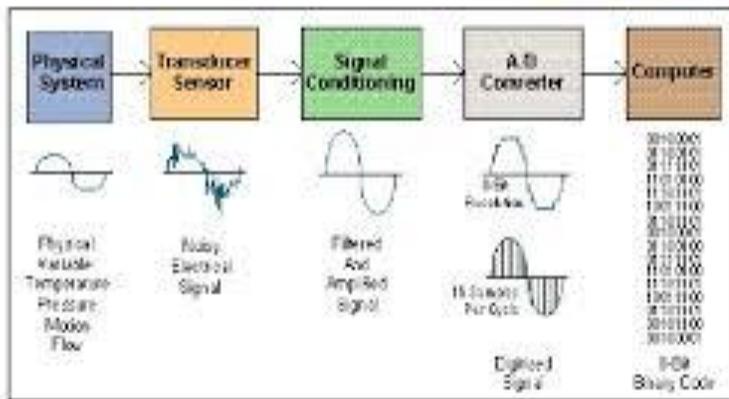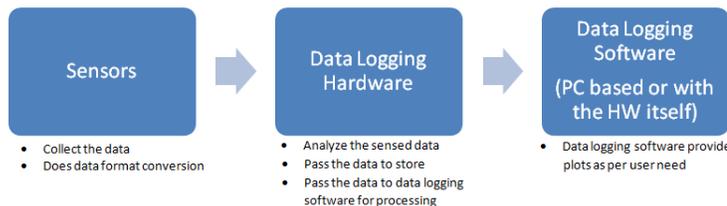|			
		{any other relevant and appropriate criteria may also considered}	
	d)	ADC and DAC ADC :- analog to digital convertor, converts analog input signal into digital form. Applications: - in microprocessor/ microcontroller applications like temp measurement, level, lift controllers.. in instrumentation systems, in digital equipments (other suitable and relevant applications may also considered, any 2) DAC:- Digital to analog convertors, converts digital input signals into analog output signals Applications:- in computer systems, in microprocessor/microcontroller systems applications (other suitable and relevant applications may also considered, any 2)	01+01 01+01
	e)	Single channel Data acquisition system Or And explanation of each block	02+02

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f)	Working principle of Photo diode and LDR	
	Photo diode:- it converts light energy into electric current.	
Basic Biasing Arrangement and Construction Photodiode
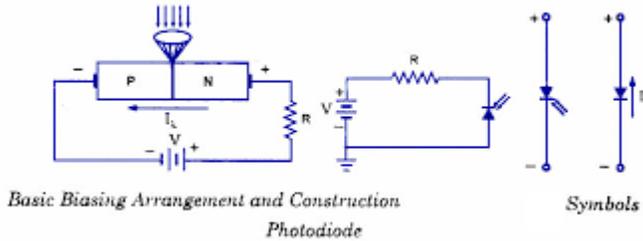
Symbols | 02 |
| | When the P-N junction is reverse-biased, a reverse saturation current flows due to thermally generated holes and electrons being swept across the junction as the minority carriers. With the increase in temperature of the junction more and more hole-electron pairs are created and so the reverse saturation current I_0 increases. The same effect can be had by illuminating the junction. When light energy bombards a P-N junction, it dislodges valence electrons. The more light striking the junction the larger the reverse current in a diode. It is due to generation of more and more charge carriers with the increase in level of illumination. This is clearly shown in ' figure for different intensity levels. The *dark current* is the current that exists when no light is incident. It is to be noted here that current becomes zero only with a positive applied bias equals to V_Q. The almost equal spacing between the curves for the same increment in luminous flux reveals that the reverse saturation current I_0 increases linearly with the luminous flux as shown in figure. Increase in reverse voltage does not increase the reverse current significantly, because all available charge carriers are already being swept across the junction. For reducing the reverse saturation current I_0 to zero, it is necessary to forward bias the junction by an amount equal to barrier potential. Thus the photodiode can be used as a *photoconductive device*.
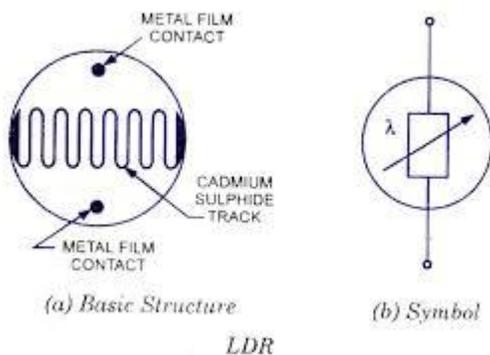
LDR:- | |
| |
(a) Basic Structure   (b) Symbol
LDR | 02 |
| | A light dependant resistor(LDR) or a photoresistor or photocell is a light controlled variable resistor. Its resistance changes with the light intensity that falls on it. • The resistance of a photoresistor decreases with increasing incident light intensity. In other words, it exhibits photoconductivity. | |
| 5 | Attempt any four | |

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a)	**What is signal condition? Explain with the help of diagram AC signal conditioning.**	

Signal conditioning is the manipulation of a *signal* in a way that prepares it for the next stage of processing. It includes amplification, modulation, sampling, filtering etc.
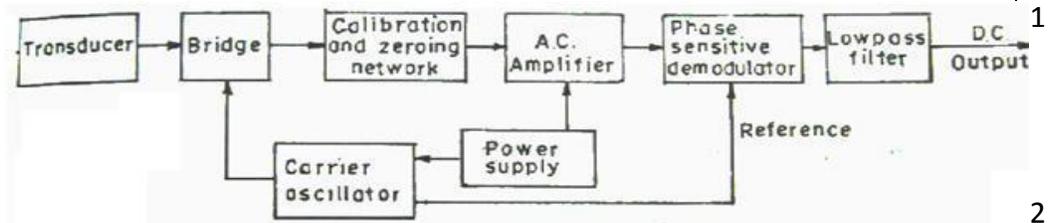

Fig: AC signal conditioning

Explanation:

- Variable resistance or variable inductance type of transducers are used which forms the one arm of bridge.

- The bridge receive an ac carrier from oscillator which operates at the frequency between 50Khz to 200Khz.

- Output of transducer is applied to bridge circuit which gives AM signal.

- AC amplifier amplifies this AM signal. This amplify can be RC coupled or transformer couple amplifier.

- Amplifier output is given to photosensitive demodulator.

- Detector produces dc signal which indicates the direction of parameter change in bridge output

b) **Explain any four criteria for selection of a transducer for an application.**

(1 mark each)

Selection 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 .

c)

8. Compatibility: Transducer should be compatible with the measuring system.

Draw the symbol and write any two applications of

1) UJT (Symbol : 1 marks, 2 application: 1 mark)

UJT
Symbol

Construction

Simplified
Equivalent Circuit
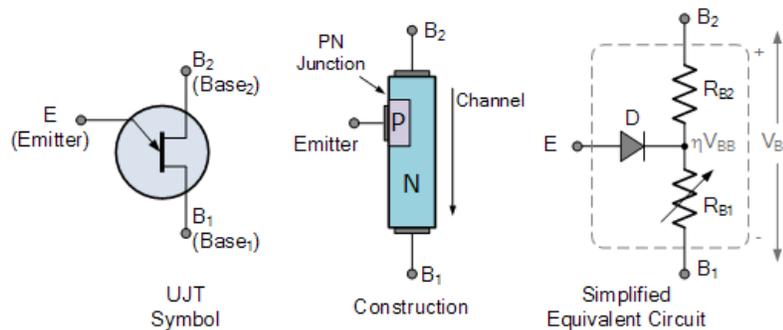
Applications:

1) Relaxation oscillator

2) As a triggering device for thyristor

2) Zener diode (Symbol : 1 marks, 2 application: 1 mark)

Anode   Cathode

Applications:

1) As a voltage regulator

d)

2) Waveform clipper

What is opto coupler? How it is used as an isolator?

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Opto coupler (2 marks) Explaination (2 marks)

Opto coupler: a device containing light-emitting and light-sensitive components, used to couple isolated circuits.
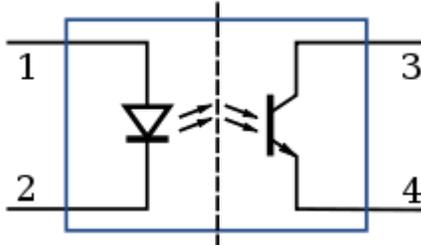
Usage : opto-isolator contains a source (emitter) of light, almost always a near infrared light-emitting diode (LED), that converts electrical input signal into light, a photosensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from 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.

e) **Draw the construction of decade counter using T-flip flop. (4 marks)**
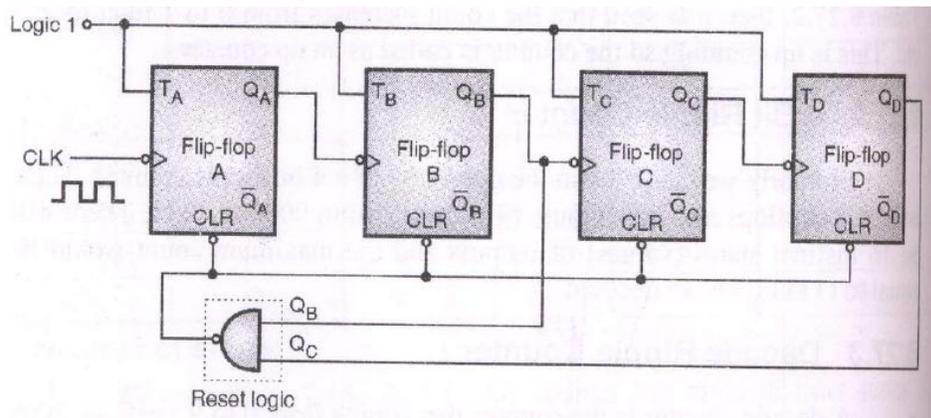
f) **Differentiate between intrinsic and extrinsic semiconductor (any 4 points)**

Intrinsic Semiconductor	Extrinsic Semiconductor

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It is pure semi-conducting material and no impurity atoms are added to it.	It is prepared by doping a small quantity of impurity atoms to the pure semi-conducting material.
Its electrical conductivity is low.	Its electrical conductivity is high.
Its electrical conductivity is a function of temperature alone.	Its electrical conductivity depends upon the temperature as well as on the quantity of impurity atoms doped the structure.
Examples: crystalline forms of pure silicon and germanium.	Examples: n-type, p-type

Attempt any four:

What do you mean by load regulation and line regulation?

Load regulation (2 marks)

Load regulation is the capability to maintain a constant output voltage despite changes in the supply's load current from no load to full load.

$$\%\text{Load Regulation} = 100\% \frac{V_{min-load} - V_{max-load}}{V_{nom-load}}$$

Line regulation (2 marks)

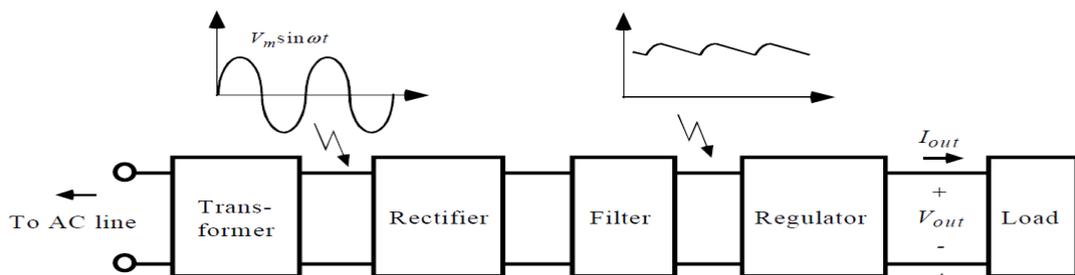It is the change in the regulated load voltage due to change in line voltage in a specified range of

230V ±10% at constant load current.

% Line regulation = VLH – VLL/ Vnom * 100

Draw block diagram of regulated power supply. State its two applications.

Block diagram (2 marks) and any 2 applications(2 marks)

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Applications:

1) Its function is to **supply** a stable voltage (or less often current), to a circuit or device that must be operated within certain **power supply** limits.

2) Mobile Phone power adaptors

3) Regulated power supplies in appliances

4) Various amplifiers and oscillators

2

What is crystal oscillator? State its any four applications

Crystal oscillator (2 marks)

A **crystal oscillator** is an electronic **oscillator** circuit that uses the mechanical resonance of a vibrating **crystal** of piezoelectric material to create an electrical signal with a precise frequency.

2

Oscillator With Crystal Operating
in Parallel Resonance
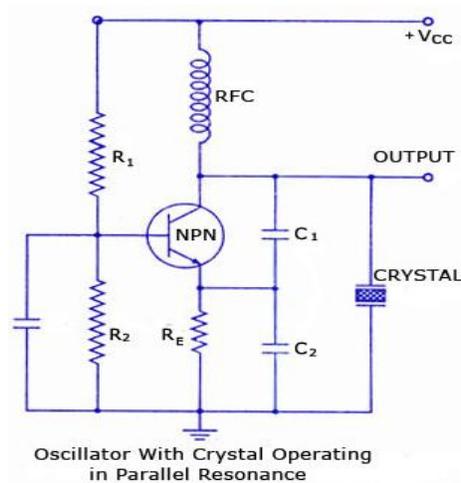
2

Applications any four (½ marks each):-

• In Military and Aerospace

- In Research and Measurement

- In Automotive

c)

- Consumer Applications

Draw the block diagram of SR flip flop. Write its truth table
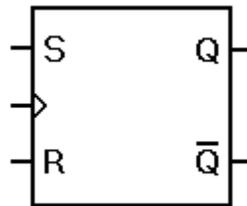
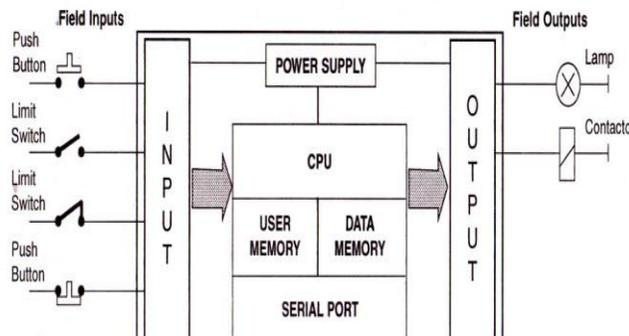Block diagram (2 marks) , truth table (2 marks)   2

Fig : SR flip flop

Truth table of SR Flip Flop

Inputs			Outputs		Comments
E	S	R	Q_{n+1}	$\overline{Q}_{n+1}$	
1	0	0	Q_n	$\overline{Q}_n$	No change
1	0	1	0	1	Rset
1	1	0	1	0	Set
1	1	1	x	x	Indeterminate

2

e)

Draw block diagram of PLC. State function of each block.

Block diagram 2 marks, functions 2 marks

2

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A Programmable Controller is a specialized computer. Since it is a computer, it has all the basic component parts that any other computer has; a Central Processing Unit, Memory, Input Interfacing and Output Interfacing. A typical programmable controller block diagram is shown above.

- **Input units**
1. The input section can accept discrete or analog signals of various voltage and current levels.

2. Present day controllers offer discrete signal inputs of both AC and DC voltages from TTL to 250 VDC and from 5 to 250 VAC.

3. Analog input units can accept input levels such as ±10 VDC, ±5 VDC and 4-20 ma. current loop values.

4. Discrete input units present each input to the CPU as a single 1 or 0 while analog input units contain analog to digital conversion circuitry and present the input voltage to the CPU as binary number normalized to the maximum count available from the unit.

5. The number of bits representing the input voltage or current depends upon the resolution of the unit.

6. This number generally contains a defined number of magnitude bits and a sign bit.

7. Register input units present the word input to the CPU as it is received (Binary or BCD).
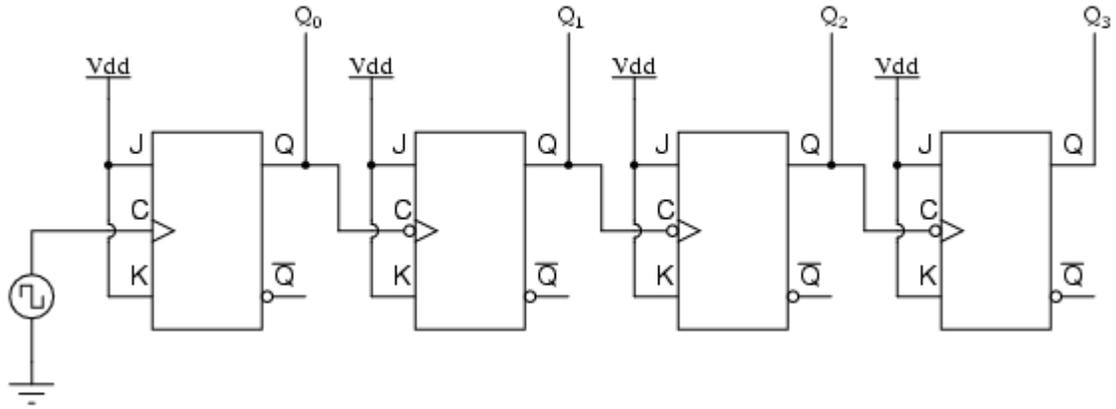
Draw 4 bit asynchronous counter circuit. (any appropriate diagram 4 marks)

2

4

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A four-bit "up" counter

Q. No.	Sub Q. N.	Answer	Marking Scheme

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