

# CBCS SCHEME

USN

--	--	--	--	--	--	--	--	--	--

BEMEM103/203

## First/Second Semester B.E/B.Tech. Degree Examination, June/July 2025 Elements of Mechanical Engineering

Time: 3 hrs.

Max. Marks:100

- Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.  
 2. M : Marks , L: Bloom's level , C: Course outcomes.  
 3. Use of steam table is permitted.

Module – 1			M	L	C
1	a.	Explain the role of mechanical engineering in industry and society.	7	L2	CO1
	b.	Explain emerging trends and technologies in automobile sector.	7	L2	CO1
	c.	Find enthalpy of 1 kg of steam at 12 bar when steam is : i) Dry saturated ii) 22% wet iii) Super heated to 250°C Assume specific heat of super heated steam as 2.25 kJ/kg K.	6	L3	CO4
<b>OR</b>					
2	a.	Explain with neat sketch working principle of hydel power plant.	7	L2	CO1
	b.	Explain with neat sketch working principle of nuclear power plant.	7	L2	CO1
	c.	Find the enthalpy of 0.5 kg of steam at a pressure of 10 bar when steam is : i) Dry saturated ii) 1.5% wet iii) Super heated to 200°C Assume specific heat of super heated steam as 2.25 kJ/kg K.	6	L3	CO4
<b>Module – 2</b>					
3	a.	Explain with neat sketches the following lathe operations : i) Turning ii) Knurling iii) Thread cutting.	10	L2	CO2
	b.	Explain with neat sketches the following drilling operations : i) Drilling ii) Boring iii) Counter sinking.	10	L2	CO2
<b>OR</b>					
4	a.	Explain with neat sketches the following milling operations : i) Plain milling ii) Slot milling iii) End milling.	10	L2	CO2
	b.	Explain the basic components and applications of CNC.	10	L2	CO2

**Module – 3**

5	a.	Explain with neat sketches the working principle of four stroke petrol engine.	10	L2	CO2
	b.	Explain the properties of refrigerants.	5	L2	CO2
	c.	A four stroke single cylinder diesel engine has a piston diameter of 250 mm and stroke 400 mm. The mean effective pressure is 4 bar and speed is 500 rpm. The diameter of the brake drum is 1000 mm and effective brake load is 400 N. Find IP, BP and FP.	5	L3	CO4

**OR**

6	a.	Explain with neat sketch the working principle of VCR.	10	L2	CO2
	b.	Explain the applications of Air Conditioner.	5	L2	CO2
	c.	A single cylinder four stroke engine runs at 1000 rpm and has a bore of 115 mm. stroke 140 mm. The brake load is 60 N at 600 mm radius and mechanical efficiency is 80%. Find IP, BP and mean effective pressure.	5	L3	CO4

**Module – 4**

7	a.	Explain with neat sketch spur and simple gear train.	8	L2	CO3
	b.	Explain flat and v-belt drive.	6	L2	CO3
	c.	A simple gear train consists of 3 gears. The number of teeth on the driving gear is 60, on the idler gear 40 and on the driven gear 80. If the driving gear rotates at 1200 rpm. Find the speed of the driven gear and also velocity ratio. Sketch the arrangement of gear drive.	6	L3	CO4

**OR**

8	a.	Explain with a neat sketch Arc welding.	8	L2	CO3
	b.	Explain with neat sketches types of flames used in gas welding.	6	L2	CO3
	c.	It is required to drive a shaft as 600 rpm by a belt using a pulley of 150 mm diameter on another parallel shaft B running at 240 rpm. What would be the diameter of the pulley on the shaft A and also find velocity ratio.	6	L3	CO4

**Module – 5**

9	a.	Explain the basic components of hybrid vehicle.	10	L2	CO3
	b.	Explain advantages of electric and hybrid vehicles.	10	L2	CO3

**OR**

10	a.	Explain with block diagram open and closed loop mechatronics system.	10	L2	CO3
	b.	Explain with neat sketch robot anatomy and applications of robots.	10	L2	CO3

\*\*\*\*\*

## Module - 1

Qno 1 a) The present day that we are living in is filled with numerous technological acts that define our society and influence our values. From the minimal simplest of tasks to the most dangerously complex jobs, almost every single thing today can be achieved with the use of an associated technology. Mechanization has always been an entrenched characteristic of the human race. People have always turned to creating machines that do the job for us, whenever they have faced any hurdle or ~~need~~ the need arose.

Mech Engineers have previously been involved in power generation whether hydro or thermal. Recent world has seen their contribution in the development of ~~a~~ renewable energy infrastructure across the world starting from huge solar projects to using wind, ocean or tidal energy to develop power.

Qno 1 b) Micro mobility as service is one of the significant drivers of automotive industry. It creates customized travel options by integrating various transport networks, catering

to the shift from vehicle ownership to service-based transportation. The recent trends in the automotive industry such as AI, ML, robotics, computer vision, and deep learning have transformed the way manufacturing and usage of vehicles happened. Additionally, such facilities have provided immense opportunities to generate newer automotive app ideas and make a great business out of them.

Qno 1 (c) Enthalpy of 1 kg Steam at 12 bar  
 From Steam tab  $h_f = 798 \text{ kJ/kg}$   
 $h_{fg} = 1984 \text{ kJ/kg}$   $T_{sat} = 188^\circ\text{C}$

i) Dry Saturated Steam

$$h = h_f + h_{fg}$$

$$h = 798 + 1984$$

$$h = 2782 \text{ kJ/kg}$$

ii) 22% wet Steam

$$x = 1 - 0.22 = 0.78$$

$$h = h_f + x h_{fg}$$

$$h = 798 + (0.78)(1984)$$

$$h = 798 + 1547.52$$

$$h = 2345.5 \text{ kJ/kg}$$

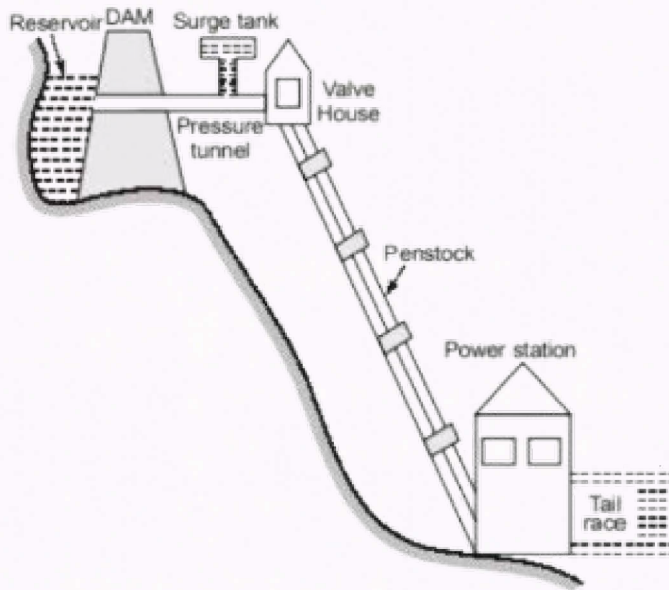
iii) Superheated Steam at  $250^\circ\text{C}$

$$h = h_g + C_p (T_{sup} - T_{sat})$$

$$h = 2782 + 2.25(30 - 188)$$

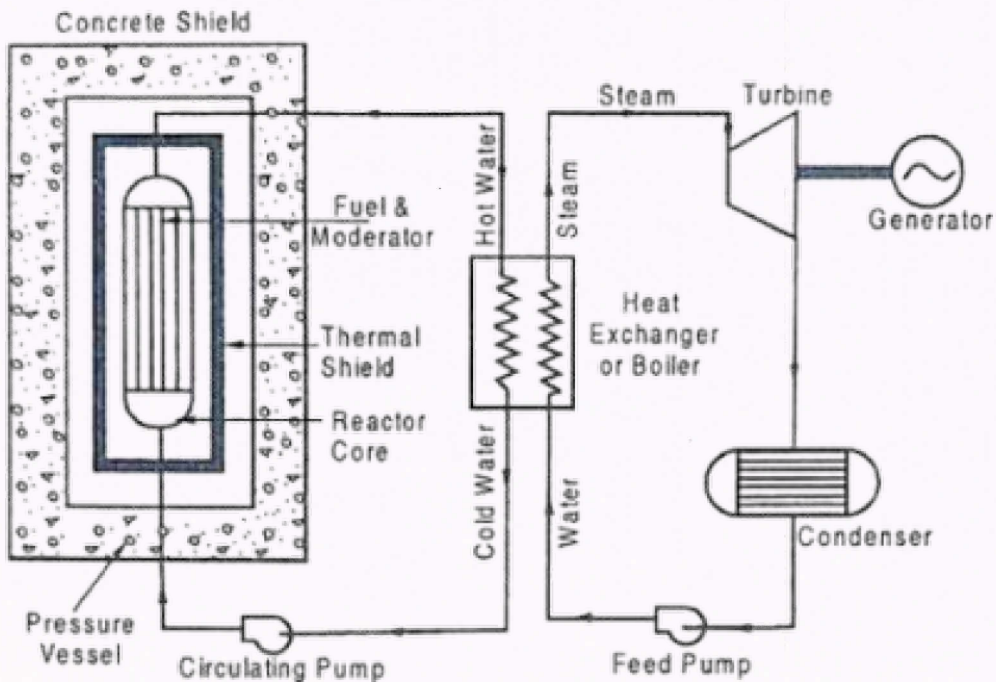
$$h = 2782 + 139.5 = 2921.5 \text{ kJ/kg}$$

Qn 2(a)



Water stored in reservoir possess potential energy, water flows through penstock due to gravitational head. Flowing water strikes turbine blades causing rotation. Turbine shaft rotates electric generator. Generator produces electric power. Electricity transmitted to grid.

Qno-2(b)



In the reactor, Uranium undergoes nuclear fission releasing heat. Control rods regulate the reaction rate. Heat is transferred to coolant. Coolant produces high pressure steam. Steam rotates steam turbine. Turbine drives generator to produce electricity. Steam condensed & recycled.

2(c) Enthalpy of 0.5 kg steam at 10 bar

From steam table at 10 bar

$$h_f = 726 \text{ kJ/kg} \quad h_{fg} = 2014 \text{ kJ/kg} \quad h_g = 2776 \text{ kJ/kg}$$

$$T_{\text{sat}} = 180^\circ\text{C}$$

i) Dry Saturated Steam

$$h = h_g \quad h = 2776 \text{ kJ/kg} \quad \text{for } 0.5 \text{ kg}$$

$$H = 0.5 \times 2776 = 1388 \text{ kJ/kg}$$

ii) 1.5% wet steam

$$\text{Dryness fraction } x = 1 - 0.015 = 0.985$$

$$h = h_f + x h_{fg}$$

$$h = 762 + (0.985 \times 2014) = 2745.8 \text{ kJ/kg}$$

$$\text{for } 0.5 \text{ kg} \quad H = 1372.9 \text{ kJ}$$

iii) Superheated steam at  $200^\circ\text{C}$

$$h = h_g + C_p (T_{\text{sup}} - T_{\text{sat}})$$

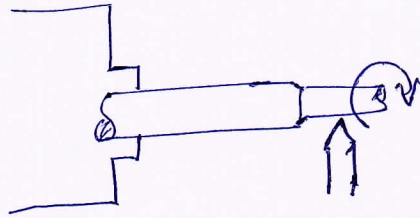
$$h = 2776 + 2.25 (200 - 180) = 2776 + 45 = 2821 \text{ kJ/kg}$$

$$\text{for } 0.5 \text{ kg} \quad H = 1410.5 \text{ kJ}$$

## Module - 2

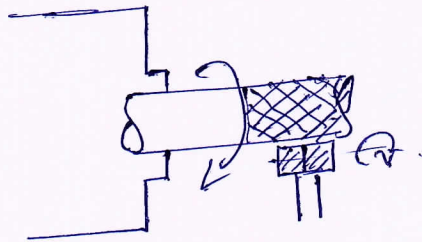
### Qn-3a) i) Turning

It is the operation of reducing diameter of cylindrical workpiece using single point cutting tool. It is used to produce shaft, cylindrical surface.



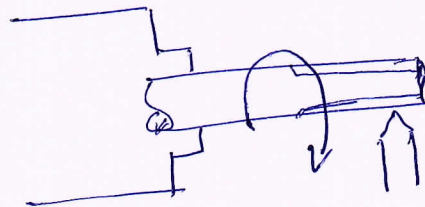
### ii) Knurling

Knurling produces rough patterned surface using knurling rollers. It is used to create grip, decorative finish.



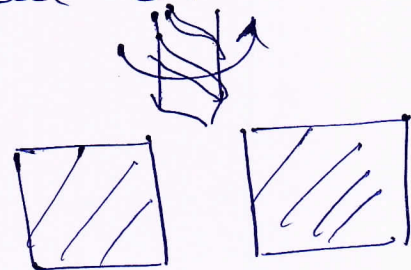
### iii) Thread Cutting

It is used to produce helical groove on cylindrical surfaces & it is used to create external thread & internal thread. It is used for bolts, screws and fasteners.



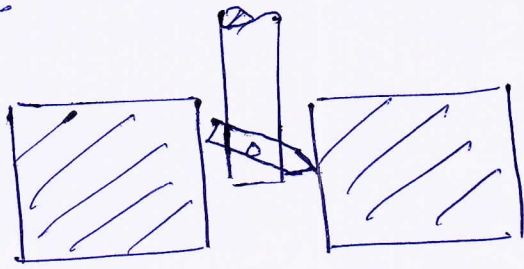
### 3b) Drilling

This operation using to produce circular hole using drilling bit.



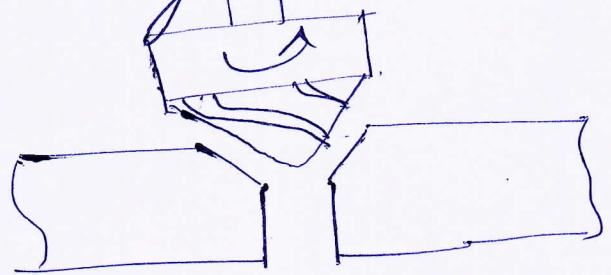
## Boring

This operation is used to enlarge already drilled hole using single point cutting tool. This is helpful for creating large size hole.



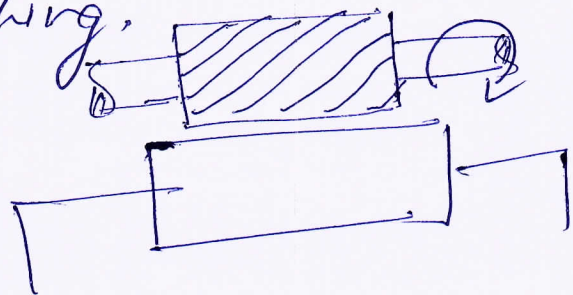
## Countersinking

It is helpful for making conical enlargement at hole entrance for screw heads. This is helpful for creating seat to the heads of screws.



## A a) i) plain milling

It is operation of machining a flat surface parallel to the axis of milling cutter. It is used to produce flat surfaces, steps, slots and surface finishing.



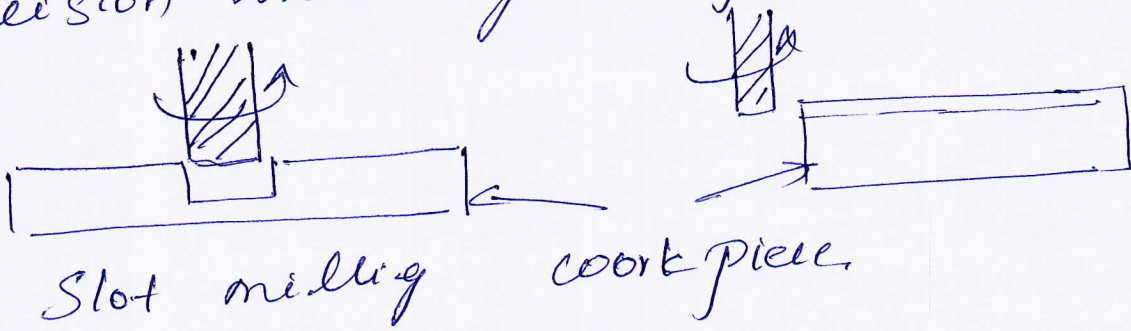
## ii) Slot Milling

It is used to produce slots or grooves in the workpiece. Cutter rotates and moves along the workpiece a slot or

Or groove is produced of required width & depth. This process applied to  
keways, T-slots, Grooves in m/c components.

### End milling

It is the operation of machining surfaces, slots, or profiles using end mill cutter.  
This is useful for Die or Mold making.  
Precision machining, Complex profiles



### 4b) Basic Components of CNC machine

#### \* Input device

Used to input the machining program through keyboard, USB drive. Computer interface

#### \* Machine control unit

It is brain or main control unit of CNC machine. Reads program instruction, convert them into electrical signal.

#### \* Drive System

It provides motion to machine axes using servo motor, stepper motor.

#### \* Machine tool

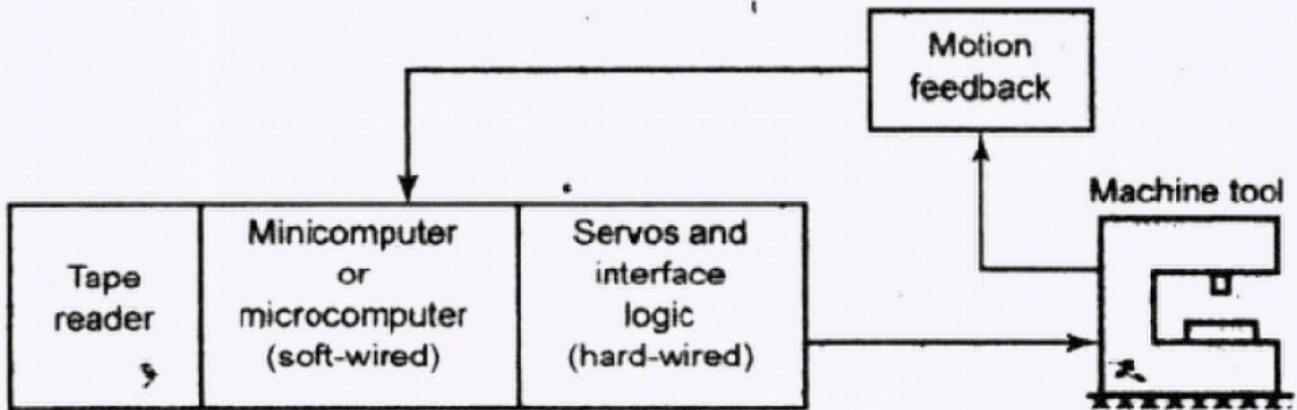
It is the tool machine for different operations of CNC lathe, CNC Milling machine, CNC drilling machine.

# Feed back System

Measure position and speed of machine elements such as encoders, & Servos.

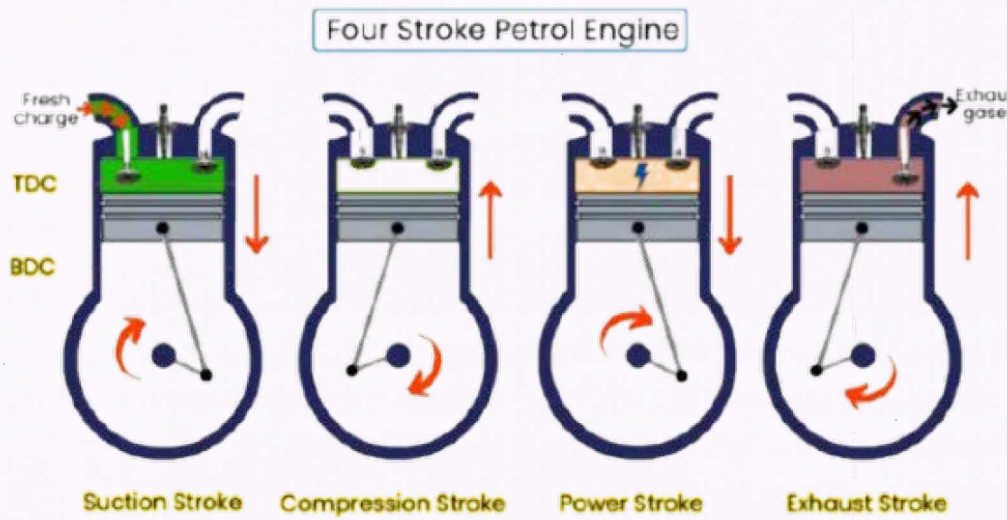
## Appln of CNC m/c

- \* Automobile Component manufacturing
- \* Aerospace Component
- \* Tool & Die making.



# Module-3

Qn-5 a)



## Suction Stroke

During this stroke inlet valve open and air-fuel mixture enters cylinder

## Compression Stroke

During this stroke both valves are closed mixture air & fuel compressed

## Power Stroke

During this stroke spark plug ignites the air-fuel mixture & pushes the piston in down-ward direction

## Exhaust - Stroke

During this stroke exhaust valve opens the burnt gases expelled through the exhaust valve.

Qn5b) Following are the properties of refrigerants, Refrigerant must be

- # Low boiling temperature
- High latent heat
- Low toxicity
- Non flammable
- Chemical stability
- Low specific volume
- Environment friendly

Qn5(c) Given data

$\overline{D} = 0.25 \text{ m}$ ,  $L = 0.4 \text{ m}$ ,  $N = 500 \text{ rpm}$   
 $P = 4 \text{ bar} = 400 \text{ kPa}$  Brake drum dia =  $1 \text{ m}$   
 Load =  $400 \text{ N}$

Indicated power  $IP = \frac{P L A N}{60}$

Area  $A = \frac{\pi}{4} D^2 = 0.049 \text{ m}^2$

$IP = \frac{400000 \times 0.4 \times 0.049 \times 500}{60} = 60.53 \text{ kW}$

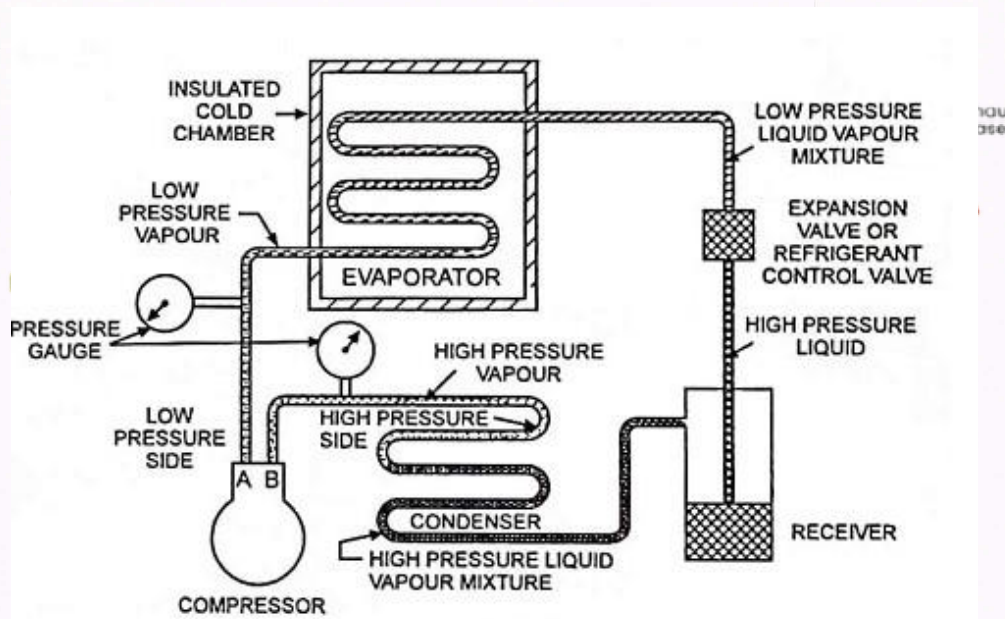
BP  $T = W \times R$   $R = 0.5 \text{ m}$

$T = 400 \times 0.5 = 200 \text{ N-m}$

$BP = \frac{2\pi NT}{60} = 47 \text{ kW}$

$FP = IP - BP = 27.53 \text{ kW}$

Qn 6(a)



### Compression

In this process refrigerant is compressed to high pressure & temperature.

Vapour compressed

### Condensation

In this process refrigerant releases heat in condenser & becomes liquid.

### Expansion

In this process pressure is reduced through the expansion valve.

### Evaporation

In this process low pressure refrigerant absorbs heat from surrounding & evaporates. It gives cooling effect.

### Qn 6(b) Application of Air Conditioning

- i) Residential building
- ii) Hospital
- iii) Theater & mall
- iv) Computers & Server rooms

v) Industrial process

vii) Automobile Cabin

viii) Pharmaceutical Industry

ix) Aircraft Cabin

Qn 6 c) Engine Speed = 1000 rpm

Bore  $D = 115 \text{ mm} = 0.115 \text{ m}$

Stroke  $L = 0.14 \text{ m}$  Load  $W = 60 \text{ N}$

Radius  $r = 600 \text{ mm} = 0.6 \text{ m}$   $\eta_{\text{mech}} = 80\%$

BP

$$T = W \times r$$

$$T = 60 \times 0.6$$

$$T = 36 \text{ Nm}$$

$$BP = \frac{2\pi NT}{60}$$

$$BP = \frac{2\pi \times 1000 \times 36}{60}$$

$$BP = 3.77 \text{ kW}$$

IP

$$\eta_m = \frac{BP}{IP}$$

$$IP = \frac{BP}{\eta_m} = \frac{3.77}{0.80} = 4.71 \text{ kW}$$

P<sub>m</sub>

$$A = \frac{\pi D^2}{4} = 0.0104 \text{ m}^2$$

$$IP = \frac{P_m LAN}{120}$$

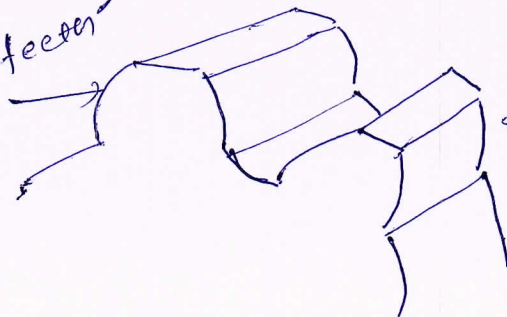
$$4.71 \times 1000 = \frac{P_m \times 0.14 \times 0.0104 \times 1000}{120}$$

$$P_m = 3.87 \text{ bar}$$

Qn 7 (a) Spur gear is mainly with straight teeth parallel to the shaft used to transmit power from one point to other point. It is high efficiency simple in construction.

St

Gear teeth



Simple gear train

Simple gear train consist of two or more gears arranged in a series, with only one gear mounted on each shaft, used to transmit motion between parallel shafts

Qn 7b Flat belt drives use rectangular belts for long distances, high speed & low tension application.

V-belt drives utilize trapezoidal endless belts for compact, high torque, & short distance and high efficiency power transmission due to their wedge effect gripping in pulley.

Qn 7c) Given that

Driven teeth = 60

Idler teeth = 40

Driven teeth = 80

Speed of driven = 1200 rpm

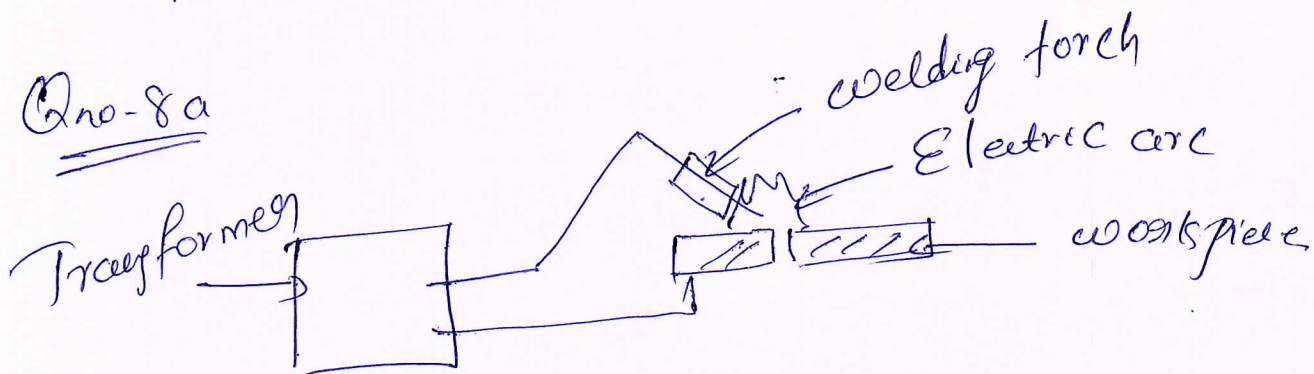
$$VR = \frac{T_3}{T_1} = \frac{80}{60} = 1.33$$

$$N_1 T_1 = N_3 T_3$$

$$1200 \times 60 = N_3 \times 80$$

$$N_3 = 900 \text{ rpm}$$

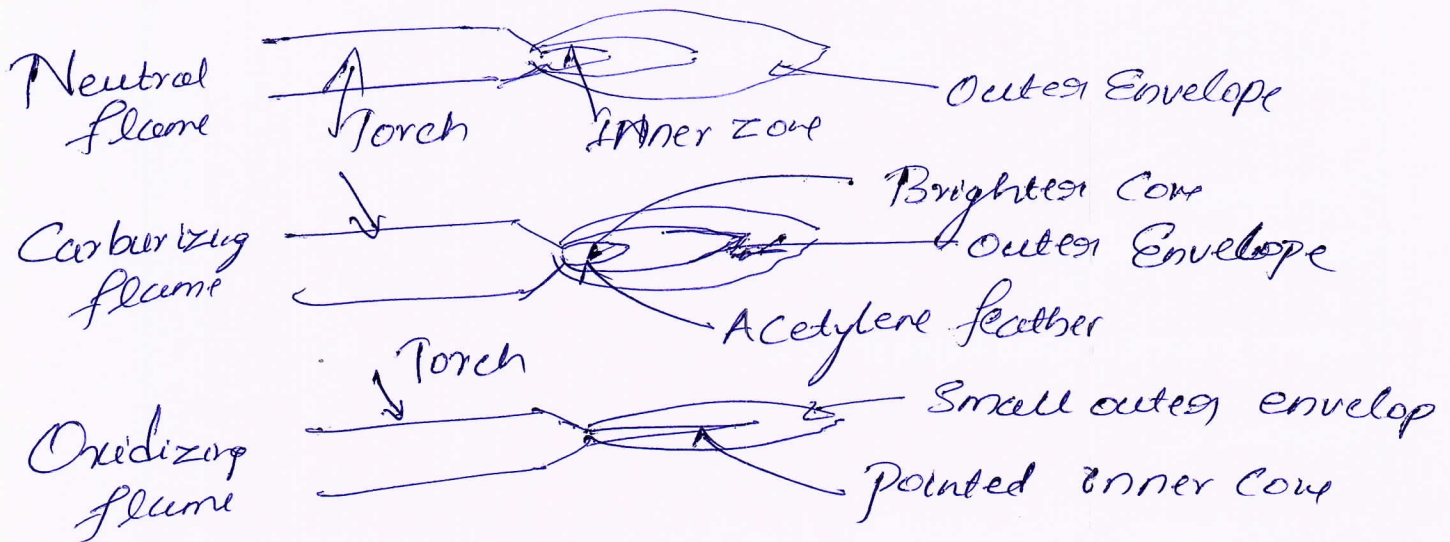
Qno-8a



Electrode touches workpiece creating an arc. The arc temp up to 5500°C. Metal melts and forms weld pool. On cooling, strong joint forms.

Application in ship building. Automobile industry.

# 8(b) Types of flame



Neutral flame It is created with roughly equal parts oxygen & acetylene, resulting in a white inner cone & a blue outer cone. with a temp around  $3200^{\circ}\text{C}$

Oxidizing flame: produced when there is more oxygen than acetylene this flame is shorter & sharper used for cutting.

Carburizing flame: Formed with excess acetylene producing three zone flame. helpful for high-carbon steel hard facing.

8Qn8c

Speed of shaft A = 600 rpm  
" B = 240 rpm

Dia of pulley B = 150 mm

$$N_1 D_1 = N_2 D_2 \quad \left| \quad 600 D_A = 240 \times 150 \right. \\ 600 D_A = 240 \times 150 \quad \left| \quad D_A = 60 \text{ mm} \right.$$

Velocity Ratio  $VR = \frac{N_1}{N_2}$

$$VR = \frac{600}{240} = 2.5$$

Qn-9a) Basic Components of Hybrid Vehicle  
Internal Combustion Engine

Electric motor

Battery pack

Power Control unit

Transmission System

Regenerative Braking System

Electric motor assist engine & energy recovery ~~for~~ during braking operation. It improves fuel efficiency

Qn-9b) Advantages of Electric Vehicle

- i) Zero emission, reduced carbon footprint.
- ii) Low running cost with 80-90% fewer
- ~~iii) moving parts~~
- iii) Convenience - The ability to charge at home eliminates frequent trips to gas station
- iv) Energy efficient compare to IC Engine.

Advantages of hybrid vehicle

- i) Superior fuel economy. Hybrids use an electric motor to assist an engine
- ii) Eco friendly. Lower fuel consumption

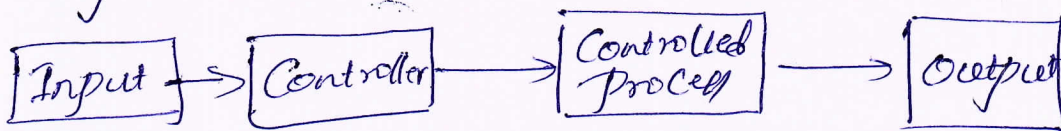
reduced CO<sub>2</sub> emission

No charge anxiety: Unlike EV, conventional hybrid vehicles do not need to be plugged in.

Qno 10a)

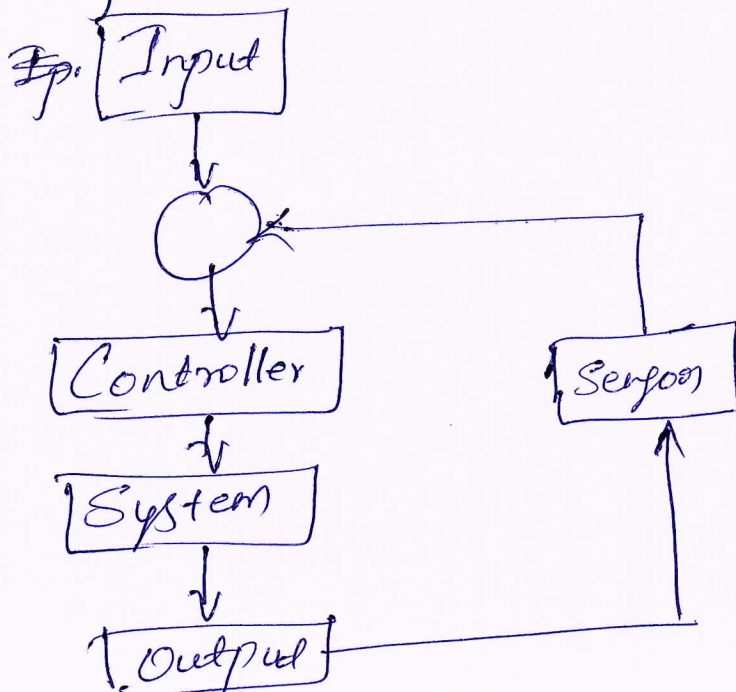
### Open loop mechatronics system

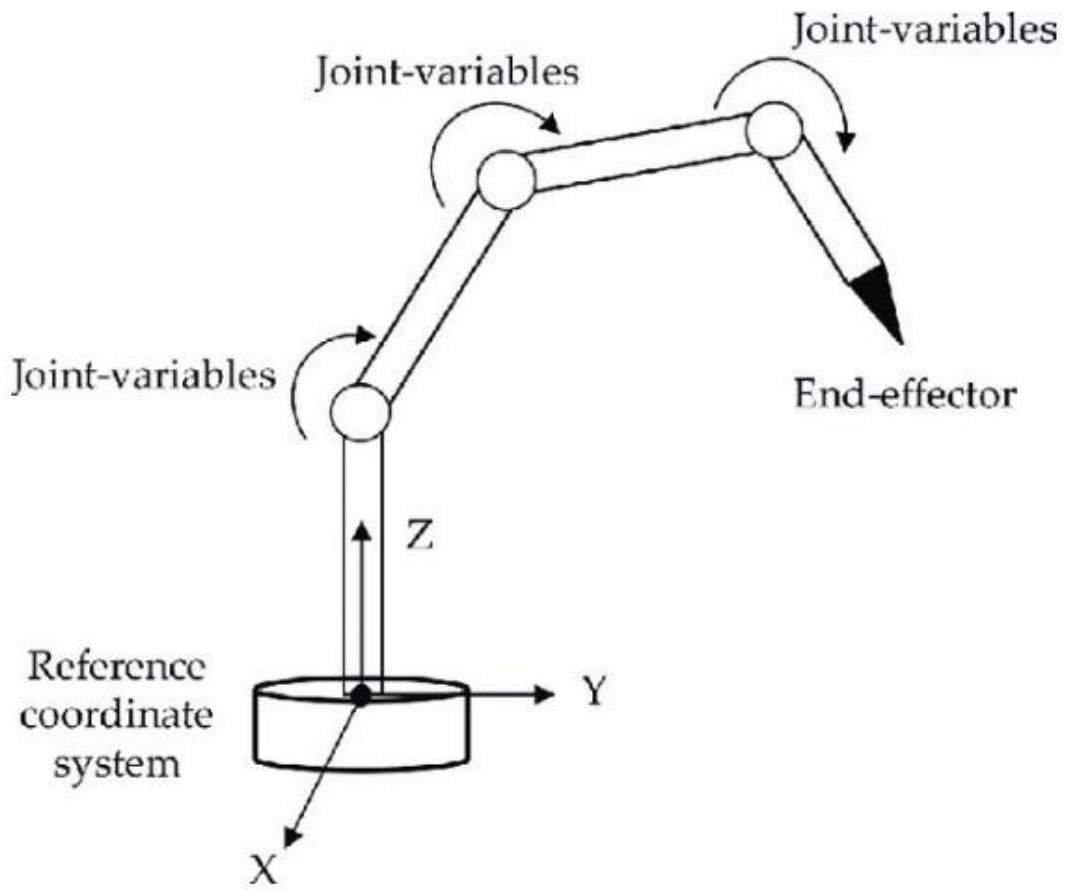
A system operates without feedback, so output is not compared with desired input. Such system remains simple in design & economical to implement.



### Closed loop Control System

A system is used in applications where feedback and error correction are required. The output is continuously compared with the desired input, and automatic adjustments reduce the error. The design is more complex and the cost is higher compared to open loop systems.





Qno 10(b) Robot anatomy refers to the Physical System Structure of a robot, Primarily consisting of base, links, and joints that form a manipulator. These systems are designed with varying degrees of freedom to control movement, driven by actuators.

Following are the components of Robot anatomy.

- i) Manipulator - This is main structure that position the end effector, comprising 3 DOF.
- ii) Wrist Assembly - Connects to the arm allowing the end effector to be oriented in various position.
- iii) Joint (Axis): provide relative motion between links.
- iv) Links - The rigid member connecting the joints.
- v) End effector - The tool, gripper or device attached to the wrist to perform specific tasks.
- vi) Actuators - The muscles that drive the joints such as electric motors, hydraulic cylinders or pneumatic systems.

  
HOD



