PVP 23

Code: 23ES1201

I B.Tech - II Semester – Regular / Supplementary Examinations
JUNE 2026

BASIC CIVIL & MECHANICAL ENGINEERING
(Common for CE, ME, IT, AIML, DS)

Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts: Part-A and Part-B.
2. Each Part contains:
- 5 short answer questions. Each Question carries 1 Mark and
- 3 essay questions with an internal choice from each unit. Each question carries 10 marks.

3. All parts of Question paper must be answered in one place.

BL – Blooms Level CO – Course Outcome

PART – A

		BL	CO
1.a)	Mention various disciplines of civil engineering.	L1	CO1
1.b)	Interpret the composition of bricks.	L2	CO5
1.c)	Explain the check used in Height of Instrument method and its terms.	L2	CO2
1.d)	Illustrate the importance of transportation engineering in Nation's economic development.	L2	CO3
1.e)	Differentiate between Dams and Reservoirs.	L3	CO4

			BL	CO	Max. Marks
UNIT-I					
2	a)	Describe the Geo-technical engineering discipline in detail.	L2	CO1	5 M
	b)	Summarize the popularity of cement concrete as a construction material and types of concrete.	L2	CO5	5 M

OR					
3	a)	Demonstrate the importance of various disciplines of civil engineering for infrastructural development of a nation.	L2	CO1	5 M
	b)	Classify aggregates based on origin, size and shape for use in construction.	L3	CO5	5 M
UNIT-II					
4	a)	Classify bearings and illustrate system of measurements for measuring horizontal angles in WCB and QB with examples.	L3	CO2	5 M
	b)	A staff is held on a benchmark (BM) of RL 100.00 m. The Backsight (BS) is 1.50 m. The staff is then held on a point A, and the Foresight (FS) is 2.20 m. Calculate the RL of point A.	L3	CO2	5 M
OR					
5	a)	What are the various levelling methods? Explain any one method used to determine the reduced level of a point.	L2	CO2	5 M
	b)	Illustrate the characteristics of a contour map with neat sketches.	L3	CO2	5 M
UNIT-III					
6	a)	Interpret the key differences between flexible and rigid pavements.	L2	CO3	5 M
	b)	Explain various qualities of drinking water.	L2	CO4	5 M
OR					

7	a)	Describe various modes of transportation and differentiate highway transportation from other modes.	L2	CO3	5 M
	b)	Discuss the advantages of rainwater harvesting.	L2	CO4	5 M

PART – B

		BL	CO
1.f)	Define machine.	L1	CO1
1.g)	Give two examples of non-ferrous metals.	L1	CO1
1.h)	State the principle of casting.	L1	CO2
1.i)	Define CNC machine.	L1	CO2
1.j)	Define belt drive.	L1	CO3

			BL	CO	Max. Marks
UNIT-I					
8	a)	Discuss ceramic materials and their engineering applications.	L2	CO1	5 M
	b)	Discuss the importance of Mechanical Engineering in society.	L2	CO1	5 M
OR					
9	a)	Classify engineering materials with suitable examples.	L2	CO1	5 M
	b)	Explain the properties and applications of ferrous and non-ferrous metals.	L2	CO1	5 M

UNIT-II					
10	a)	Explain the basic principles of casting process with advantages.	L2	CO2	5 M
	b)	Describe forming processes used in manufacturing industries.	L2	CO2	5 M
OR					
11	a)	Explain the concept of 4 stroke IC engine with neat sketch.	L2	CO2	5 M
	b)	Describe the basic machining processes and their applications.	L2	CO2	5 M
UNIT-III					
12	a)	Explain the working principle of a steam power plant.	L2	CO3	5 M
	b)	Describe the working principle of a hydroelectric power plant.	L2	CO3	5 M
OR					
13	a)	Explain the working principle of a nuclear power plant.	L2	CO3	5 M
	b)	Discuss belt drives and their applications.	L2	CO3	5 M

I.B.Tech Sem II End Examinations – June-2026
23ES1201-BCME Evaluation Scheme Marks Distribution
PART-A (1 Mark Questions)

1(a) Mention various disciplines of Civil Engineering

- Any four correct disciplines – 0.25 mark each = 1 mark.

1(b) Composition of bricks

- Silica – 0.20 mark
- Alumina – 0.20 mark
- Lime – 0.20 mark
- Iron oxide – 0.20 mark
- Magnesia – 0.20 mark

  If writes all above 5 – 1 mark

1(c) HI Method Check

- Correct expansion of terms – 0.50 mark
- Arithmetic check $\Sigma BS - \Sigma FS$ = Last RL−First RL – 0.50 mark

1(d) Importance of Transportation Engineering

- Each valid point – 0.25 mark (4×0.25=1 mark).

1(e) Difference between Dam and Reservoir

Write definition of each

- Each correct definition – 0.5 mark (2×0.5=1mark).

PART-B (5 Mark Questions)

Q2(a) Geotechnical Engineering

1. Introduction – 1 mark
2. Any four explained points – 4 marks (1 mark each)

Q2(b) Cement Concrete

1. Introduction – 1
2. Advantages – 2
3. Types – 2

Q3(a) Civil Engineering Disciplines

1. Introduction –1
2. Five disciplines –3
3. Conclusion –1

Q3(b) Aggregates

1. Definition–1
2. Origin–1
3. Size–1
4. Shape–2

Q4(a) Bearings

1. Definition/Types–1
2. WCB–2
3. QB–2

Q4(b) Levelling Numerical

1. Given–1
2. Formula–1
3. Calculations–2
4. Check & final answer–1

Q5(a) Levelling Methods

1. Definition–1
2. Methods–2
3. Explanation–2

Q5(b) Contours

1. Definition–1
2. Characteristics–3
3. Sketch/Conclusion–1

Q6(a) Flexible vs Rigid Pavements

1. Definition–1
2. 10 differences–4

Q6(b) Drinking Water

1. Definition–1
2. Qualities–3
3. Conclusion–1

Q7(a) Transportation

1. Introduction–1
2. Modes–2
3. Differences–2

Q7(b) Rainwater Harvesting

1. Introduction–1
2. Advantages–3
3. Applications/Conclusion–1

B.Tech I Year II Semester End Examinations June-2026
23ES 1201- Basic Civil & Mechanical Engineering
ANSWER KEY

PART-A (Each Question Carries 1 Mark)

1(a) Mention various disciplines of Civil Engineering.
Structural Engineering, Geotechnical Engineering, Transportation Engineering, Environmental Engineering, Water Resources Engineering, Surveying & Geomatics, Construction Engineering & Management, and Urban Planning.

1(b) Interpret the composition of bricks.
Good brick earth consists of Silica (50–60%), Alumina (20–30%), Lime (2–5%), Iron Oxide (5–6%) and Magnesia (about 1%). Silica prevents cracking, alumina provides plasticity, lime acts as a flux, iron oxide gives colour and strength, while magnesia reduces shrinkage.

1(c) Explain the check used in Height of Instrument (HI) method and its terms.
Terms: BS–Back Sight, FS–Fore Sight, HI–Height of Instrument, RL–Reduced Level.
Formulae: HI = RL + BS;
RL = HI − FS.
Arithmetic check: $\Sigma BS - \Sigma FS$ = Last RL − First RL.

1(d) Illustrate the importance of transportation engineering in Nation's economic development.
Transportation engineering improves connectivity, facilitates trade and commerce, supports industries and agriculture, reduces travel time and transportation cost, promotes tourism, creates employment and accelerates regional and national economic growth.

1(e) Differentiate between Dams and Reservoirs.
Dam: A structure constructed across a river to obstruct and control water.
Reservoir: The water storage basin formed behind the dam for irrigation, drinking water, flood control and hydropower.

PART-B (EACH QUESTION CARRIES 10 MARKS)

2(a) Describe the Geo-technical engineering discipline in detail. (5 MARKS)

Geotechnical Engineering deals with the engineering behaviour of soil and rock and their application in foundation and earthwork design.

1. Study of soil and rock properties such as strength, compressibility, permeability and bearing capacity.
2. Site investigation by boreholes, sampling and field exploration before construction.
3. Soil testing in laboratory and field to determine engineering properties.
4. Design of shallow and deep foundations based on soil conditions.
5. Analysis and construction of retaining walls, earth dams, embankments and tunnels.
6. Ground improvement using compaction, grouting and stabilization techniques.
7. Ensures safe, stable and economical construction.

2(b) Summarize the popularity of cement concrete as a construction material and types of concrete. (5 MARKS)

Cement concrete is one of the most widely used construction materials in the world. It is a mixture of cement, fine aggregate (sand), coarse aggregate (gravel or crushed stone), and water. When these materials are mixed in proper proportions, they form a strong, durable, and workable material suitable for almost all types of civil engineering structures. Because of its excellent engineering properties and versatility, concrete is used in buildings, bridges, dams, roads, airports, tunnels, and water-retaining structures.

Popularity of Cement Concrete as a Construction Material

1. High Compressive Strength

- Concrete possesses high compressive strength, enabling it to withstand heavy loads.
- It is suitable for constructing foundations, columns, beams, bridges, and high-rise buildings.

2. Durable and Long Service Life

- Concrete is highly resistant to weathering, moisture, and environmental effects.
- Properly designed concrete structures can last for several decades with minimum deterioration.

3. Can Be Moulded into Any Shape

- Fresh concrete is plastic and can be cast into any desired shape and size.
- This property allows the construction of complex architectural and structural forms.

4. Fire and Water Resistant

- Concrete is non-combustible and provides excellent resistance to fire.
- It also performs well in water-retaining structures such as dams, reservoirs, tanks, and canals.

5. Economical

- The ingredients of concrete (cement, sand, aggregates, and water) are readily available.
- It offers an economical solution for both small and large construction projects.

6. Low Maintenance

- Concrete structures require comparatively less maintenance than steel or timber structures.
- They have low repair costs over their service life.

7. **Good Bond with Steel**
   - Concrete develops an excellent bond with steel reinforcement.
   - This property makes **Reinforced Cement Concrete (RCC)** suitable for modern structural construction.
8. **Versatile Material**
   - Concrete can be produced with different strengths and properties by altering the mix proportions and using admixtures.
   - It is suitable for residential, commercial, industrial, hydraulic, and transportation structures.

Types of Concrete

1. **Plain Cement Concrete (PCC)**
   - Contains cement, sand, coarse aggregate, and water without steel reinforcement.
   - Used for flooring, pavements, foundations, and levelling courses.
2. **Reinforced Cement Concrete (RCC)**
   - Concrete reinforced with steel bars or steel mesh.
   - Used for beams, slabs, columns, bridges, and multistorey buildings.
3. **Prestressed Concrete (PSC)**
   - Steel tendons are prestressed before applying loads.
   - Used for long-span bridges, flyovers, railway sleepers, and large industrial structures.
4. **Precast Concrete**
   - Concrete members are cast in factories and transported to the construction site.
   - Used for wall panels, beams, columns, pipes, and bridge components.
5. **Ready Mix Concrete (RMC)**
   - Concrete manufactured in batching plants and delivered to the site in transit mixers.
   - Ensures better quality control, uniformity, and faster construction.
6. **Lightweight Concrete**
   - Manufactured using lightweight aggregates or air voids.
   - Used in roofs, partition walls, and thermal insulation.
7. **High-Density Concrete**
   - Made using heavy aggregates such as barite or magnetite.
   - Used in nuclear power plants and radiation shielding structures.
8. **Polymer Concrete**
   - Prepared by using polymer binders or polymer-modified cement.
   - It has high strength, excellent durability, and superior chemical resistance.
   - Used in marine structures, industrial floors, sewage works, and waterproofing.
9. **Fibre Reinforced Concrete (FRC)**
   - Contains steel, glass, or synthetic fibres.
   - Improves tensile strength, crack resistance, impact resistance, and durability.

3(a) Demonstrate the importance of various disciplines of civil engineering for infrastructural development of a nation. (5 MARKS)

Civil Engineering is one of the oldest and most important branches of engineering. It deals with the **planning, design, construction, operation, and maintenance** of infrastructure such as buildings, roads, bridges, dams, airports, railways, water supply systems, and environmental facilities. The various disciplines of civil engineering work together to ensure the sustainable growth and economic development of a nation.

Importance of Various Disciplines of Civil Engineering

1. Structural Engineering

- Structural Engineering deals with the analysis and design of buildings, bridges, flyovers, towers, and other structures.
- It ensures that structures are safe, strong, durable, and economical.
- Proper structural design minimizes the risk of failure due to earthquakes, wind, and other loads.
- It plays a vital role in developing modern cities and urban infrastructure.

2. Geotechnical Engineering

- Geotechnical Engineering deals with the study of soil and rock for construction purposes.
- It helps in selecting suitable foundation types and improving weak soil conditions.
- It ensures the stability of buildings, dams, embankments, tunnels, and retaining walls.
- Proper geotechnical investigation prevents settlement and structural failures.

3. Transportation Engineering

- Transportation Engineering involves the planning, design, construction, and maintenance of roads, highways, railways, airports, harbours, and metro systems.
- It improves connectivity between rural and urban areas.
- Efficient transportation promotes trade, tourism, industries, and economic development.
- It reduces travel time and transportation costs.

4. Water Resources Engineering

- Water Resources Engineering deals with the development and management of water resources.
- It includes the construction of dams, reservoirs, canals, irrigation systems, and flood control structures.
- It ensures the availability of water for drinking, agriculture, industries, and hydroelectric power generation.
- It helps in conserving water resources and managing floods and droughts.

5. Environmental Engineering

- Environmental Engineering focuses on protecting the environment and public health.
- It deals with water supply, wastewater treatment, solid waste management, air pollution control, and environmental protection.
- It provides safe drinking water and proper sanitation facilities.
- It helps maintain a clean and healthy environment.

3(b) Classify aggregates based on origin, size and shape for use in construction. (5 MARKS)

1. **By Origin:** Natural, Artificial and Recycled.
2. **By Size:** Fine (<4.75 mm) and Coarse (>4.75 mm).
3. **By Shape:** Rounded, Irregular, Angular, Flaky, Elongated and Flaky & Elongated.
4. Natural aggregates are obtained from rivers and quarries.
5. Artificial aggregates are manufactured for special purposes.
6. Proper selection improves concrete strength and durability.

Applications

- Fine aggregate → Mortar and plaster
- Coarse aggregate → Concrete

4(a) Classify bearings and illustrate systems of measuring horizontal angles in WCB and QB with examples. (5 MARKS)

Definition: Bearing is the horizontal angle measured between the reference meridian and a survey line.

Classification

- Whole Circle Bearing
- Quadrantal Bearing

1. WCB is measured clockwise from North (0°–360°).
2. QB is measured from North/South towards East/West (0°–90°).
3. WCB examples: 60°, 145°, 300°.
4. QB examples: N30°E, S45°W, N70°W, S20°E.
5. WCB is easy for calculations; QB is easy for field description.
6. Bearings are measured using a compass.

4(b) A staff is held on a benchmark (BM) of RL 100.00 m. The Backsight (BS) is 1.50 m. The staff is then held on a point A, and the Foresight (FS) is 2.20 m. Calculate the RL of point A. (5 MARKS)

Given Data

- Reduced Level (RL) of Benchmark (BM) = **100.00 m**
- Backsight (BS) = **1.50 m**
- Foresight (FS) = **2.20 m**

Formula Used (Height of Instrument Method)

1. **Height of Instrument (HI)**

$$HI = RL + BS$$

Reduced Level (RL) of the next point

$$RL = HI - FS$$

Step 1: Calculate the Height of Instrument (HI)

$$HI = RL + BS$$
$$HI = 100.00 + 1.50$$
$$HI = 101.50 \text{ m}$$

Step 2: Calculate the Reduced Level (RL) of Point A

$$RL = HI - FS$$
$$RL = 101.50 - 2.20$$
$$RL = 99.30\text{m}$$

Arithmetic Check

For a single instrument setup,

$$\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}$$
$$1.50 - 2.20 = 99.30 - 100.00$$
$$-0.70 = -0.70$$

Hence, the calculation is **correct**.

Observation Table

Station	BS (m)	HI (m)	FS (m)	RL (m)
BM	1.50	101.50	–	100.00
A	–	–	2.20	99.30

Final Answer

RL of Point A = 99.30 m.

5(a) What are the various levelling methods? Explain any one method used to determine the reduced level of a point. (5 MARKS)

Levelling is the branch of surveying used to determine the difference in elevation (height) between two or more points on the earth's surface. It is also used to establish points at a required elevation for construction works such as roads, buildings, canals, railways, and dams.

Various Methods of Levelling

The commonly used methods of levelling are:

1. **Simple Levelling**
   - Used when the two points are visible from a single instrument position.
   - Suitable for determining the difference in elevation between nearby points.
2. **Differential Levelling**
   - Used when the points are far apart or when the difference in elevation is large.
   - The level instrument is shifted several times using change points.
3. **Fly Levelling**
   - Used to transfer the Reduced Level (RL) from one benchmark to another quickly.
   - Commonly employed before starting or after completing a survey.
4. **Profile (Longitudinal) Levelling**
   - Used to determine the ground profile along the center line of roads, railways, canals, and pipelines.
5. **Reciprocal Levelling**
   - Used when two points are separated by obstacles such as rivers or valleys.
   - It minimizes errors due to curvature of the earth and atmospheric refraction.
6. **Check Levelling**
   - Performed to verify the accuracy of levelling work and to ensure that no mistakes have occurred.
7. **Precise Levelling**
   - A highly accurate method carried out using precise instruments and strict procedures.
   - Used for major engineering and geodetic projects.

Height of Instrument (HI) Method

The **Height of Instrument (HI) Method** is the simplest and most widely used method for determining the **Reduced Level (RL)** of a point.

Principle

In this method, the **Height of Instrument (HI)** is first calculated using the known Reduced Level (RL) of a benchmark and the **Backsight (BS)** reading. The RL of the unknown point is then obtained by subtracting the **Foresight (FS)** or **Intermediate Sight (IS)** from the HI.

Formulae

- **Height of Instrument**

HI=RL+BSHI = RL + BSHI=RL+BS

- **Reduced Level**

RL=HI−FS or

RL=HI−IS

Procedure

1. Set up the level instrument at a suitable position.
2. Take a **Backsight (BS)** reading on a benchmark whose RL is known.
3. Calculate the **Height of Instrument (HI)**.
4. Take **Intermediate Sight (IS)** or **Foresight (FS)** readings on the required points.
5. Calculate the **Reduced Level (RL)** of each point using the formula: RL=HI−FS

Check the accuracy using the arithmetic check:

$$\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}$$

Rise and Fall Method

The Rise and Fall Method is one of the methods used in levelling to determine the Reduced Levels (RLs) of various points. In this method, the difference in elevation between two consecutive points is determined by comparing their staff readings. If the next staff reading is smaller than the previous reading, it indicates a Rise; if it is larger, it indicates a Fall. The Reduced Level of each point is then calculated accordingly.

Principle

The method is based on the principle that:

- **Smaller next staff reading → Rise**
- **Larger next staff reading → Fall**

The RL of each point is obtained by adding the rise or subtracting the fall from the RL of the previous point.

Formulae

- Rise = Previous Staff Reading − Present Staff Reading
- Fall = Present Staff Reading − Previous Staff Reading

If there is a **Rise**:

$$RL_{new} = RL_{previous} + \text{Rise}$$

If there is a **Fall**:

$$RL_{new} = RL_{previous} - Fall$$

Procedure

1. Set up the level instrument and take a **Backsight (BS)** reading on the benchmark.
2. Take staff readings on the subsequent points.
3. Compare two consecutive staff readings.
4. Determine whether there is a **Rise** or a **Fall**.
5. Calculate the Reduced Level (RL) of each point using the appropriate formula.
6. Continue the process until all points are completed.
7. Verify the calculations using the arithmetic check.

Arithmetic Check

The Rise and Fall Method provides two independent checks:

$$\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall = Last\ RL - First\ RL$$

If all these values are equal, the calculations are correct.

5(b) Illustrate the characteristics of a contour map with neat sketches. (5 MARKS)

The contours have the following characteristics:

1. Contour lines must close, not necessarily in the limits of the plan.
2. Widely spaced contour indicates flat surface.
3. Closely spaced contour indicates steep ground.
4. Equally spaced contour indicates uniform slope.
5. Irregular contours indicate uneven surface.
6. Approximately concentric closed contours with decreasing values towards centre (Fig. 1) indicate a pond.
7. Approximately concentric closed contours with increasing values towards centre indicate hills.
8. Contour lines with U-shape with convexity towards lower ground indicate ridge (Fig. 2)
9. Contour lines with V-shaped with convexity towards higher ground indicate valley.
10. Contour lines generally do not meet or intersect each other.
11. If contour lines are meeting in some portion, it shows existence of a vertical cliff. (Fig. 3)
12. If contour lines cross each other, it shows existence of overhanging cliffs or a cave (Fig. 4).

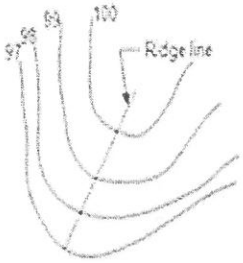

Fig. 1

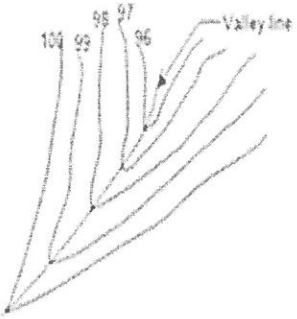

Fig.2

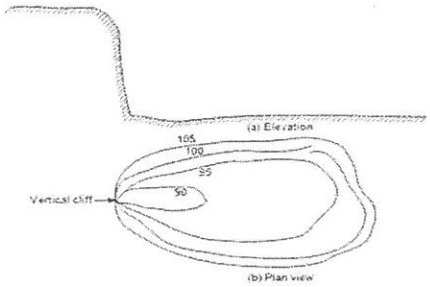

Fig. 3

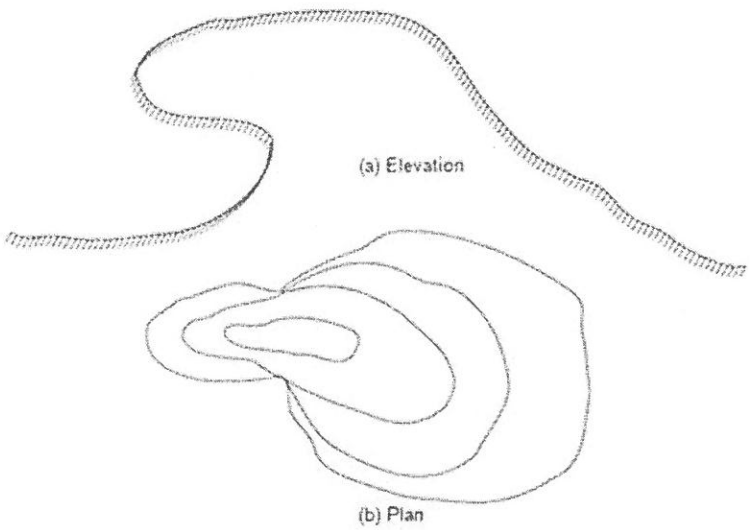

Fig. 4

6(a) Interpret the key differences between flexible and rigid pavements. (5 MARKS)

S. No.	Flexible Pavement	Rigid Pavement
1	Constructed using **bitumen/asphalt** and aggregates.	Constructed using **cement concrete (PCC/RCC).**
2	Load is transferred **layer by layer** to the subgrade.	Load is distributed through **slab action** over a larger area.
3	Flexible in nature and undergoes slight deformation under traffic.	Rigid in nature with very little deformation.
4	**Lower initial construction cost.**	**Higher initial construction cost.**
5	Requires **frequent maintenance** and periodic resurfacing.	Requires **less maintenance** during its service life.
6	Service life is **10–15 years** (approximately).	Service life is **20–30 years or more.**
7	Construction is **faster** and can be opened to traffic quickly.	Construction is **slower** due to concrete curing.
8	More affected by **temperature changes** (softens in hot weather).	Less affected by temperature; **expansion joints** are provided.
9	Suitable for **low and medium traffic** roads.	Suitable for **heavy traffic**, highways, airports, and industrial roads.
10	Lower strength but provides a smooth riding surface initially.	Higher strength, greater durability, and better resistance to heavy loads.

6(b) Explain various qualities of drinking water. (5 MARKS)

Drinking water (potable water) is water that is **safe, clean, and fit for human consumption**. It should be free from harmful microorganisms, toxic substances, unpleasant taste, odour, and colour. Good quality drinking water is essential for maintaining public health and preventing water-borne diseases.

Qualities of Good Drinking Water

1. Clear and Colourless

- Drinking water should be clear, transparent, and free from suspended impurities such as mud, silt, and clay.
- It should not have any objectionable colour.

2. Odourless

- Water should be free from unpleasant smell or odour.
- Bad odour may indicate the presence of decaying organic matter, sewage, or harmful gases.

3. Pleasant Taste

- Good drinking water should have a pleasant and refreshing taste.
- Unpleasant taste may result from excessive salts, dissolved gases, or industrial pollutants.

4. Free from Disease-Causing Microorganisms

- Drinking water should be free from bacteria, viruses, protozoa, and other pathogens.
- Water contaminated with microorganisms can cause diseases such as cholera, typhoid, dysentery, and hepatitis.

5. Low Turbidity

- Turbidity is caused by suspended particles.
- Drinking water should have very low turbidity, making it suitable for consumption and disinfection.

6. Proper pH Value

- The pH of drinking water should be between 6.5 and 8.5.
- Water outside this range may be acidic or alkaline and can affect health, plumbing systems, and water quality.

7. Free from Harmful Chemicals

- Drinking water should not contain harmful chemicals such as:
  - Arsenic
  - Lead
  - Mercury
  - Fluoride (in excess)
  - Pesticides
  - Industrial wastes
- These substances can cause serious health problems.

8. Acceptable Hardness

- Water should have moderate hardness.
- Excessively hard water causes scaling in pipes and reduces the effectiveness of soap, while very soft water may be corrosive.

9. Adequate Dissolved Oxygen

- Good quality water should contain sufficient dissolved oxygen, which indicates freshness and improves taste.
- It also helps maintain aquatic life in natural water sources.

10. Free from Suspended and Dissolved Impurities

- Drinking water should be free from excessive suspended solids, dissolved salts, and organic matter.
- It should meet the permissible limits prescribed by drinking water quality standards.

7(a) Describe various modes of transportation and differentiate highway transportation from other modes. (5 MARKS)

Transportation is the movement of people and goods from one place to another. It plays a vital role in the economic, industrial, social, and cultural development of a country. An efficient transportation system facilitates trade, agriculture, industries, tourism, and national defence. The major modes of transportation are roadways, railways, waterways, airways, pipelines, and ropeways.

Various Modes of Transportation

1. Road Transportation (Highways)

- It is the most common and widely used mode of transportation.
- It consists of roads, highways, streets, and expressways.
- Suitable for transporting both passengers and goods over **short and medium distances**.
- Provides **door-to-door service** and connects rural as well as urban areas.

Examples:

Cars, buses, trucks, motorcycles, auto-rickshaws, bicycles.

2. Railway Transportation

- Railways transport passengers and heavy goods over **long distances**.

- Suitable for carrying bulk materials such as coal, cement, steel, and food grains.
- More economical than road transport for heavy loads.

Examples:

Passenger trains, freight trains, metro rail.

3. Water Transportation

- Transportation through **rivers, canals, lakes, seas, and oceans**.
- Cheapest mode for transporting bulky and heavy goods over long distances.
- Mainly used for international trade and coastal transport.

Examples:

Ships, boats, barges, ferries.

4. Air Transportation

- Fastest mode of transportation.
- Used for transporting passengers and valuable or perishable goods over long distances.
- Essential for emergency services and international travel.

Examples:

Aeroplanes, helicopters, cargo aircraft.

5. Pipeline Transportation

- Used for transporting **liquids and gases** continuously.
- Requires less manpower and has low operating costs.
- Commonly used for petroleum products and natural gas.

Examples:

Oil pipelines, gas pipelines, water pipelines.

6. Ropeway (Cableway) Transportation

- Used in hilly and mountainous regions.
- Suitable for transporting passengers and light goods where roads are difficult to construct.
- Also used in mining and tourism.

Examples:

Cable cars, ropeways.

Difference Between Highway Transportation and Other Modes

S. No.	Highway Transportation (Roadways)	Other Modes of Transportation
1	Provides **door-to-door service**.	Usually provides **terminal-to-terminal service** (railway stations, airports, ports).
2	Routes are **flexible** and can be changed easily.	Routes are generally **fixed** (rail tracks, air routes, waterways).
3	Best suited for **short and medium distances**.	More suitable for **long-distance transportation**.
4	Initial investment is **comparatively low**.	Requires **high initial investment** for tracks, airports, ports, etc.
5	Connects **villages, towns, and cities directly**.	Does not reach remote areas directly; depends on roads for last-mile connectivity.
6	Suitable for **small quantities and perishable goods**.	Suitable for **bulk goods and heavy loads** (especially railways and waterways).
7	More flexible in terms of timing and scheduling.	Operates according to fixed schedules and timetables.
8	Faster for local transportation.	Air transport is fastest for long distances, while rail and waterways are slower but economical.
9	Maintenance cost is comparatively higher due to frequent repairs.	Maintenance depends on the mode but infrastructure is generally more permanent.
10	Acts as a **feeder service** to railways, airports, and seaports.	Other modes depend on roads to transport passengers and goods to and from terminals.

7(b) Discuss the advantages of rainwater harvesting. (5 MARKS)

Rainwater Harvesting (RWH) is the process of **collecting, storing, and utilizing rainwater** for future use instead of allowing it to flow away as surface runoff. Rainwater may be collected from rooftops or open surfaces and stored in tanks or used to recharge groundwater. It is an economical and environmentally friendly method of water conservation.

Advantages of Rainwater Harvesting

1. Recharges Groundwater

- Rainwater harvesting helps replenish underground aquifers by allowing rainwater to percolate into the soil.
- It increases the groundwater level and reduces the depletion caused by excessive pumping.

2. Reduces the Effects of Drought

- Stored rainwater can be used during dry seasons and periods of low rainfall.
- It provides an alternative source of water for domestic, agricultural, and industrial purposes during water scarcity.

3. Improves Groundwater Table and Saves Energy

- Recharging aquifers raises the groundwater table, reducing the depth from which water must be pumped.
- This decreases the energy required to lift water, resulting in lower electricity costs.

4. Environmentally Friendly

- Storing rainwater underground reduces evaporation losses.

- It helps prevent seawater intrusion into coastal aquifers and protects ecosystems that depend on groundwater.
- It also reduces soil erosion and maintains ecological balance.

5. Cost-Effective Method

- Rainwater harvesting systems are economical to install and maintain.
- They reduce dependence on municipal water supply and lower household water bills.
- It is a long-term investment that provides continuous benefits.

6. Conserves Water Resources

- Rainwater harvesting promotes efficient utilization of natural rainfall.
- It reduces wastage of rainwater and supports sustainable water management.
- It helps meet future water demands without overexploiting natural resources.

7. Reduces Surface Runoff and Flooding

- Collecting rainwater decreases the amount of runoff flowing into drains and rivers.
- This helps reduce urban flooding, waterlogging, and soil erosion during heavy rainfall.

8. Improves Water Availability

- Stored rainwater can be used for gardening, washing, flushing toilets, irrigation, and after suitable treatment, even for drinking.
- It provides a reliable source of water throughout the year.

9. Reduces Dependence on External Water Supply

- Households, industries, and institutions become less dependent on municipal water supply and groundwater extraction.
- This improves water security, especially during summer months.

10. Supports Sustainable Development

- Rainwater harvesting promotes water conservation, environmental protection, and sustainable use of natural resources.
- It ensures that future generations have access to adequate water resources.

1. part – A, [10 Qsns] 2 M
[5 Qsns for two parts] 8M
BCME
BEEE

2. part – B [5 Qsns choice]
[3 Qsns for two parts]
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BEEE

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ME

I B.Tech – II Semester – Regular Examinations – June 2026

BASIC CIVIL & MECHANICAL ENGINEERING (23ES1201)

KEY and Scheme of evaluation

PART – B

1. f) A machine is a physical device that uses energy to apply forces, control movement, and perform tasks (1M)

1. g) Nonferrous metals example - Aluminium, Copper, Tin, Lead, Nickel (1M)

1. h) Casting is a process of pouring liquid metal into a mold (mould) containing the hollow shape of the desired outcome. (1M)

1. i) CNC machine is a manufacturing process that uses computerized controls and rotating cutting tools to remove material from a workpiece. (1M)

1. j) Belt drive is a mechanism that transmits rotational motion from one pulley mounted on a shaft to another by means of a belt. (1M)

UNIT – I

8. a) Ceramic materials and their applications (5M)

The ceramic materials consist of compounds of metallic and nonmetallic elements that exhibit useful properties like strength and hardness, high melting temperatures, chemical resistance and low thermal and electrical conductivity. Ceramics include a wide variety of substances such as brick, stone, concrete, glass. The common ceramic products are made from common naturally occurring minerals such as clay and sand for the pottery, bricks, etc. Some of their examples are Tungsten carbide, Silicon carbide, Beryllia, Zirconia, Alumina, Magnesia.

Applications of Ceramics

Traditional Ceramics: Traditional ceramic items are almost as old as the human race. Examples like brick, tiles, pot and decorating articles.

Automotive Ceramics: Some advanced ceramics are used for making spark plugs, catalysts, emission control devices, and sensors of various kinds in automobiles.

Conductive Ceramics: Electronically, conductive ceramics are used as transistors, semiconductors.

Nuclear Ceramics: In nuclear power generation, oxide ceramics are used to make uranium and plutonium fuel pellets for both water-cooled and liquid-metal-cooled reactors.

Optical Ceramics: Optical materials derive their utility from their response to infrared, optical and ultraviolet lights. The most obvious optical materials are glasses.

Advanced ceramics: Advanced ceramics have been developed for use as tools, rockets, missile applications.

b) Importance of mechanical engineering in society (5M)

i. Safety - Mechanical engineers are fundamentally responsible for establishing structural integrity and public welfare.
ii. Security - On a structural and systemic level, mechanical systems secure our environments and daily operation.
iii. Efficiency - Mechanical engineering is vital to optimizing resources and minimizing energy waste across global industries.
iv. Comfort - Virtually all elements that make modern daily life convenient and pleasant stem from mechanical design.

OR

9. a) Classification of engineering materials (5M)

Engineering materials are essential components in various industries and play a crucial role in the design and manufacturing of products. These materials possess specific properties and characteristics that make them suitable for particular engineering applications. When selecting engineering materials for a specific application, engineers consider factors such as mechanical properties, thermal conductivity, electrical conductivity, corrosion resistance, and cost. The choice of materials can significantly impact the performance, reliability, and cost-effectiveness of the final product or structure.

Types of engineering materials

1. Metals
   - Ferrous
   - Non- Ferrous
2. Ceramics
3. Composites
4. Smart Materials

Ferrous metals are a category of metals that are primarily composed of iron and have iron as their main constituent.

Non-ferrous metals are metals that do not contain significant amounts of iron in their composition

Ceramic materials are a class of inorganic, non-metallic compounds made primarily from elements such as oxygen, nitrogen, carbon and metals.

Composite materials often referred to as composites. They are engineered materials made by combining two or more constituent materials with distinct physical and chemical properties to create a material that exhibits improved or tailored characteristics.

Smart materials are also known as intelligent or responsive materials. These materials can be altered or controlled in response to external stimuli, such as temperature, pressure, electric or magnetic fields, light or chemical compounds. These materials have the ability to sense changes in their environment and adapt their behavior accordingly.

b) Properties and applications of ferrous and non-ferrous metals (5M)

Ferrous metals

Ferrous Metal	Properties	Applications
Wrought iron	Strength, fatigue resistance etc	Bolts and nuts, chain, crane hooks, railway couplings, pipe and fittings
Cast iron	Compressive strength, brittle	Engine blocks, cylinder heads, gearbox cases
Steel	Tensile strength, rigidity	Structural beams, vehicle frames, wires, cutting tools
Alloy Steel	Strength, hardness, wear resistance	Heavy-duty machinery, gears, pipelines, automotive parts.

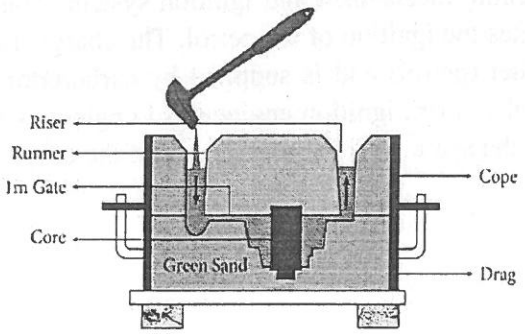
Non-Ferrous metals

Non-Ferrous Metal	Properties	Applications
Aluminum	High thermal and electrical conductivity, good machinability, formability, castability and non-magnetic	Air craft and automobile industry, door and window frames, electric wires, cables
Copper	Soft, malleable, good conductor of electricity	Electric cables and wires for electric machinery and appliances, refrigerators etc
Lead	Corrosion resistant, good lubricant	Acid tanks, water pipes, batteries, bearings etc
Tin	Soft and malleable	Protective coating, tin foil

UNIT – II

10. a) Casting process (5M)

In casting, liquid metal is poured into the cavity of a mold, which can be expendable or reusable. The liquid then cools into a solid object with the same shape as the mold. An attractive feature of casting is that complex shapes can be produced as solid objects without the need to join any piece.



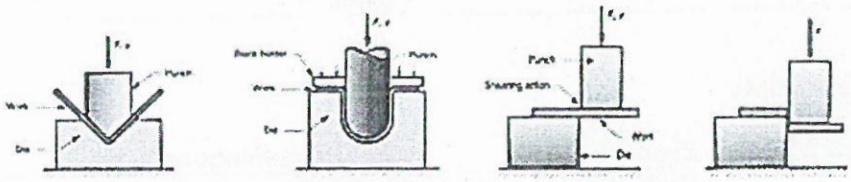
Advantages:

i) Casting is an efficient process for creating many copies of a three- dimensional object, and, for that reason, cast components are relatively inexpensive.

ii) Casting can be used with a wide range of materials, including metals (such as steel, aluminum, and copper), non-metals (such as plastics and ceramics), and even composite material

b) Forming process (5M)

Forming is a manufacturing process that uses suitable stresses such as compression, tension or shear to deform the material and get the desired shape. This process involves deformation and displacement of material leading to no material removal or loss of material.



1. Bulk deformation process (low surface area to volume ratio).

   Forging: Applies compressive forces to shape the material.

   Rolling: The process of shaping metals & alloys is plastically deformed into semi-finished or finished condition by passing between the rolls.

   Extrusion: Extrusion process of confining the metal in a closed cavity and then allowing it to flow from only one opening. The extrusion process is just like often compared to the squeezing of tooth paste from a tube.

   Drawing: It refers to the forming of a flat metal sheet into a hollow or concave shape.

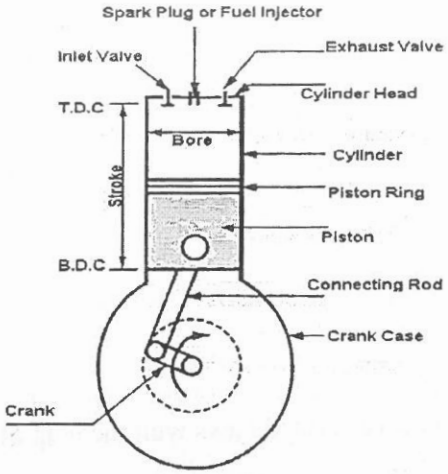
2. Sheet metal working processes (high surface area to volume ratio).

   Press working is the term often applied to sheet metal operations because the machines used to perform these operations are presses.

OR

11. a) 4 Stroke IC engine (5M)

The main components of the engine are cylinder, piston, connecting rod, crankshaft, inlet and exhaust valves, valve opening mechanism and ignition system. The spark plug fitted at the top of the cover end initiates the ignition of the petrol. The charge used in a 4-s petrol engine is a mixture of air and fuel (petrol) and is supplied by carburettor in suitable proportions. Petrol engines are also called spark ignition engines (S I engines) since the charge is ignited by the spark generated by the spark plug fitted at the top of the cover end.



Working of Four-Stroke Petrol Engine

1. Suction Stroke: During this stroke, the inlet valve is kept opened and the exhaust valve is closed. The piston comes down to the bottom dead centre (BDC) from the top dead centre (TDC). Pressure in the cylinder will be slightly less than the atmospheric pressure. Petrol–air in the correct proportion from the carburetter is drawn inside the engine cylinder through the inlet valve.

2. Compression Stroke: In this stroke, both the inlet and exhaust valves are kept closed. The mixture of petrol–air is compressed when the piston moves up to TDC. The compression ratio varies from 7–10 for petrol engines. The ratio between the cylinder volume before compression to the volume after compression is known as the compression ratio. At the end of the compression stroke, a spark is produced at the spark plug due to which combustion starts resulting in high pressure and temperature which are comparatively less than that of a diesel engine.

3. Working or Power Stroke: During this stroke, both valves are kept closed. The piston is pushed down from TDC to BDC. The force above the piston is transmitted to the crank shaft through the connecting rod and crank mechanism. Excess energy due to the combustion is stored in the flywheel which helps for the operation of three idle strokes.

4. Exhaust Stroke: During the stroke, the exhaust valve is kept opened and the inlet valve is kept closed. The piston moves up from BDC to TDC. The waste gases are sent out through the exhaust valve and the cycle is repeated. This is also called scavenging. During these four strokes, the crank shaft will make two revolutions. The thermal efficiency of a four-stroke engine is higher compared to a two-stroke cycle engine. Most of the cars operate on a 4-stroke cycle

b) Machining processes (5M)

Machining is a process in which a material (often metal) is cut to a desired final shape and size by a controlled material-removal process.

Milling: Milling is a process of removal of material from a workpiece using rotary cutters and getting the desired shape.

Turning: Turning is a process of removal of unwanted material from circular parts using a cutting tool. This process requires a lathe, workpiece, fixture, and a cutting tool.

Shaping: Shaping process uses a cutting tool that reciprocates against a stationary workpiece producing a plane or a desired surface.

Drilling: Drilling process uses a drill bit to make a hole of circular cross-section into the solid material.

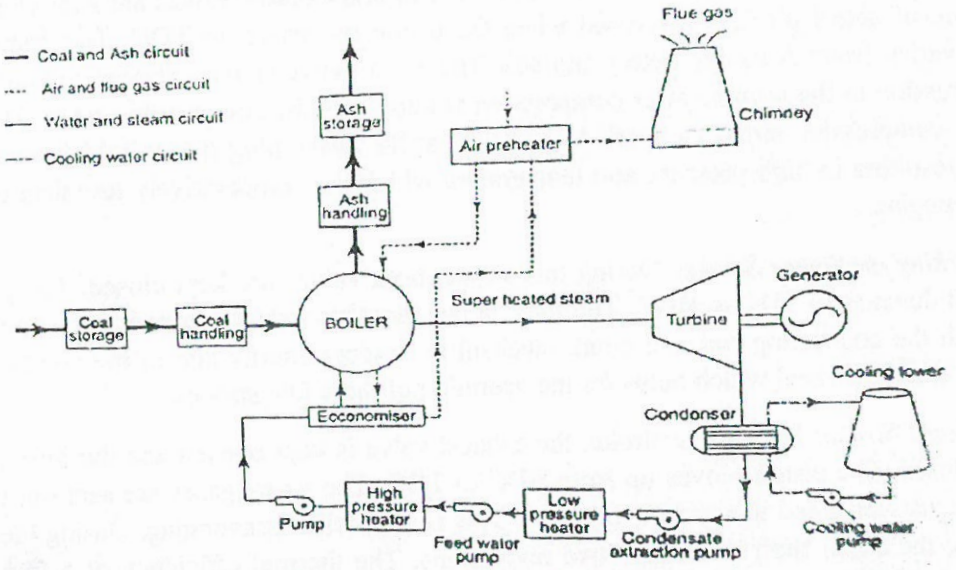
Honing: Honing process produces a precision surface on a metal workpiece by scrubbing an abrasive stone against it.

Finishing: Finishing process is used to improve appearance, adhesion, wettability, wear resistance, hardness or to remove surface flaws with the help of sanders.

UNIT – III

12. a) Steam power plant (5M)

Steam Power Plant is defined as a power station, where electricity is produced using a steam-driven electric generator. The working fluid is water known as feed water and works with steam cycle. Where Steam is produced from the boiler from water and generated steam is used to rotate turbine. Turbine is a device that convert the energy in a stream of fluid into mechanical energy.



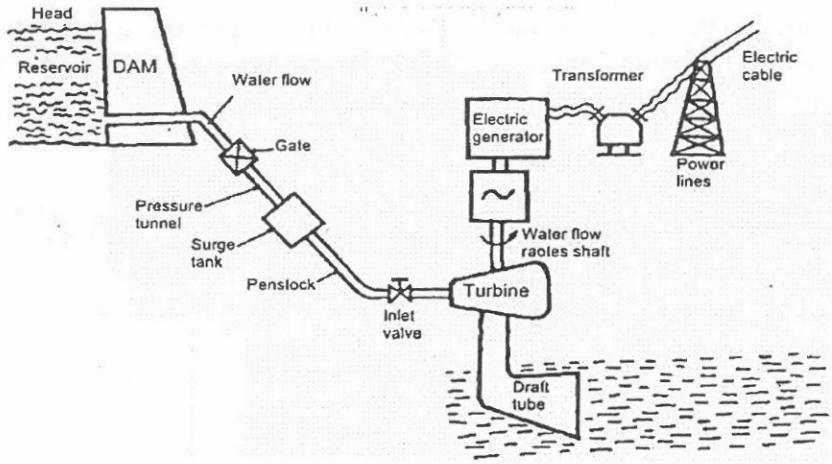
In a steam boiler, the water is heated up by burning the fuel in the air in the furnace, and the function of the boiler is to give dry superheated steam at the required temperature. The steam so produced is used in driving the steam turbines. This turbine is coupled to synchronous generator (usually three-phase synchronous alternator), which generates electrical energy. The exhaust steam from the turbine is allowed to condense into the water in steam condenser of turbine, which creates suction at very low pressure and allows the expansion of the steam in the turbine to very low pressure.

The principal advantage of the condensing operation is to increase the amount of energy extracted per kg of steam and thereby increasing efficiency, and the condensate which is fed

into the boiler again reduces the amount of fresh feed water. The condensate along with some fresh makeup feed water is again fed into the boiler by a pump (called the boiler feed pump). In the condenser, the steam is condensed by cooling water. Cooling water recycles through the cooling tower. This constitutes a cooling water circuit.

b) Hydroelectric power plant (5M)

Hydroelectric power plant is one of the alternate methods of power producing. In this plants water used as working substance. Plant is designed to produce electric power from water so named as hydro-electric power plant. Hydroelectric power plants convert the potential and kinetic energy of water into mechanical energy. This mechanical energy is then used to generate electricity. At the plant level, water flows through a pipe (also known as a penstock) and then spins the blades in a turbine, which, in turn, spins a generator that ultimately produces electricity.



The dam serves as a barrier, raising the water level in the reservoir to increase its potential energy. The height difference between the reservoir and the penstock is the key factor behind the pressure that drives the turbine, generating power. When the control gates are opened, water flows through the penstock toward the turbine. Along the penstock's length, surge tanks and trash racks are strategically placed. The surge tank is vital for preventing water hammering, compensating for sudden changes in load on the turbine and ensuring a consistent flow of water to the turbine, preventing power output fluctuations. Trash racks remove impurities from the water before it reaches the turbine, reducing wear and tear on the turbine and extending its lifespan. As water strikes the turbine blades, it converts the pressure energy into mechanical energy, which is then transformed into electrical energy by the generator. The resulting high-voltage electricity is transmitted to the power grid via transmission lines.

OR

13. a) Nuclear power plant (5M)

Nuclear power plants use nuclear fission to generate electricity. Nuclear fission is the process of splitting heavy nuclei (nucleus) into two other nuclei in this process three additional neutrons are liberated from the nucleus of radioactive atom followed by release of huge

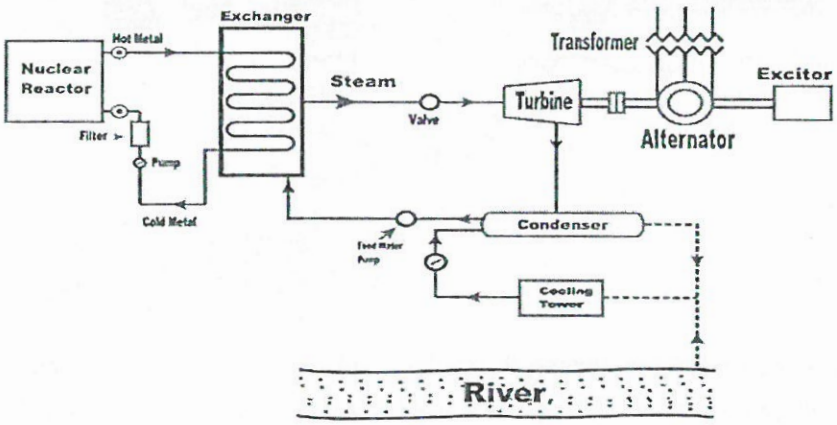
amount of heat energy. The center of the atom is called nucleus. It contains neutrons and protons.

The process involves:

- ✓ Nuclear fission: A controlled nuclear chain reaction that fissions uranium atoms to generate heat.
- ✓ Rankine cycle: Combines the heat from the reactor with water to create steam.
- ✓ Steam: Spins a turbine that drives a generator to produce electricity.

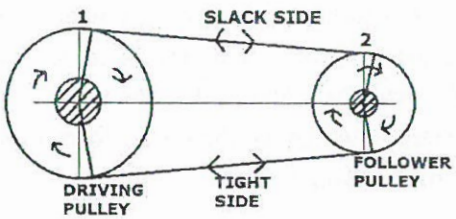
The steam is routed through the reactor's steam system. The turbine blades spin magnetic generators to produce electricity.

In nuclear power plant, the reactor heat by the fission and the heat liberated in the reactor is taken up by the coolant circulating through the reactor core. Heat coolant leaves the reactor at the top and them flows through the tubes of steam generator and passed on its heat to the feed water. The steam so produced expands in the steam turbine producing work and thereafter is condensed in the condenser. The steam turbine in turn runs an electric generator there by producing electrical energy and the process is shown in figure.



b) Belt drive (5M)

In case of belts, friction between the belt and pulley is used to transmit power. In practice, there is always some amount of slip between belt and pulleys.



A belt drive is a method of transferring rotary motion between two shafts.

A belt drive includes one pulley on each pulley.
The motion of the driving pulley is, generally, transferred to the driven pulley via the friction between the belt and the pulley

Applications:
Industrial Machinery

a) *Conveyors:* Used in industries like manufacturing, mining, and logistics for transporting
goods or materials.

b) *Machine Tools:* Belt drives are integral in lathes, milling machines, grinders, and other
machining equipment.

c) *Pumps and Compressors*

Automotive

Engine Systems: Timing belts are used to synchronize the camshaft and crankshaft in internal combustion engines.

Home Appliances

a) *Washing Machines:* Belts facilitate the rotation of the drum during washing and spinning cycles

b) *Fitness Equipment:* Treadmills, stationary bikes, and other exercise machines often use belt drives for the rotating components.

Scheme of Evaluation

1. f) Definition of a machine	1M
1. g) Any two non-ferrous metals	1M
1. h) Principle of casting	1M
1. i) Definition of CNC machine	1M
1. j) Definition of belt drive	1M

UNIT – I

8. a) Discussion about ceramic materials	3M
Applications of ceramic materials	2M
8. b) Listing of importance of mechanical engineering in society	2M
Explanation	3M

OR

9. a) Classification of engineering materials	3M
Examples	2M
9. b) Properties and applications of any two ferrous metals	2.5M
Properties and applications of any two nonferrous metals	2.5M

UNIT – II

10. a) Basic principle of casting process	3M
Advantages of casting process	2M
10. b) Explanation of forming process	3M
Types of forming process	2M

OR

11. a) Diagram of 4 stroke IC engine	3M
Explanation about 4 strokes	2M
11. b) Explanation about machining processes	2M
Applications of machining processes	3M

UNIT – III

12. a) Layout diagram of steam power plant	3M
Explanation	2M
12. b) Layout diagram of hydroelectric power plant	3M
Explanation	2M

OR

13. a) Layout diagram of nuclear power plant	3M
Explanation	2M
13. b) Diagram of a belt drive	3M
Applications of belt drive	2M