RAILWAY RECRUITMENT BOARD

RRB JE

MECHANICAL

&

ALLIED ENGINEERING

SOLVED PAPERS & PRACTICE BOOK

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₹ 595/-

CONTENT

SOLVED PAPERS

PRACTICE SET

SYLLABUS

Government of India, Ministry of Railways,
Railway Recruitment Boards
CENTRALISED EMPLOYMENT NOTICE (CEN) No.03/2018
Recruitment of Junior Engineer (JE), Junior Engineer (Information Technology) [JE(IT)], Depot Material Superintendent (DMS)

2nd Stage CBT : Short listing of Candidates for the 2nd Stage CBT exam shall be based on the normalized marks obtained by them in the 1st Stage CBT Exam. Total number of candidates to be shortlisted for 2nd Stage shall be 15 times the community wise total vacancy of Posts notified against the RRB as per their merit in 1st Stage CBT. However, Railways reserve the right to increase/decrease this limit in total or for any specific category(s) as required to ensure availability of adequate candidates for all the notified posts.

Duration : 120 minutes *(160 Minutes for eligible PwBD candidates accompanied with Scribe)*

No of Questions : 150

Syllabus : The Questions will be of objective type with multiple choices and are likely to include questions pertaining to General Awareness, Physics and Chemistry, Basics of Computers and Applications, Basics of Environment and Pollution Control and Technical abilities for the post. The syllabus for General Awareness, Physics and Chemistry, Basics of Computers and Applications, Basics of Environment and Pollution Control is common for all notified posts under this CEN as detailed below:-

a) **General Awareness :** Knowledge of Current affairs, Indian geography, culture and history of India including freedom struggle, Indian Polity and constitution, Indian Economy, Environmental issues concerning India and the World, Sports, General scientific and technological developments etc.

b) **Physics and Chemistry:** Up to 10th standard CBSE syllabus.

c) **Basics of Computers and Applications:** Architecture of Computers; input and Output devices; Storage devices, Networking, Operating System like Windows, Unix, Linux; MS Office; Various data representation; Internet and Email; Websites & Web Browsers; Computer Virus.

d) **Basics of Environment and Pollution Control:** Basics of Environment; Adverse effect of environmental pollution and control strategies; Air, water and Noise pollution, their effect and control; Waste Management, Global warming; Acid rain; Ozone depletion.

e) **Technical Abilities:** The educational qualifications mentioned against each post shown in Annexure-A, have been grouped into different exam groups as below. Questions on the Technical abilities will be framed in the syllabus defined for various Exam Groups given at Annexure-VII-A, B, C, D, E, F & G.

The section wise Number of questions and marks are as below :

Subjects	No. of Questions	Marks for each Section
	Stage-II	Stage-II
General Awareness	15	15
Physics & Chemistry	15	15
Basics of Computers and Applications	10	10
Basics of Environment and Pollution Control	10	10
Technical Abilities	100	100
Total	150	150
Time in Minutes	120	

The section wise distribution given in the above table is only indicative and there may be some variations in the actual question papers.

Minimum percentage of marks for eligibility in various categories: UR -40%, OBC-30%, SC-30%, ST -25%. This percentage of marks for eligibility may be relaxed by 2% for PwBD candidates, in case of shortage of PwBD candidates against vacancies reserved for them.

Virtual calculator will be made available on the Computer Monitor during 2nd Stage CBT.

2nd Stage Syllabus for Mechanical & Allied Engineering Exam Group – JE

1. **Engineering Mechanics :** Resolution of forces, Equilibrium and Equilibrant, parallelogram law of forces, triangle law of forces, polygon law of forces and Lami's theorem, couple and moment of a couple, condition for equilibrium of rigid body subjected to number of coplanar non-concurrent forces, definition of static friction, dynamic friction, derivation of limiting angle of friction and angle of repose, resolution of forces considering friction when a body moves on horizontal plane and inclined plane, calculation of moment of inertia and radius of gyration of : (a) I-Section (b) channel section (c) T-Section (d) L-Section (Equal & unequal lengths) (e) Z-Section (f) Built up sections (simple cases only), Newton's laws of motion (without derivation), motion of projectile, D'Alembert's principle, definition law of conservation of energy, law of conservation of momentum.
2. **Material Science :** Mechanical properties of engineering materials – tensile strength, compressive strength, ductility, malleability, hardness, toughness, brittleness, impact strength, fatigue, creep resistance. Classification of steels, mild steel and alloy steels. Importance of heat treatment. Heat treatment processes – annealing, normalizing, hardening, tempering, carburizing, nitriding and cyaniding.
3. **Strength of Materials :** Stress, strain, stress strain diagram, factor of safety, thermal stresses, strain energy, proof resilience and modules of resilience. Shear force and bending moment diagram – cant leaver beam, simply supported beam, continuous beam, fixed beam. Torsion in shafts and springs, thin cylinder shells.
4. **Machining :** Working principle of lathe. Types of lathes – Engine lathe – construction details and specifications. Nomenclature of single point cutting tool, geometry, tool signature, functions of tool angles. General and special operations – (Turning, facing, taper turning thread cutting, knurling, forming, drilling, boring, reaming, key way cutting), cutting fluids, coolants and lubricants. Introduction to shaper, slotter, plainer, broaching, milling and manufacture of gears, heat treatment process applied to gears.
5. **Welding :** Welding – Introduction, classification of welding processes, advantages and limitations of welding, principles of arc welding, arc welding equipment, choice of electrodes for different metals, principle of gas (oxy-acetylene) welding, equipment of gas welding, welding procedures (arc & gas), soldering and brazing techniques, types and applications of solders and fluxes, various flame cutting processes, advantages and limitations of flame cutting, defects in welding, testing and inspection modern welding methods, (submerged, CO2, atomic – hydrogen, ultrasonic welding), brief description of MIG & TIG welding.
6. **Grinding & Finishing Process :** Principles of metal removal by grinding, abrasives, natural and artificial, bonds and binding processes, vitrified, silicate, shellac rubber, grinding machines, classification: cylindrical, surface, tool & cutter grinding machine, construction details, relative merits, principles of centreless grinding, advantages & limitations of centreless grinding work, holding devices, wheel maintenance, balancing of wheels, coolants used, finishing by grinding, honing, lapping, super finishing, electroplating, basic principles – plating metals, applications, hot dipping, galvanizing tin coating, parkerising, anodizing, metal spraying, wire process, powder process and applications, organic coatings, oil base paint, lacquer base enamels, bituminous paints, rubber base coating.
7. **Metrology :** Linear measurement – Slip gauges and dial indicators, angle measurements, bevel protractor, sine bar, angle slip gauges, comparators (a) mechanical (b) electrical (c) optical (d) pneumatic. Measurement of surface roughness; methods of measurements by comparison, tracer instruments and by interferometry, collimators, measuring microscope, interferometer, inspection of machine parts using the concepts of shadow projection and profile projection.
8. **Fluid Mechanics & Hydraulic Machinery :** Properties of fluid, density, specific weight, specific gravity, viscosity, surface tension, compressibility capillarity, Pascal's law, measurement of pressures, concept of buoyancy. Concept of Reynold's number, pressure, potential and kinetic energy of liquids, total energy, laws of conservation, mass, energy and momentum, velocity of liquids and discharge, Bernoulli's equation and assumptions, venturimeters, pitottube, current meters. Working principle & constructional details of centrifugal pump, efficiencies – manometric efficiency, volumetric efficiency, mechanical efficiency and overall efficiency, cavitation and its effect, working principle of jet & submersible pumps with line diagrams.
9. **Industrial Management :** Job analysis, motivation, different theories, satisfaction, performance reward systems, production, planning and control, relation with other departments, routing, scheduling, dispatching, PERT and CPM, simple problems. Materials in industry, inventory control model, ABC Analysis, Safety stock, re-order, level, economic ordering quantity, break even analysis, stores layout, stores equipment, stores records, purchasing procedures, purchase records, Bin card, Cardex, Material handling, Manual lifting, hoist, cranes, conveyors, trucks, fork trucks.
10. **Thermal Engineering :** Laws of thermo dynamics, conversion of heat into work vice versa , laws of perfect gases, thermo dynamic processes – isochoric, isobaric, isothermal hyperbolic, isentropic, polytrophic and throttling, modes of heat transfer, thermal conductivity, convective heat transfer coefficient, Stefan Boltzman law by radiation and overall heat transfer coefficient. Air standards cycles – Carnot cycle, Otto cycle, Diesel cycle, construction and working of internal combustion engines, comparison of diesel engine and petrol engine. Systems of internal combustion engine, performance of internal combustion engines. Air compressors their cycles refrigeration cycles, principle of a refrigeration plant.

RAILWAY RECRUITMENT BOARD (RRB)
JUNIOR ENGINEER MECHANICAL
Re-EXAM-2025

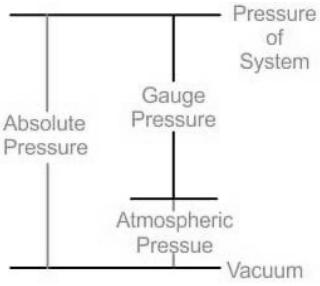
EXAM DATE : 04.06.2025 **EXAM TIME : 9.00AM-11.00AM**

1. Gauge pressure is measured as :

(a) the pressure relative to a perfect vacuum
(b) the difference between absolute pressure and atmospheric pressure
(c) the pressure due solely to the fluid's density
(d) the pressure including atmospheric pressure

Ans. (b) : The gauge pressure is measured as the difference between absolute and atmospheric pressure.
Gauge pressure = Absolute pressure – atmospheric pressure.

- It is pressure measured relative to local atmospheric pressure.
- Gauge pressure is measured above the atmospheric pressure and the atmospheric pressure is taking as datum i.e. atmospheric pressure is marked as zero.
- The absolute pressure measured with respect at zero pressure. It is measured by aneroid barometer.



2. The moment of inertia of a circular area about a tangent to the circle is calculated as the moment of inertia of the circular area about its centroidal axis in the plane of the lamina _____ (where r is the circle radius).

(a) $\times \pi r^2/2$ (b) $+\pi r^4$
(c) $\times 1.5$ (d) $-\pi r^4$

Ans. (b) : The moment of inertia of the circular area about its centroid axis in the plane of the lamina

$I = Ar^2$
$= \pi r^2 \times r^2$
$= \pi r^4$.

3. If any part is immersed in a heated 'magnesium dihydrogen phosphate' solution, then what could be the coating process?

(a) Cladding (b) Anodising
(c) Calorising (d) Parkerizing

Ans. (d) : If any part is immersed in a heated 'magnesium dihydrogen phosphate' solution, then parkerizing could be the coating process.

- Parkerizing is a method of protecting steel surfaces from corrosion and increasing their wear resistance by creating a layer of phosphate crystals on the surface.
- It is a process of applying an anti-corrosion and lubricating phosphatized surface treatment.
- It is also used extensively on automobiles to protect unfinished metal parts from corrosion.
- Anodising is an oxidising process used for aluminium and magnesium articles.

4. According to Herzberg's Two-Factor Theory, the 'hygiene factor' that leads to job dissatisfaction is :

(a) achievement (b) salary
(c) responsibility (d) recognition

Ans. (b) : According to Herzberg's two-factor theory, the 'hygiene factor' that leads to job dis-satisfaction is salary.

- Hygiene factors are those job factors that are essential for the existence of motivation in the workplace.
- These do not load to positive satisfaction long term.
- Hygiene factors are also called as dissatisfiers or maintenance factors as they are required to avoid dis-satisfaction.

Hygiene factors include–
(i) Salary and benefits
(ii) Job security
(iii) Work environment
(iv) Job policies
(v) Supervisory practices
(vi) Company policies and administration
(vii) Company reputation.

5. A material exhibits a large amount of plastic deformation before fracture and can absorb significant energy. This material is said to have:

(a) high hardness
(b) high strength
(c) high modulus of elasticity
(d) high toughness

Ans. (d) : A material exhibits a large amount of plastic deformation before fracture and can absorb significant energy. This material is said to have high toughness.

Hardness– It is the ability of a material to resist identation or surface abrasion.

- Brinell hardness test is used to check hardness.

Strength– This property enables material to resist fracture under load. It is very important property from design point of view.

Modulus of elasticity– It is also known as young modulus. It is defined as the ratio of stress to strain in the linearly elastic region of the stress-strain curve.

6. The influence of forecasting in volume decision-making with regards to production is that it:

(a) ensures that all products meet international standards
(b) determines the specific design of the product
(c) reduces manufacturing costs
(d) determines whether production is for stock or for immediate orders

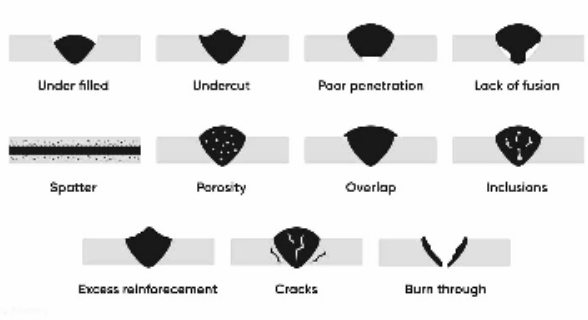
Ans. (d) : The influence of forecasting in volume decision making with regards to production is that is determines whether production is for stock or for immediate orders.

- It ensures that all products meet international standards.
- It determines the specific design of the product.
- It reduces manufacturing cast.

7. What is lack of penetration in welding defects?

(a) Small holes throughout the weld metal
(b) Failure of the filler metal to fuse with the parent metal
(c) Cracks either in the weld metal or in the parent metal
(d) Failure of the filler metal to penetrate into the root of the joint

Ans. (d) : Lack of penetration in welding defects is defined as the failure of the filler metal to penetrate into the root of the joint.



- The small holes throughout the weld metal is called weld porosity failure of the filler metal to fuse with the parent metal is called lack of fusion.
- Cracks either in the weld metal or in the parent metal is called weld crack.
- All of these defects are comes in the category of welding defect.

8. In the _____ method, a large amount of solder is melted in a tank that is closed.

(a) dip soldering (b) flame soldering
(c) infrared soldering (d) soldering iron

Ans. (a) : In the dip soldering method, a large amount of solder is melted in a tank that is closed.

- Dip soldering is a method of joining two or more objects, typically metals, using a solder that is heated until it melts and them applied to objects to be joined.
- The process involves dipping the objects to be soldered into a molten solder bath.

9. The disadvantage of the early shadow projector was that the:

(a) magnification was insufficient
(b) screen was too far from the operator
(c) image was too small
(d) image was distorted

Ans. (a) : The disadvantage of the early shadow projector are :

(i) Magnification was insufficient.
(ii) Limited to inspecting surface profiles.
(iii) Requires proper calibration and alignment for accurate results.
(iv) May be not suitable for analyzing material composition.

- The primary purpose of a shadow projector is to produce an undistorted magnified reflected image of an object.

10. Which of the following is generally used for melting metal in the metallic gun type of metal spraying process?

(a) Compressed air (b) Plasma torch
(c) Oxy acetylene flame (d) Electric arc

Ans. (c) : Oxy-acetylene flame is generally used for melting metal in the metallic gun type of metal spraying process due to their ability to generate high temperatures needed to melt the metal.

- An oxy-acetylene flame is sometimes called oxidizing flame.
- In this, the ratio of oxygen to acetylene is 1.5 : 1.
- A plasma torch is a versatile tool used in various industries for cutting, welding and coating applications.

11. The _____ concept is derived from the Pareto's 80/20 rule curve.

(a) XYZ (b) FSN
(c) ABC (d) VED

Ans. (c) : The ABC concept is derived from the Pareto's 80/20 rule curve.

- It is used for identifying and prioritizing the most impactful factors that contribute to a significant outcome.
- It suggests that roughly 80% of results come from 20% of the causes of efforts.

- This principle is widely applied in business project management and personal productivity to optimize resource allocation.
- ABC, VED, HML are some selective inventory control techniques.

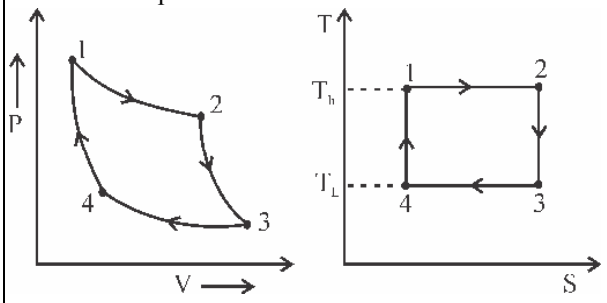
12. The efficiency of the Carnot cycle is defined as:

(a) $\frac{\text{Heat rejected}}{\text{Heat supplied}}$ (b) $\frac{\text{Work done}}{\text{Heat supplied}}$

(c) $\frac{\text{Heat supplied}}{\text{Work done}}$ (d) $\frac{\text{Work done}}{\text{Heat rejected}}$

Ans. (b) : The efficiency of the carnot cycle is defined as the ratio of work done and heat supplied.

- The carnot cycle consist two isentropic and two isothermal process.



Process–

(1-2) : Reversible isothermal expansion or heat addition.

(2-3) : Reversible adiabatic or isentropic expansion.

(3-4) : Reversible isothermal compression or heat rejection.

(4-1) : Reversible adiabatic or isentropic compression.

- The efficiency of carnot cycle $(\eta_c) = \frac{\text{Work done}}{\text{Heat supplied}}$

$$(\eta_c) = 1 - \frac{Q_R}{Q_A}$$

Q_A = Heat added during process (1-2)

Q_R = Heat rejected during process (3-4)

$$Q_A = (\partial Q)_{1-2} = T_H (S_2 - S_1)$$

$$Q_R = (\partial Q) s_{3-4} = T_H (S_3 - S_4)$$

$$\left[\because (2-3) \,\&\, (4-1) \text{ are isentropic} \;\; \therefore S_3 = S_2 \,\&\, S_4 = S_1\right]$$

$$\eta_c = 1 - \frac{Q_R}{Q_A} = 1 - \frac{T_H (S_3 - S_4)}{T_H (S_2 - S_1)}$$

$$\boxed{\eta_c = 1 - \frac{T_L}{T_H}}$$

13. Which of the following is true about the weldability of mild steel and alloy steel?

(a) Alloy steel is easier to weld than mild steel.

(b) Weldability depends only on the thickness of the steel.

(c) Mild steel is easier to weld than alloy steel.

(d) Both mild and alloy steel have the same weldability.

Ans. (c) : Mild steel is easier to weld than alloy steel.

Weldability–To ease with which welding of a given material can be done without producing any defect under the fabrication condition is called weldability.

Iron > mild steel > low alloy steel > stainless steel > aluminium > copper.

$$\boxed{\%\,\text{weldability} = \frac{\text{Resistivity} \times 100}{K_{\text{relative constant}} \times T_{\text{melting point}}}}$$

14. How does indicated power differ from brake power in an internal combustion engine?

(a) Indicated power is measured at the engine's output shaft, while brake power is measured in the cylinders.

(b) Indicated power is derived from combustion chamber pressures, whereas brake power is the net output at the crankshaft after mechanical losses.

(c) Both indicated and brake power represent the same value under ideal conditions.

(d) Indicated power accounts for frictional losses, whereas brake power does not.

Ans. (b) : Indicated power is measured at the engine's input i.e. inside the engine cylinder. While brake power is measured on the crank shaft of the engine that is called output of the engine.

$$\boxed{\text{I.P} = \frac{P_m LANK}{60}} \qquad \boxed{\text{B.P} = \frac{2\pi NT}{60}}$$

- Brake power is always less than indicated power.

Friction power– It is the difference of indicated power and brake power.

$$\boxed{\text{F.P} = \text{I.P} - \text{B.P}}$$

- It is called power loss in overcoming the friction between piston and cylinder walls, between the crankshaft and camshaft and their bearing etc.

15. Which of the following interactions is expected to produce chip during a grinding process?

(a) Grit-workpiece (b) Bond-workpiece

(c) Chip-workpiece (d) Chip-bond

Ans. (a) : Grit-workpiece interactions is expected to produce chip during a grinding workpiece.

The grain sizes are used in grinding–

Coarse grain : 8-24

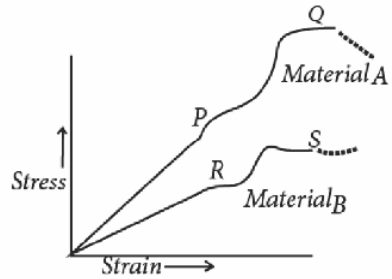
Medium grain : 30-60

Fine grain : 80-180

Very fine grain : 220-600

16. The diagram below shows the stress-strain curves of two materials, Material A and Material B. Material A has a finer grain structure, while Material B has a coarser grain structure. Based on the diagram, which of the

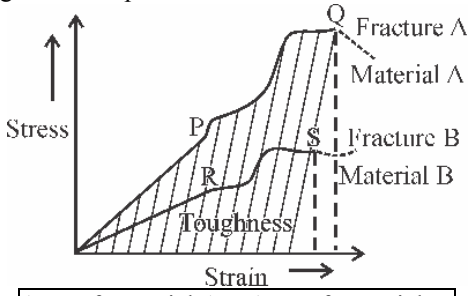
following statements is correct regarding their toughness?



(a) Material A (finer grain size) has lower toughness than Material B (coarser grain size).
(b) Both materials have the same toughness, as indicated by their identical total strain values.
(c) Material A (finer grain size) has higher toughness than Material B (coarser grain size).
(d) Toughness can be determined directly by comparing the slopes of the stress-strain curves.

Ans. (c) : The stress-strain curve of two materials A and B.

- Material A has a finer grain structure and material B has coarse grain structure.
- Toughness is represented by the area under the stress-strain curve up to the fracture point.
- Material A curve encompasses a larger area than material B. Therefore, material A has higher toughness compared to material B.



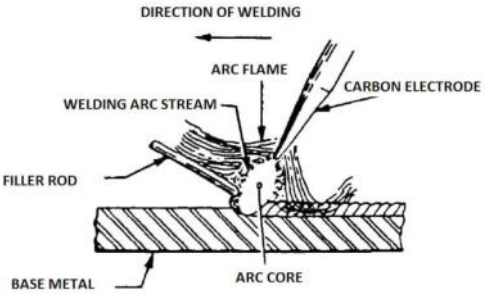
Area of material A > Area of material B.

17. In the Carbon Arc Welding (CAW) process, _____ is used to create an electric arc.

(a) pure graphite electrode
(b) stainless steel electrode
(c) cellulosic electrode
(d) rutile electrode

Ans. (a) : In the carbon arc welding (CAW) process, pure graphite electrode is used to create an electric arc.

- In this, arc is produced between a carbon electrode and the workpiece . This arc generates the heat required to melt the metals at the welding point.
- Shielding is not used in CAW.
- No pressure applied in it.
- It may be used in twin arc method that is between two carbon (graphite) electrodes.



18. What bond is commonly employed in super abrasive grinding wheels?

(a) Metal bond (b) Oxychloride bond
(c) Brazed bond (d) Shellac bond

Ans. (a) : Metal bond is commonly employed in super abrasive grinding wheels.

- Metallic bond is used for diamond wheels only.
- Shellac bond (E) is used for thin but strong wheels possessing some elasticity. It produce high polish thus used for grinding such parts as camshaft and mill rolls.
- Brazed bond is a joint created using a process called brazing where metals are joined by melting a filler metal.
- In oxychloride bond, the abrasive grains are mixed with magnesium chloride and magnesium oxide. This bond is used for making disc-shaped wheels.

19. Which of the following CANNOT be generally utilised as an abrasive material in the grinding process?

(a) Super alloy (b) Silicon carbide
(c) Aluminium oxide (d) Diamond

Ans. (a) : Super alloy cannot be generally utilised as an abrasive material in the grinding.

Silicon carbide– It is less hard than diamond and less tough than aluminium oxide. It is used for grinding of the material of low tensile strength.

e.g. Cemented carbide, stone and ceramic, grey cast iron, brass, bronze.

Aluminium oxide– It is tough and fracture-resistant. It is preferred for grinding of materials of higher tensile strength like steel, high carbon and high speed steel and tough bronze.

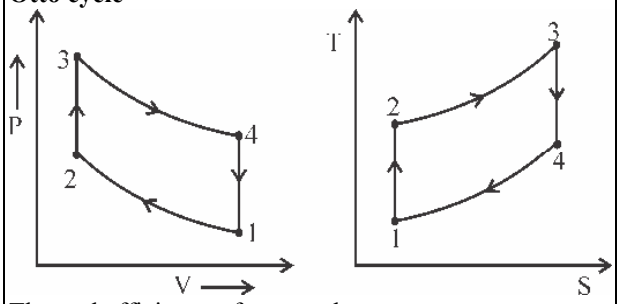
- Diamond is used for glass, tungsten carbide and ceramics.

20. The thermal efficiency of the Otto cycle is a function of:

(a) engine size and speed
(b) heat supplied and pressure ratio
(c) temperature and mass flow rate
(d) compression ratio and the ratio of specific heats

Ans. (d) : The thermal efficiency of the otto cycle is a function of compression ratio and the ratio of specific heats. Its consists two reversible isentropic and two isochoric i.e. constant volume process.

Otto cycle–



Thermal efficiency of otto cycle–

$$\eta_{otto} = 1 - \frac{1}{(r)^{\gamma-1}}$$

Compression ratio (r) = $\frac{V_1}{V_2}$, $\boxed{\gamma = \frac{C_p}{C_v}}$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{r}} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$\frac{T_2}{T_1} = (r)^{\gamma-1}$$

$$\frac{V_1}{V_2} = r$$

$$\eta_{otto} = 1 - \frac{1}{(r)^{\gamma-1}} = 1 - \frac{1}{\left(\frac{T_2}{T_1}\right)} = 1 - \frac{T_1}{T_2}$$

$$\boxed{\eta_{otto} = 1 - \frac{T_1}{T_2}}$$

21. Which of the following statements accurately describes vacuum pressure?

(a) It is the pressure due to the weight of a fluid column.

(b) It is the pressure below atmospheric pressure in a system.

(c) It is the absolute pressure at any point in a fluid.

(d) It is the pressure exerted by the atmospheric air.

Ans. (b) : Vacuum pressure is the pressure below atmospheric pressure in a system.

$$\boxed{P_{vacuum} = P_{atm} - P}$$

- Gauge pressure (P_{gauge}) measured with respect to atmospheric pressure is taken as datum.
- Absolute pressure is defined as the pressure which is measured with zero pressure. It is measured by aneroid barometer.

$$P_{abs} = P_{atm} + P_{gauge}$$

22. Which of the following statements best describes a special-purpose lathe used for heavy duty applications?

(a) A T-lathe is used for machining flat plates and sheet metal components.

(b) A missile lathe is designed for lightweight parts with small diameters.

(c) A wheel lathe is designed for machining railway wheels, including journals and treads.

(d) A gap bed lathe is mainly used for cutting small, high-precision components.

Ans. (c) : Special-purpose lathe–

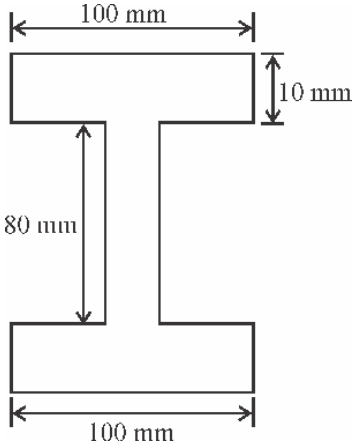
A special-purpose lathe is designed for specific machining applications that cannot be efficiently performed using standard lathes. These machines are tailored for specialized tasks, offering enhanced precision, productivity, and functionality in handling unique or heavy-duty machining requirements. Among the various types of special-purpose lathes, a wheel lathe stands out for heavy-duty applications, particularly in machining railway components like wheels, journals and treads.

23. A symmetrical channel section has width of its top and bottom flanges as 100 mm and thickness 10 mm. The web is 80 mm high between flanges and 10 mm thick. Its moment of inertia about a centroidal axis in its plane parallel to the flanges is 449.3 X 10^4 mm^4. Calculate its moment of inertia about a parallel axis at the top face of the upper flange.

(a) 1149.3×10^4 (b) 20.3×10^4

(c) 1415×10^3 (d) 43,000

Ans. (a) :



Width of top and bottom flanges = 100 mm

Thickness of flanges = 10 mm

Height of the web = 80 mm

$$Y = \frac{80}{2} + 10 = 50$$

Thickness of the web = 10 mm

$A = 2 \times b \times t_f + h_w \cdot t_w = 2 \times 100 \times 10 + 80 \times 10$

$= 2800\ mm^2$

Moment of inertia about the centroidal axis

$= 449.3 \times 10^4$

$I = I_C + AY^2$

$= 449.3 \times 10^4 + 2800 \times (50)^2$

$I = 4493000 + 70,00000$

$I = 11493000$

$I = 1149.3 \times 10^4\ mm^4$

24. What does mean effective pressure (MEP) indicate in engine performance analysis?

(a) The pressure of the fuel injected into the cylinder

(b) The average pressure acting on the piston during the complete engine cycle that would produce the measured work output

(c) The maximum pressure reached in the combustion chamber

(d) The difference between intake and exhaust pressures

Ans. (b) : The engine performance analysis the mean effective pressure (MEP) indicates the average pressure acting on the piston during the complete engine cycle that would produce the measured work output.

- Mean effective pressure is defined as ratio of workdone per cycle to the swept volume.

$$MEP = \frac{\text{Work done per cycle}}{\text{Swept volume}}$$

- Mean effective pressure increases with compression ratio because of an increase in efficiency.

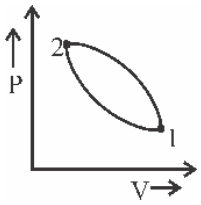
25. For a closed system undergoing a process (not a cycle), the first law is expressed as:

(a) $Q = W$ (b) $\Delta S \geq 0$

(c) $\Delta U = Q - W$ (d) $PV = nRT$

Ans. (c) : For a closed system undergoing a process, the first law is expressed as-

$$\Delta U = Q - W$$



Where,

ΔU = Change in internal energy of the system.

Q = Heat added to the system

W = Work done by the system.

- For a closed system, undergoing a thermodynamic cycle, the first law of thermodynamics states that the net work done by the system over one complete cycle is equal to the net heat added to the system over the cycle.
- During a complete cycle, the system returns to its initial state, which means the change in internal energy (ΔU) is zero.

$$\Delta U = 0$$

26. When is the lead screw engaged in a lathe?

(a) Only for turning and facing operations

(b) Only during thread-cutting operations

(c) Continuously for all machining processes

(d) During both knurling and continuous feed motion

Ans. (b) : The lead screw engaged in the lathe only during thread-cutting operations.

- Turning, facing and knurling operation also performed on the lathe machine but it does not required any lead screw.
- Knurling is operation of embossing a diamond shape pattern on the workpiece.
- Thread cutting operation of cutting helical grooves on the external cylindrical surface of the workpiece.

27. Which of the following end conditions could characterise a cantilever beam?

(a) A fixed support at one end and free at the other

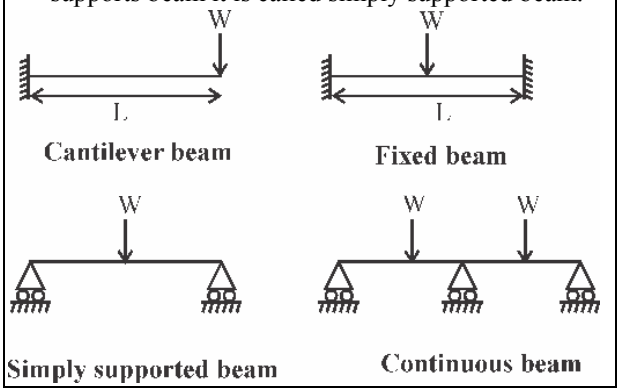
(b) A roller support at one end and hinged at the other

(c) A hinged support at one end and free at the other

(d) A fixed support at one end and pin support at the other

Ans. (a) : A fixed support at one end and free at other end is called cantilever beam.

- If a beam is fixed at both end, it is called fixed beam.
- If the ends of a beam are made to rest freely on supports beam it is called simply supported beam.



28. When using a Venturimeter, a decrease in the cross-sectional area causes:

(a) a decrease in static pressure

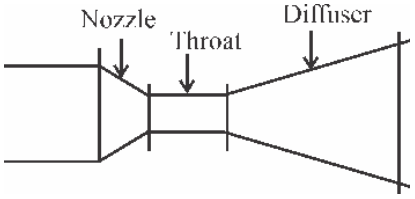
(b) no change in velocity

(c) an increase in fluid density

(d) an increase in static pressure

Ans. (a) : When using a venturimeter, a decrease in the cross-sectional area causes a decrease in static pressure and increase velocity.

- Venturimeter is used for measuring the flow rate or discharge of the fluid.



- It is a gradually converging and gradually diverging device used for the measurement of flow in a pipeline.
- It is based on the principle of Bernoulli's theorem.

It have three parts–

- Converging cone → (20^o - 22^o)
- Throat (Area is minimum)
- Diverging cone → (5^o - 7^o)

29. The manometric efficiency in a pump is the ratio of:

(a) the actual pressure head produced to the theoretical pressure head
(b) the theoretical head to the actual head
(c) the temperature difference between inlet and outlet
(d) the fluid density to the pump speed

Ans. (a) : The manometric efficiency in a pump is the ratio of the actual pressure head produced to the theoretical pressure head.

- Manometric efficiency is also called hydraulic efficiency.

$$\eta_m = \frac{\text{rotor or impeller power}}{\text{shaft power}}$$

- Volumetric efficiency is defined as the ratio of actual discharge to theoretical discharge.

$$\eta_v = \frac{\text{Actual discharge}}{\text{theoretical discharge}}$$

- Overall efficiency (η_o)= $\eta_{mech} \times \eta_v \times \eta_{mano}$

30. What happens to the mechanical properties of mild steel when carbon content increases?

(a) Strength decreases and ductility increases
(b) Both strength and hardness decrease
(c) Strength increases and ductility decreases
(d) Both strength and ductility increase

Ans. (c) : As the carbon content increase in mild steel–

- The ultimate strength of steel increases.
- The ductility of the metal decreases.
- The elongation before fracture decreases.
- Increasing carbon also reduces the weldability.
- Especially above 0.25% carbon
- Increasing carbon content increases hardness and strength and improve hardenability.

31. Which of the following elements is NOT a primary alloying element in stainless steel?

(a) Carbon (b) Nickel
(c) Chromium (d) Lead

Ans. (d) : Lead is not a primary alloying element in stainless steel.

Stainless composition–

- Nickel (Ni) → 18
- Chromium (Cr) → 8
- Carbon (C) → 0.12% to 0.35%
- Rest iron present in the stainless steel.
- Stainless steel can be easily welded and machined. It have better corrosion resistance property.

32. The purpose of scheduling in Production Planning and Control is to:

(a) determine the cost of materials
(b) hire old personnel
(c) hire new personnel
(d) ensure products are completed on time

Ans. (d) : The purpose of scheduling in production planning and control is to ensure products are completed on time.

- It is the function of management which plans, directs and controls the material supply and processing activities of an enterprise.
- Scheduling is that steps in production planning and control (PPC), it determines sequence of each operation, its starting and finishing time so that required material and machines are kept ready as per the time table in order to avoid delay in processing.
- So, scheduling may be defined as the fixing of time and date for each operation as well as determining the sequence of operation.

33. The design of a semi-open impeller makes it suitable for:

(a) only low flow rate applications
(b) applications requiring the highest efficiency regardless of clogging
(c) fluids with moderate amounts of suspended solids while providing better efficiency than open impellers
(d) liquids with very high solid content

Ans. (c) : The design of a semi-open impeller makes it suitable for fluids with moderate amounts of suspended solids while providing better efficiency.

- Semi-open impellers have a back shroud but no front shroud.
- They are less prone to clogging and can handle larger solids compared to closed impellers.
- It is suitable for liquids with some suspended solids and for applications requiring frequent cleaning and maintenance.

34. If the degree of the shear force diagram is x, then the:

(a) degree of the loading curve is x + 1
(b) degree of the bending moment diagram is x − 1
(c) degree of the bending moment diagram is x + 1
(d) degree of the loading curve is x

Ans. (c) : Relationship between shear force and bending moment diagram– If the degree of the shear force diagram is x, then the bending moment diagram is x + 1.

Relationship between loading and shear force– If the degree of the loading curve is x, then the degree of the shear force diagram is x + 1. Conversely, if the degree of shear force diagram is x, then the degree of the loading curve is x – 1.

35. If the area under the shear force diagram between two specified points is equal to P, then the difference in the bending moments at those points will be :

(a) $\frac{P}{2}$ (b) Zero

(c) 2P (d) P

Ans. (d): If the area under the shear force diagram between two specified point is equal to P, then the difference in the bending moments at those points will be P.

$$\boxed{\sum M_A - \sum M_B = P}$$

36. If 30 m is the height difference between the two rollers and 60 m is the distance between the centres of the rollers, what is the angle formed between the upper surface of a sine bar and the surface plate (datum)?

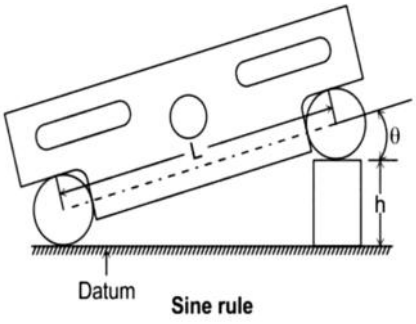
(a) 45° (b) 90°

(c) 60° (d) 30^o

Ans. (d) : Give,

Height difference between the two roller (H) = 30 m

Distance between the centres of roller (L) = 60 m



Sine rule

The angle formed between the upper surface of a sine bar and the surface plate (datum) = $\sin\theta = \frac{H}{L}$

$$\sin\theta = \frac{30}{60} = \frac{1}{2}$$

$$\sin\theta = \sin 30^o$$

$$\boxed{\theta = 30^o}$$

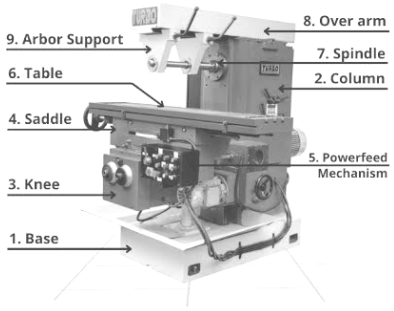
37. Name the part of a milling machine on which milling cutters are securely mounted and rotated.

(a) Arbor (b) Front brace

(c) Overhanging arm (d) Saddle

Ans. (a) : Arbor is the part of a milling machine on which milling cutters are securely mounted and rotated.

- Its one end is attached to the column and other end is supported by on overam. Its holds and drive different types of milling cutters.
- Milling is defined as the process of cutting, shaping and finishing a piece of metal.
- Milling is used when more complex metal shapes are desired.
- It involves cutting away pieces of metal to create dovetails, thread, bevels, slot and ridges.



38. In the analytical method, how is the resultant force determined when all forces act in the same direction?

(a) By adding all the forces together

(b) By subtracting the smallest force from the largest

(c) By dividing the total force by the number of forces

(d) By multiplying all the forces together

Ans. (a) : In the analytical method, the resultant force is determined by adding all the forces act in the same direction.

$$\boxed{\sum R = F_1 + F_2 + F_3}$$

39. What is the primary mechanism by which thermal radiation transfers energy?

(a) Convection due to fluid motion

(b) Direct transfer via physical contact

(c) Conduction through molecular collisions

(d) Electromagnetic waves

Ans. (d) : The primary mechanism by thermal radiation transfer energy is electromagnetic waves.

- Radiation does not require the presence of any medium.
- It is the fastest mode of energy transfer.
- Thermal radiation is the radiation because of its temperature.
- Radiation is volumetric phenomenon and all solids, liquids and gases emit, absorbs or transmit radiation, treated as surface phenomenon.

40. The Stefan-Boltzmann law is derived from:

(a) Wien's Displacement Law

(b) Kirchhoff's Law

(c) Fourier's Law

(d) Planck's Law

Ans. (d) : The Stefan-Boltzman law is derived from Planck's law.

- Planck's law describes the spectrum of electromagnetic radiation emitted by a black body in thermal equilibrium at a given temperature.

Planck's constant is –

$$h = \frac{E}{\nu} = \frac{\text{Joule}}{1/\text{sec}} = \text{Joule-sec.}$$

$h = 6.67 \times 10^{-34}$ J-s

Where, E = Energy

ν = Frequency

h = Plank's constant.

Stefan Boltzman law– $\boxed{Q_{\text{max radiation}} = \sigma A T^4}$

$$\boxed{\sigma = 5.67 \times 10^{-8}\ W/m^2K^4}$$

41. In a two-stroke petrol engine, the inlet port is opened by the piston:

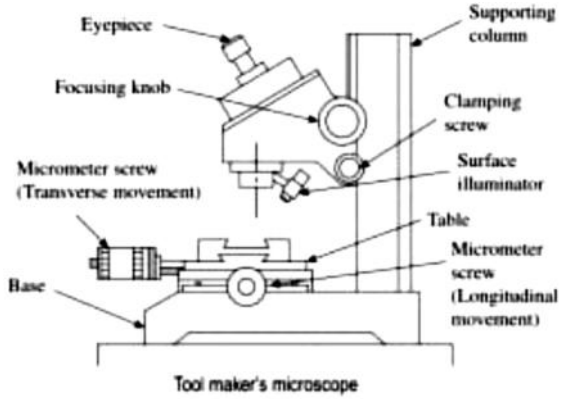
(a) 30° to 40° before BDC
(b) 40° to 55° before BDC
(c) 30° to 40° after BDC
(d) 45° to 55° before TDC

Ans. (a) : In a two-stroke petrol engine, the inlet port is opened by the piston 30^o to 40^o before BDC.

42. The function of the supporting column in a Tool Maker's Microscope is to _____.

(a) provide vertical working distance
(b) magnify the image
(c) illuminate the workpiece
(d) hold the specimen in place

Ans. (d) : The function of the supporting column in a tool maker's microscope is to hold the specimen in place.



Tool maker's microscope

- A tool maker's microscope (also known as a measuring microscope) is a versatile, high precision instrument used in metrology and quality control.

43. What is the effect of compression ratio (CR) on the air standard efficiency of otto and diesel cycles?

(a) CR has no effect on efficiency.
(b) Efficiency increases with CR in SI engines and decreases in CI engines.
(c) Higher CR always leads to higher efficiency.
(d) Lower CR always leads to higher efficiency.

Ans. (c) : The effect of compression ratio (CR) on the air standard efficiency of otto and diesel cycles that higher CR always leads to higher efficiency.

- The compression ratio of otto cycle 6 to 12 and diesel cycle is 16 to 20.
- The efficiency of otto cycle is higher than diesel cycle at the same compression ratio.

$$\boxed{\eta_{\text{otto}} = 1 - \frac{1}{r^{\gamma-1}}} \qquad \boxed{\eta_{\text{diesel}} = 1 - \frac{1}{r^{\gamma-1}}\left[\frac{\alpha^{\gamma}-1}{\gamma(\alpha-1)}\right]}$$

44. The flange of an I-section is 100 mm wide and 10 mm thick, and has moment of inertia I_f about its own centroidal axis parallel to flange length, in the plane of the flange. Its centroidal axis is 50 mm from the centroidal axis X-X of the I-section normal to the web in the plane of the I-section. Area moment of inertia of the flange about axis X-X is :

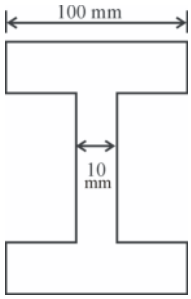
(a) 8333 mm^4 (b) $I_f + 25X10^5$ mm^4
(c) $I_f - 25X10^5$ mm^4 (d) $I_f + 50{,}000$ mm^4

Ans. (b) : Given,

Width = 100 mm

Thickness = 10 mm

d = 50 mm



A = Width × thickness

$A = 100\ mm \times 10\ mm = 1000\ mm^2$

$I_{xx} = I_f + Ad^2$

$I_{xx} = I_f + 1000 \times (50)^2$

$I_{xx} = I_f + 2500000$

$I_{xx} = I_f + 25 \times 10^5\ mm^4$

45. Broaching is a _____ that uses a toothed tool to remove the material from the workpiece.

(a) grinding process (b) boring process
(c) machining process (d) casting process

Ans. (c) : Broaching is a machining process that uses a toothed tool to remove the material from the workpiece.

- The grinding process is used to produce a high surface finish with a close tolerance and for machining hard materials.
- The boring process is an accurate internal cylindrical surface is produced by enlarging an existing opening in the workpiece. The workpiece move parallel to the axis of rotation of the cutting tool.
- Casting is a manufacturing process in which a liquid material is usually poured into a mold which contains a hollow cavity of the desired shape and then allowed to solidify.

46. Which of the following is NOT a type of nitriding process?

(a) Vacuum nitriding (b) Gas nitriding
(c) Liquid nitriding (d) Plasma nitriding

Ans. (a) : Vacuum nitriding is not a type of nitriding process.

- Nitriding is a process used to harden the surface of metal parts by introducing nitrogen into the surface. This process can improve wear resistance, fatigue resistance and corrosion resistance.
- Gas nitriding process uses ammonia gas to introduce nitrogen to the surface of the metal.
- Liquid nitriding process involves imersing the metal part in the molten salt bath contains nitrogen.
- Plasma nitriding uses a plasma to introduces nitrogen to the surface of the metal.

All these are the type of nitriding process.

47. Which of the following best describes the primary function of a simple carburetor in a petrol engine?

(a) To electronically control the fuel injection timing
(b) To compress the air-fuel mixture before combustion
(c) To atomise and mix fuel with air in the proper ratio
(d) To regulate exhaust emissions via catalytic conversion

Ans. (c) : The primary function of a simple carburetor in petrol engine to atomise and mix fuel with air in proper ratio.

- The process of formation of a combustible fuel-air mixture by mixing the proper amount of fuel with air before a mixture to the engine cylinder is called carburetion and the device which does this job is called a carburetor.
- In CI engines, only air is compressed and then fuel is injected into the cylinder by an injector. So, the CI engine does not require the carburetor.

48. Blowholes are welding defects caused by _____.

(a) unsuitable parent metals used in the weld
(b) gas being trapped and due to moisture
(c) poor edge preparation
(d) too great a heat concentration

Ans. (b) : Blowholes are welding defects caused by gas being trapped and due to moisture contains.

- Under cut is a welding defects where a groove or depression is formed along the edge of the weld bead. It occurs when the base metal is melted away and not filled with weld metal.
- Burn through is a defects that occurs when the weld metal penetrates through the base metal, creating a hole. This defects is typically caused by excessive heat input or incorrect welding parameters.

49. A centrifugal pump has a hydraulic power output of 10 kW and consumes 15 kW of mechanical power. Calculate its overall efficiency.

(a) 66.7% (b) 75%
(c) 50% (d) 80%

Ans. (a) : Given,
Hydraulic power output = 10 kW
Mechanical power output = 15 kW

$$\text{Overall efficiency } (\eta_o) = \frac{\text{Hydraulic power output}}{\text{Mechanical power input}}$$

$$= \frac{10}{15} \times 100$$
$$= 0.6667 \times 100$$
$$= 66.67\%$$

50. Forced convection is primarily characterised by:

(a) the absence of any temperature gradients in the fluid
(b) heat transfer occurring solely through radiation
(c) the natural buoyancy-driven flow of the fluid
(d) the use of external devices such as fans or pumps to move the fluid

Ans. (d) : Force convection is primarily characterised by the use of external devices such as fans or pumps to move the fluid.

- This external force enhances heat transfer compared to natural convection.

51. The function of fluxes in soldering is _____.

(a) to heat metal over a range of temperature up to fusion and then allow to cool
(b) to remove oxides and other surface compounds from the surfaces to be soldered
(c) to use consumable bare electrode in combination with a flux feeder tube
(d) to remove dirt particles and other surface compounds from the surfaces to be soldered

Ans. (b) : The function of fluxes is soldering is to remove oxide and other surface compounds from the surfaces to be soldered.

- By definition, soldering is a brazing type of operation where the filler metal has a melting temperature below 450^oC.
- Most solders are alloys of lead and tin.
- In this, strength of the filler metal is low.
- Soldering is used for a leak-proof joint or a low resistance electrical joint.

52. _____ is used for mixing oxygen and acetylene in gas welding processes.

(a) Goggles (b) Earth clamp
(c) Welding torch (d) Spark-lighter

Ans. (c) : Welding torch is used for mixing oxygen and acetylene in gas welding processes.

- The mixture of oxygen and acetylene produces a high temperature flame suitable for welding, cutting and brazing metals.
- Goggles are used for eye protection.
- An earth clamp is used to provide a return path for the welding current.
- Spark lighter is used to ignite the gas mixture.

53. Which of the following is NOT a feature of pneumatic comparators?

(a) No wearing of parts
(b) High range of amplification
(c) Non-contact inspection of work parts
(d) Presence of hysteresis

Ans. (d) : Presence of hysteresis is not a feature of pneumatic comparators.

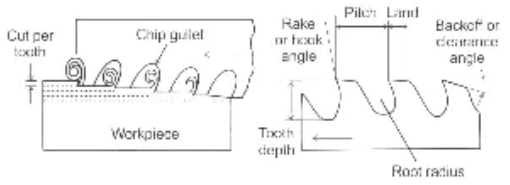
- In pneumatic comparators, either air flow or air pressure is measured to give measurement deviation from a standard.
- The response of the comparators working on air flow is quicker than those working on air pressure, but the latter is more versatile than the former.

54. The _____ in a broaching tooth is provided to prevent rubbing of the tool with the workpiece.

(a) front rake angle
(b) back-off angle
(c) face angle
(d) hook angle

Ans. (b) : The back-off angle in a broaching tooth is provided to prevent rubbing of the tool with the workpiece. The back-off angle is also known as relief angle.

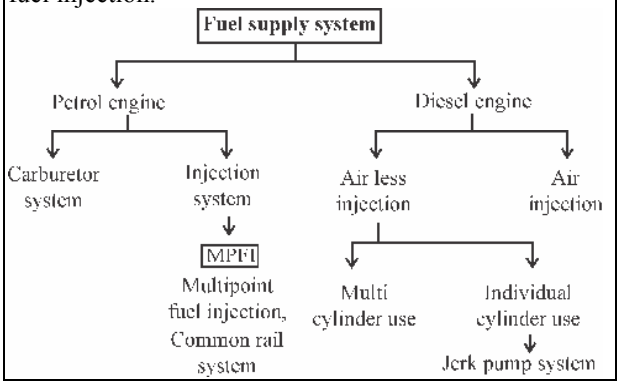
- This angle allows the cutting edge to engage the material efficiency.
- The front rake angle affects the ability of the tool to shear the work form a chip. After plastic deformation chips flow over the rake face and heavy drag exists between chip and rake face.



55. IC engines are classified into carburetor engine and air injection engine based on the:

(a) speed of the engine
(b) cooling system used
(c) number of cylinders
(d) method of fuel injection

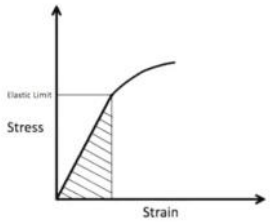
Ans. (d) : IC engines are classified into carburetor engine and air injection engine based on the method of fuel injection.



56. The modulus of resilience is characterised by the area located under the stress-strain curve upto the:

(a) ultimate point
(b) proportional limit
(c) point where strain hardening starts
(d) fracture point

Ans. (b) : The modulus of resilience is characterised by the area located under the stress-strain curve up to the proportional limit.



Area under the curve/Strain energy per unit volume

$$= \frac{1}{2} \times \sigma \times \delta$$

- It is the strain energy per unit volume.

Modulus of toughness– It is the strain energy per unit volume which can be stored in metal without fracture. It is equal to the total area under the stress-strain curve up to the fraction point.

Proof resilience– It represent strain energy per unit volume of metal. It is defined for those ductile metals which don't show clear yield point.

57. In a four-stroke diesel engine, the exhaust valve opens before the piston reaches the Bottom Dead Center to:

(a) improve fuel atomization
(b) reduce pumping losses
(c) enhance air-fuel mixing
(d) increase the compression ratio

Ans. (a) : In a four-stroke diesel engine, the exhaust valve opens before the piston reaches the bottom dead center to improve fuel atomization.

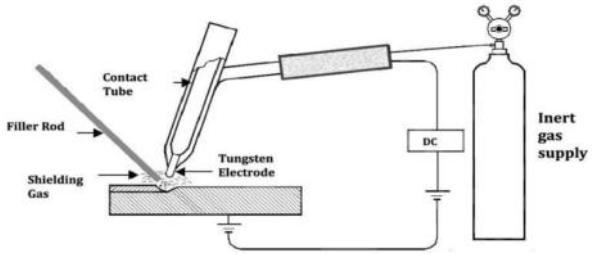
- This is because opening the valve early helps to reduce the pressure in the cylinder, which can lead to better fuel atomization during the injection process.

58. Identify the gas used in Tungsten Inert Gas Welding (TIG).

(a) Hydrogen-nitrogen mixtures
(b) Oxygen-hydrogen mixtures
(c) Oxygen-nitrogen mixtures
(d) Argon-helium mixtures

Ans. (d) : The gas used in tungsten inert gas welding is argon-helium mixtures.

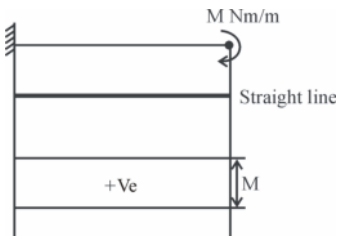
- TIG welding utilizes a non-consumable tungsten electrode to produce the weld.
- Tungsten inert gas (TIG) welding process also known as gas tungsten arc welding (GTAW).
- The heat-affected zone, the molten metal and the tungsten electrode all shielded from atmospheric contamination by a blanket of inert gas fed through the GTAW torch.



59. A cantilever beam with a span length of L m carries a uniform moment of intensity 'M' Nm/m. Which of the following statements is correct?

(a) Shear force throughout the length will be M/L.
(b) Shear force throughout the length will be ML/2.
(c) Shear force throughout the length will be zero.
(d) Shear force throughout the length will be ML.

Ans. (c) : A cantilever beam with a span length L m carries a uniform moment of intensity 'M' Nm/m.



- The shear force throughout the length will be zero and bending moment is rectangular.

60. What is the purpose of introducing two equal and opposite forces at a different point on a rigid body?

(a) To transfer the original force to a new location
(b) To change the direction of the applied force
(c) To balance the rotational motion of the body
(d) To increase the force acting on the body

Ans. (a) : The purpose of introducing two equal and opposite forces at a different point on a rigid body is to transfer the original force to a new location.

- When two equal and opposite forces are applied at a point on a rigid body, they are known as balanced forces.
- Balanced forces are forces that are equal in magnitude but opposite in direction. They act along the same line of action and as a result they cancel each other out.

61. In production engineering, gear hobbing is a _____.

(a) surface finishing process
(b) primary shaping process
(c) joining process
(d) machining process

Ans. (d) : In production engineering, gear hobbing is a machining process.

- Gear hobbing is a continuous generating process in which the tooth flanks of the constantly moving workpiece are formed by equally spaced cutting edges of the hob.
- It produce a variety of gears including spur, helical, worm wheels, serration, splines etc.
- The main advantage of the method is higher production rate of the gear due to continuously indexing.

62. Which test is commonly used to measure the malleability of a material?

(a) Torsion test (b) Compression test
(c) Hardness test (d) Impact test

Ans. (b) : Compression test is commonly used to measure the malleability of a material.

- Malleability is the ability of a material to deform under compressive stress without facturing.
- Compression tests assess how much a material can be flattened or shaped into a sheet before it breaks.
- Impact test is done to test toughness.
- Toughness is measured by Izod and Charpy impact testing machines.

63. What is lack of fusion in welding defects?

(a) It is the entrapment of slag or other impurities in the weld.
(b) It is the failure of the filler metal to fuse with the parent metal.
(c) It is the failure of the filler metal to penetrate into the welding joint.
(d) It is a group of small holes throughout the weld metal.

Ans. (b) : Lack of fusion– It is the failure of the filler metal to fuse with the parent metal.

- It is occurs due to lack of current, high welding speed and incorrect electrode and torch angle.

Incomplete penetration– It is the failure of the filler metal to penetrate into the welding joint.