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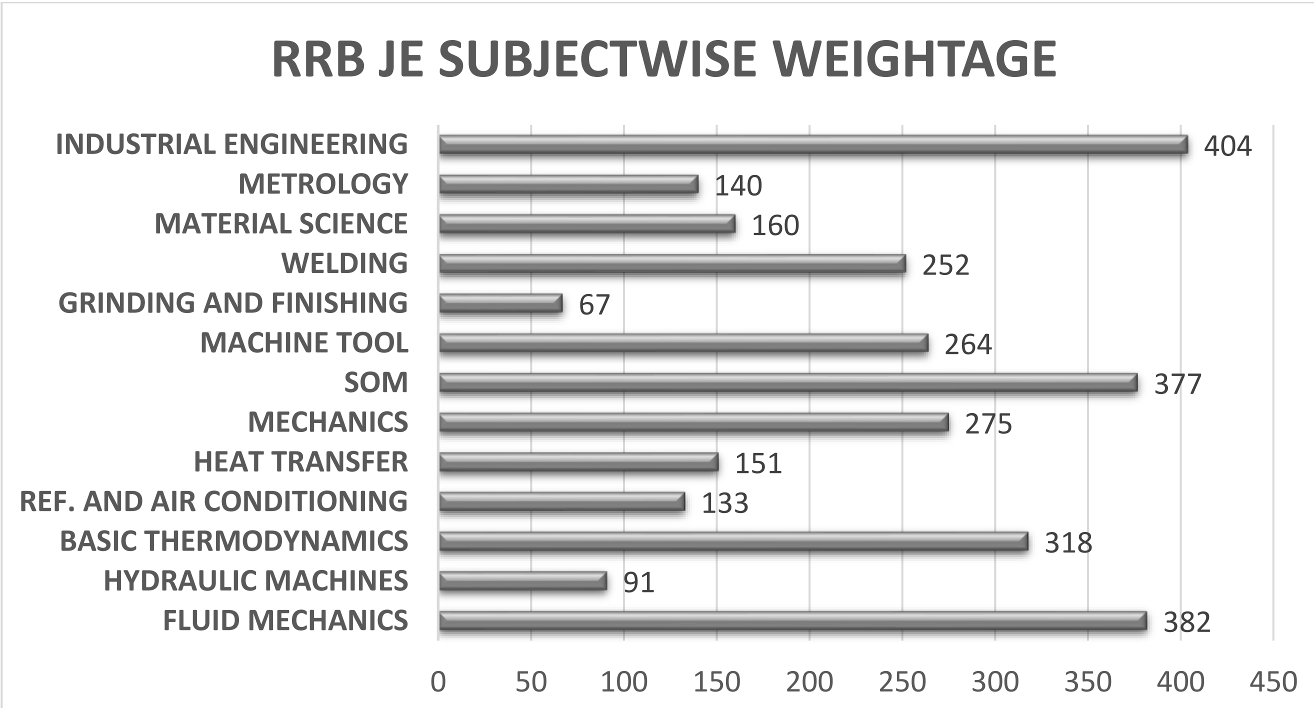
RRB JE SUBJECTWISE WEIGHTAGE
INDUSTRIAL ENGINEERING
METROLOGY
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WELDING
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SOM
MECHANICS
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REF. AND AIR CONDITIONING
BASIC THERMODYNAMICS
HYDRAULIC MACHINES
FLUID MECHANICS
404
140
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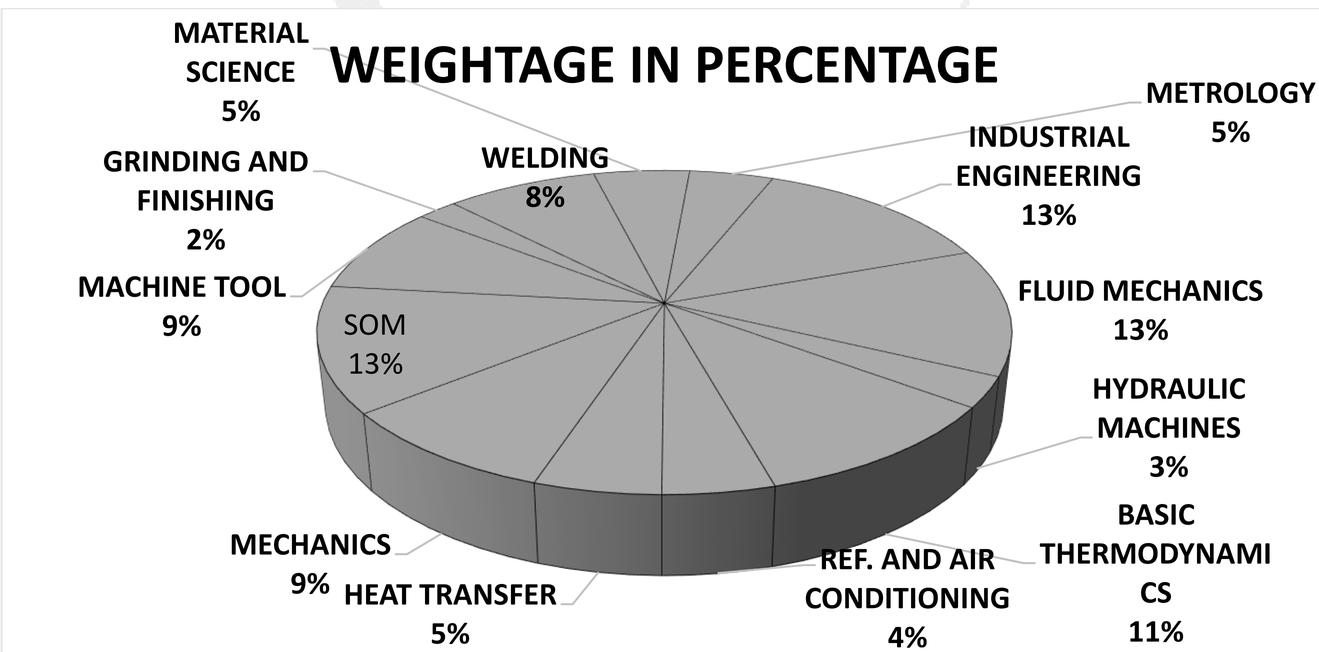
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CHAPTER - 1 ENGINEERING MECHANICS

FORCE, FORCE SYSTEM AND EQUILIBRIUM

Q1. The polygon law of forces states that if a number of forces, acting simultaneously on a particle, be represented in magnitude and direction by the sides a polygon taken in order, then their resultant is represented in magnitude and direction by the closing side of the polygon……….

(a) Taken in opposite order

(b) Taken in same order

(c) Taken in any order

(d) Taken in opposite order not required

Q2. The law of parallelogram of forces gives the resultant of

(a) Parallel forces

(b) Two coplanar concurrent forces

(c) Like parallel forces

(d) Non coplanar concurrent forces

Q3. The point of application of the resultant of all the forces which tends to cause rotation in the body about a certain axis is known as…….

(a) Center of gravity

(b) The point of metacenter

(c) Point of suspension

(d) Centre of percussion

Q4. Which equilibrium is used for two forces?

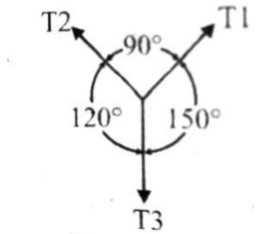
(a) Same line of action

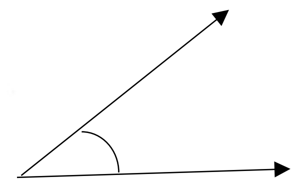
(b) Equal in magnitude

(c) Opposite in direction

(d) All of the above options

Q5. If three coplanar concurrent forces acting at a point 'O' are in equilibrium, then ratio of forces T1/T2 & T1/T3 respectively are





(a) $\sqrt{3}$ and $\frac{\sqrt{3}}{2}$ (b) $\frac{\sqrt{3}}{2}$ $and \sqrt{3}$

(c) 1 and $\frac{1}{2}$ (d) $\frac{1}{2}$ and 1

Q6. Two equal forces are acting at a point with an angle of 60° between them the resultant is $50\sqrt{3}N$, The magnitude of each force will be

(a) 100 N (b) 150 N

(c) 50 N (d) $50\sqrt{3}$ N

Q7. Two equal forces of magnitude 10 Newton act at an angle of 90°. Their resultant is equal to:

(a) 10N (b) $10\sqrt{2}$ N

(c) $10\sqrt{3}\,N$ (d) 20 N

Q8. Choose the CORRECT option regarding the effect of forces acting on the body?

(a) Introduces internal stress.

(b) Balance the order forces acting on it.

(c) Retard its motion

(d) All option are correct

Q9. The resultant force of five coplanar forces can be found out by

(a) Law of polygon

(b) Laws of equilibrium

(c) Law of parallelogram

(d) Lami's Theorem

Q10. Point of application of all force in concurrent system is:

(a) 2T/g (b) 4T/g

(c) T/g (d) T(1+$e^{4\pi}$)g

Q45. The condition of equilibrium for coplanar non-concurrent forces are

(a) $\sum H = 0, \sum V = 0$ (b) $\sum H = 0, \sum M = 0$

(c) $\sum V = 0, \sum M = 0$ (d) $\sum V = 0, \sum H = 0$

Q46. Concurrent forces are those forces whose lines of action:

(a) Lie on the same line

(b) Meet at one point

(c) Meet on the same plane

(d) None of these

ANSWER KEYS

Q1.	a	**Q8.**	d	**Q15.**	d	**Q22.**	a	**Q29.**	a	**Q36.**	a	**Q43.**	d
Q2.	b	**Q9.**	a	**Q16.**	b	**Q23.**	c	**Q30.**	a	**Q37.**	b	**Q44.**	b
Q3.	d	**Q10.**	a	**Q17.**	d	**Q24.**	b	**Q31.**	a	**Q38.**	b	**Q45.**	b
Q4.	d	**Q11.**	a	**Q18.**	d	**Q25.**	b	**Q32.**	c	**Q39.**	c	**Q46.**	b
Q5.	a	**Q12.**	b	**Q19.**	a	**Q26.**	b	**Q33.**	d	**Q40.**	d		
Q6.	c	**Q13.**	b	**Q20.**	a	**Q27.**	b	**Q34.**	b	**Q41.**	c		
Q7.	b	**Q14.**	a	**Q21.**	b	**Q28.**	c	**Q35.**	b	**Q42.**	c		

FORCE, FORCE SYSTEM AND EQUILIBRIUM SOLUTIONS

Q1: (a) Solution: The polygon law of forces states that if a number of forces, acting simultaneously on a particle, be represented in magnitude and direction by the sides a polygon taken in order, then their resultant is represented in magnitude and direction by the closing side of the polygon taken in opposite order.

Q2: (b) Solution: Law of Parallelogram of forces: This law is used to determine the resultant of two coplanar forces acting at a point.
It states that "If two forces acting at a point are represented in magnitude and direction by two adjacent sides of a parallelogram, then their resultant is represented in magnitude and direction by the diagonal of the parallelogram which passes through that common point."

Q3: (d) Solution: Centre of percussion is the point of application of the resultant of all the forces which tends to cause rotation in the body about a certain axis is known as centre of percussion.

Centre of gravity is the point in the body or system around which mass or weight is evenly distributed and through which the force of gravity acts.

Q4: (d) Solution: A solid body applied to three forces whose lines of action are not parallel, is in equilibrium if the three following conditions satisfies:

1. The lines of action are coplanar (in the same plane).

2. The lines of action are meeting at a point.

3. The vector sum of these forces is equal to the zero vector.

Q5: (a) Solution: Apply lami's Theorem

$$\frac{T_1}{Sin120} = \frac{T_2}{Sin\ 150} = \frac{T_3}{Sin\ 90}$$

$$\frac{T_1}{T_2} = \frac{Sin\ 120}{Sin\ 150} = \frac{T_1}{T_3} = \frac{Sin\ 120}{Sin\ 90}$$

$$\frac{T_1}{T_2} = \frac{180-60}{120-30} = \frac{T_1}{T_3} = \frac{Sin\ 120}{Sin\ 90}$$

$$\frac{T_1}{T_2} = \frac{\sqrt{3}/x}{1/2} = \sqrt{3}, \frac{T_1}{T_3} = \frac{\sqrt{3}/2}{1} = \frac{\sqrt{3}}{2}$$

Q6: (c) Solution: P = ?

60°

R = $\sqrt{P^2 + P^2 + 2P^2 cos\theta}$

R = $\sqrt{2P^2(1 + cos\theta)}$

R = $\sqrt{2P^2(1 + cos60)}$

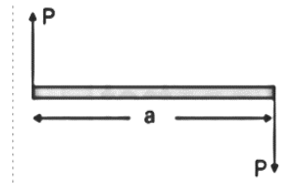
Q10: (b) Solution: When two equal, opposite and parallel forces with different lines of action act on a body, they constitute a couple.

Q11: (b) Solution: Couple is applied when trying to turn a key in lock.

Q12: (b) Solution: torque and couple both

Q13: (b) Solution: A pair of two equal and unlike parallel forces (i.e. forces equal in magnitude, with lines of action parallel to each other and acting in opposite directions) is known as a couple.

As a matter of fact, a couple is unable to produce any translatory motion (i.e, motion in a straight line). But it produces a motion of rotation in the body, on which it acts



Moment of a couple = P x a

P = Magnitude of the force

a = Arm of the couple

So if arm of a couple is doubled then moment of couple will also be doubled.

Q14: (a) Solution: Cycle pedaling is an example of Couple.

CENTROID AND MOMENT OF INERTIA

Q1. Built up section also known as

(a) Standard section (b) Compound section

(c) Both the above (d) None of these

Q2. I - section, channel-section, T-section, L-section and Z-section are known as

(a) Compound section (b) Built up section

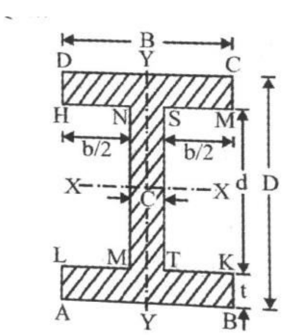
(c) Standard section (d) (a) and (b) both

Q3. Which of the following is correct expression for second moment of inertia is

(a) $I = AK^2$ (b) $I = (AK)^2$

(c) $I = \frac{A}{K^2}$ (d) $I = \sqrt{\frac{A}{K^2}}$

Q4. What is the value of moment of inertia of I-section about Centre of gravity through X-X and Y-Y axis, given figure below.



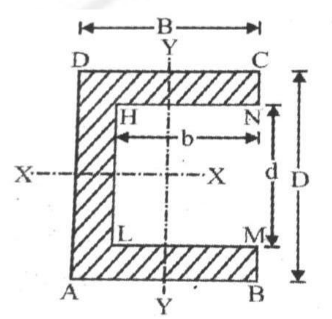
(a) $I_{XX} = \frac{BD^3 - bd^3}{12}$, $I_{yy} = \frac{2tB^3 + dc^3}{12}$

(b) $I_{xx} = \frac{ab^3 - c(b-2t)^3}{12}$, $I_{yy} = \frac{2tb^3 + dc^3}{12}$

(c) $I_{xx} = \frac{B^3D - b^3d}{12}$, $I_{yy} = \frac{2t^3 + d^3c}{12}$

(d) None of these

Q5. What is the value of moment of inertia of Channel-section about Centre of gravity through X-X, given figure below.



(a) $I_{xx} = \left[\frac{BD^3 - bd^3}{12}\right]$ (b) $I_{xx} = \left[\frac{B^2D - bd^3}{12}\right]$

(c) $I_{xx} = \left[\frac{BD^2 - b^3d}{8}\right]$ (d) $I_{xx} = \left[\frac{B^3D - b^3d}{12}\right]$

Q6. What is the value of moment of inertia of T-section about Centre of gravity through X-X and Y-Y axis, given figure below.

(a) High strength of bonds

(b) Weak bonds

(c) Combination of bonds

(d) None of these

ANSWER KEYS

Q1.	c	**Q4.**	b	**Q7.**	c	**Q10.**	d	**Q13.**	d	**Q16.**	d
Q2.	d	**Q5.**	d	**Q8.**	b	**Q11.**	d	**Q14.**	c	**Q17.**	a
Q3.	b	**Q6.**	c	**Q9.**	c	**Q12.**	c	**Q15.**	b		

MECHANICAL PROPERTIES OF MATERIALS SOLUTIONS

Q1: (c) Solution: Malleability * Malleabilit is the property by virtue of which a material may be hammered or rolled into thin sheets without rupture. This property generally increases with the increase of temperature.

* Malleability is the ability of a metal to exhibit large deformation or plastic response when being subjected to compressive force.

* Lead has maximum malleability.

* The malleable materials commonly used in engineering practice (in order of diminishing malleability) are lead, soft steel, wrought iron, copper and aluminium.

Q2: (d) Solution: Ductility: * Ductility is the property of the material that enables it to be drawn out or elongated to an appreciable extent before rupture occurs.

* The percentage elongation or percentage reduction in the area before rupture of a test specimen is the measure of ductility. Normally if the percentage elongation exceeds 15% the material is ductile and if it is less than 5% the material is brittle.

* Lead, copper, aluminium, mild steel are typical ductile materials.

* Gold > Platinum > Silver > Copper > Aluminium > Nickel > Zinc > Tin

Q3: (b) Solution: Ductility: * Ductility is the property of the material that enables it to be drawn out or elongated to an appreciable extent before rupture occurs.

* The percentage elongation or percentage reduction in the area before rupture of a test specimen is the measure of ductility. Normally if the percentage elongation exceeds 15% the material is ductile and if it is less than 5% the material is brittle.

* Lead, copper, aluminium, mild steel are typical ductile materials.

* Gold > Platinum > Silver > Copper > Aluminium > Nickel > Zinc > Tin

* Mild steel has a maximum ductility.

Q4: (b) Solution: Malleability is said to be the property of a material to deform under compression. The metals having malleable property can be rolled or beaten into sheets. An example is aluminium foil.

Ductility is said to be the property of a material to stretch without getting damaged. Metals having ductile property can be stretched into wires. An example is copper wire.

Q5: (d) Solution: Specific stiffness is a material property that is the ratio of a material's Young's Modulus to its density. It is also known as the stiffness to weight ratio.

Material	Modulus Of Elasticity (10^9Pa)	Density (kg/m^3)	Specific Stiffness (MN-m/kg)
Steel	210	7850	26.75
Aluminium	70	2700	25.92
Glass Fibre	52-87	2400 - 2760	21.67 – 31.52
C - Fibre	200 - 500	1550	129.03 – 322.58

From the above calculation we see that Carbon fiber has higher specific strength.

Q6: (c) Solution: Hot hardness is the ability of the material to retain its hardness at elevated temperature. It is to resist plastic deformation and reduce wear rate at elevated temperatures.

Q7: (c) Solution: Toughness: It is defined as the ability to absorb energy up to fracture. The energy per unit volume is the total area under the strain – stress curve. It is measured by an impact test.

(c) Austenitic stainless steel

(d) None of these

Q41. Which of the following when used in ordinary low carbon steels, makes the metal ductile and of good bending qualities?

(a) Sulphur (b) Phosphorus

(c) Manganese (d) Silicon

Q42. Stainless steel contains:

(a) Chromium. Iron, Nickel

(b) Chromium and Nickel

(c) Iron and Carbon

(d) Chromium, Nickel, Iron and Carbon

Q43. Silicon is added in low carbon steels to increases____ property

(a) Hardness (b) Brittleness

(c) Porousness (d) Softness

Q44. The percentage of carbon in low carbon steel is-

(a) 0.15% (b) 0.30%

(c) 0.50% (d) 0.70%

Q45. The hot forging of steel specimen is carried out at a temperature of

(a) 400°C (b) 600°C

(c) 500°C (d) 950°C

Q46. Manganese in steel increases its:

(a) Tensile strength (b) Hardness

(c) Ductility (d) Conductivity

ANSWER KEYS

Q1.	d	**Q8.**	c	**Q15.**	d	**Q22.**	b	**Q29.**	a	**Q36.**	a	**Q43.**	a
Q2.	a	**Q9.**	d	**Q16.**	c	**Q23.**	d	**Q30.**	b	**Q37.**	a	**Q44.**	b
Q3.	a	**Q10.**	b	**Q17.**	a	**Q24.**	c	**Q31.**	c	**Q38.**	d	**Q45.**	d
Q4.	a	**Q11.**	d	**Q18.**	a	**Q25.**	d	**Q32.**	a	**Q39.**	a	**Q46.**	a
Q5.	c	**Q12.**	a	**Q19.**	d	**Q26.**	b	**Q33.**	a	**Q40.**	c		
Q6.	a	**Q13.**	c	**Q20.**	a	**Q27.**	b	**Q34.**	b	**Q41.**	c		
Q7.	c	**Q14.**	a	**Q21.**	a	**Q28.**	b	**Q35.**	b	**Q42.**	d		

CLASSIFICATION OF STEEL AND ITS ALLOYS SOLUTIONS

Q1: (d) Solution: Killed steels: In killed steel, the Oxygen is removed completely. The solidification of such steels does not given gas porosity (blowholes).

* So steel destroyed by burning called killed steel.

* Killed steel is a type of steel from which there is practically no evolution of gas during solidification of the ingot after pouring, because of complete deoxidation, and formation of pipe in the upper central portion of the ingot, which is later cut off and discarded.

* All alloy steels, most low – alloy steels, and many carbon steel are usually killed.

* The continuous casting billets are also killed. The essential quality criterion is soundness.

* Killed steel is characterized by a homogeneous structure and even distribution of chemical compositions and properties.

* Killed steel is produced by the use of a deoxidizer such as Al and a ferroalloy of Mn or Si.

* However, calcium silicide and other special deoxidizers are sometimes used.

Q2: (a) Solution: Stainless steels are characterized primarily by their corrosion resistance, high strength and ductility, and high chromium content.

* Stainless steels contain typically 10 – 30% chromium besides other elements like C, Mn, Si, S etc. Chromium imparts corrosion resistance to steel.

Boron	Improves hardenability without the loss of machinability
Chromium	Improves oxidation and corrosion resistance Corrosion resistance may also be enchanced by Ni and Mo addition
Cobalt and Tungsten	Improves strength and hardness at elevated temperatures
Sulphur	Improves machinability when combined with manganese Alone increases the brittleness and lowers impact strength and ductility
Manganese	Improves hardenability and wear resistance Counteracts the brittleness caused by Sulphur
Molybdenum	Improves hardenability, toughness Improves elevated temperature strength, creep resistance
Nickel	Increase strength and hardness without sacrificing ductility and toughness
Vanadium	Increase strength, hardness, wear – resistance and resistance to shock impact at high temperature.
Titanium	Improve strength, deoxidizes steel.

Q28: (b) Solution: Tungsten in steel forms the tungsten carbide and every element of tungsten carbide is susceptible to magnetism.

Q29: (a) Solution: The brown smoke during the operation of a Bessemer converter indicates that the Air is burning out silicon and manganese

Q30: (b) Solution: Basic Bessemer process: * In the basic Bessemer process (Often called Thomas process), there are two differences from the normal Bessemer process:

***** The Thomas converter is lined with basic material such as calcinated dolomite or limestone. This reduces the reaction between the iron phosphate slag and the lining of the convertor.

* Limestone $CaCO_3$ or lime CaO are added as slag formers. These are basic and reacti with P_4O_{10} forming 'basic slag'$Ca_3(PO_4)_2$, thus removing P from the steel.

* Thus a Bessemer converter with its silicate lining was used for iron ore containing silicate impurities and a Thomas convertor lined with limestone or dolomite was used with ores which had a high P content.

Use of Dolomite

* Dolomite is generally used as a repairing material rather than as a direct refractory because of its defects like great porosity, shrinkage, and softness.

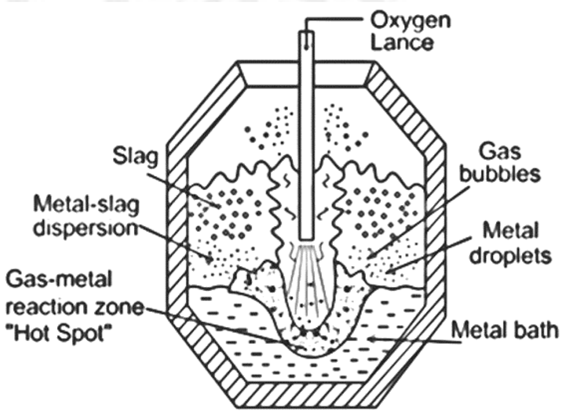
* However, stabilized dolomite bricks are used in electric furnaces, Bessemer converters, open hearth furnace, etc.

Q31: (c) Solution: Blast furnace, a vertical shaft furnace that produces liquid metals by the reaction of a flow of air introduced under pressure into the bottom of the furnace with a mixture of metallic ore, coke (blast furnace fuel), and flux fed into the top. Blast furnaces are used to produce pig iron from iron ore for subsequent processing into steel, and they are also employed in processing lead, copper and other metals.

Q32: (a) Solution: Modern steelmaking processes are broken into two categories: Primary and Secondary steelmaking.

* Primary steelmaking used mostly new iron as the feedstock, usually from a blast furnace.

* Primary, steelmaking has two methods: BOS (Basic Oxgyen Furnace) and the more modern EAF (Electric Arc Furnace) methods.



* Basic oxygen process (BOP), is also known as LD (Linz and Donawitz) or the oxygen converter process is a steelmaking method in which pure oxygen is blown into a bath of molten blast – furnace having pig iron and scrap.

1. Carburizing

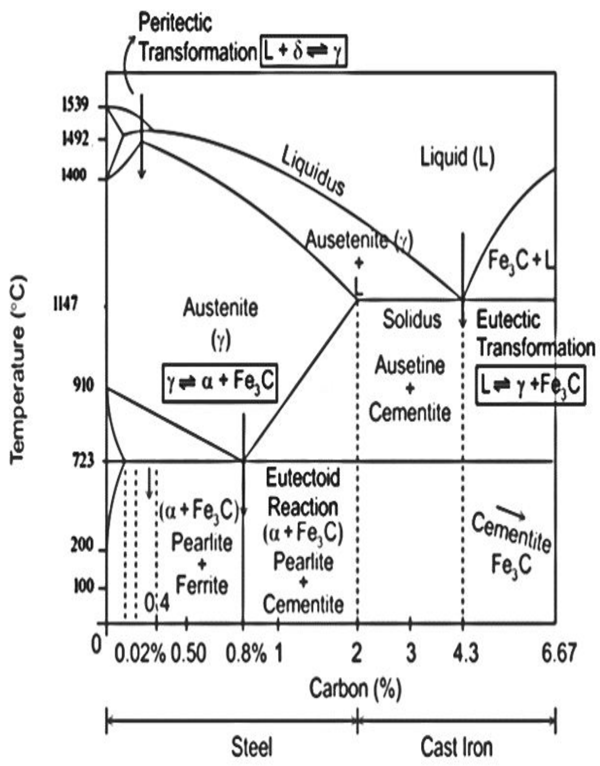
2. Cyaniding

3. Nitriding

4. Induction Hardening

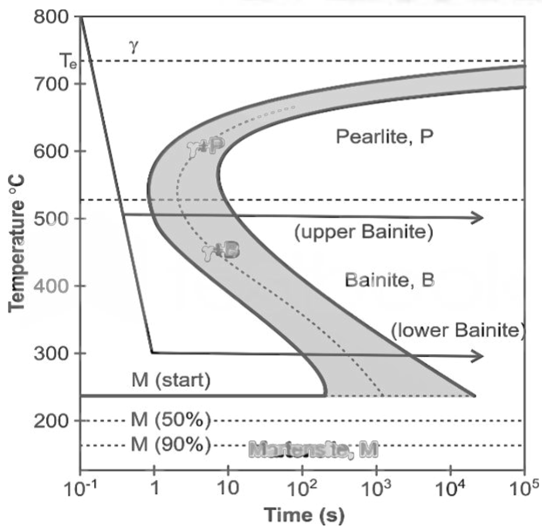
5. Flame hardening

Q10: (d) Solution:



Iron Carbon Equilibrium Diagram

Q11: (c) Solution:



TTT Diagram: * The rate of phase transformatino also depends upon the temperature.

* Temperature – time – transformation diagram (TTT), also known as isothermal transformation curves, are useful in planning heat treatments.

* The complete isothermal transformation diagram for an iron – carbon alloy of eutectoid compositon A (austenite), B (Bainite), M (Martensite), P (Pearlite) is below?

Q12: (c) Solution: Steel containing ferrite and pearlite is soft. Ferrite is a form of pure iron with a body-centered cubic crystal structure and occurs in low-carbon steel.

Q13: (d) Solution: Hypo – eutectoid steel: Plain carbon steels in which carbon percentage is less than 0.8% C are called hypo – eutectoid steel.

Hypereutectoid Steel: Plain carbon steels in which carbon percentage lies between 0.8 – 2%C and are called hyper – eutectoid steel.

Q14: (b) Solution: Bainite is produced by an austempering process, In this process, the sample is heated and quenched to room temperature below the nose of the T – T – T diagram and this temperature is maintained for a substantial period of time so that cooling curve enters into T – T – T diagram.

Q15: (d) Solution: The hardness of martensite steel depends upon its carbon content and ranges from 460 Brinell at 0.2% carbon to about 710 Brinell above 0.5% carbon.

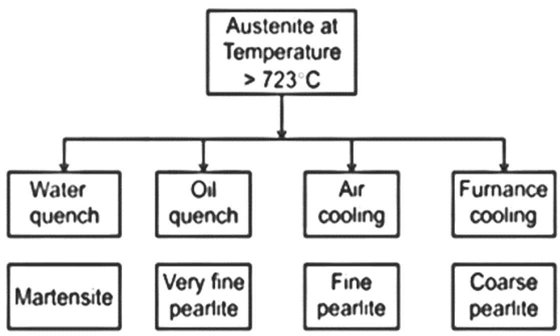
In comparison:

* Ferrite has a hardness of 90 Brinell

* Pearlite about 240 Brinell and

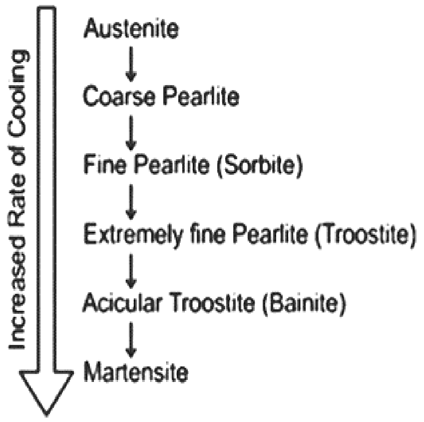
* Cementite around 550 Brinell

Q16: (d) Solution:

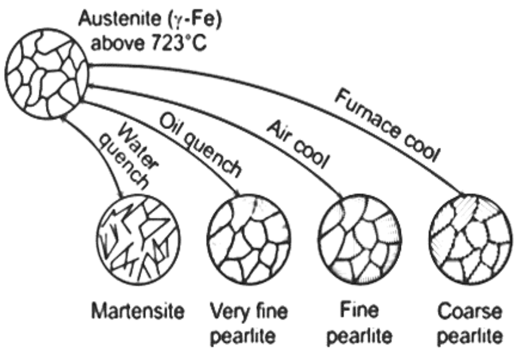


Single-piece flow – Induction machines can be installed in a manufacturing cell because induction hardening is not a batch process (typically, one component is hardened at a time). This permits the process flow to continue uninterrupted.

Q26: (d) Solution:



Effect of Rate of Cooling



Q27: (d) Solution: Steel with a carbon content of 0.35% or more can be hardened using a heat-quench-temper cycle.

Q28: (a) Solution: * Case hardening is a method used to harden the outer surface of low – carbon steel while leaving the center or core soft and ductile.

* Case hardening involves heating the metal to its critical temperature in some carbonaceous material.

* The following methods are commonly used:

1. Carburizing

2. Cyaniding

3. Nitriding

4. Induction Hardening

5. Flame Hardening

Q29: (d) Solution: Pearlite is the eutectoid mixture of cementite and ferrite.

Q30: (b) Solution: Atomization: Atomization involves a liquid metal stream produced by injecting molten metal through a small orifice. The stream is broken up by jets of inert gas or air or water.

Q31: (d) Solution: Hot – working:

If the metal forming process is done above the recrystallization temperature, then it is called not working.

Advantage	Disadvantage
The porosity of metal is largely eliminated	Expensive tools, poor surface finish
The grain structure of the metal is refined	Close tolerance can not be maintained

Cold working:

If the metal forming process is done below the recrystallization temperature then it is called cold working.

Advantage	Disadvantage
Better surface finish, close tolerances, better accuracy	A large force is required to deform the materials.
Increase strength and hardness	The surface must be free from scale, dust
No heating is required so less cost	It causes residual stress

Q32: (d) Solution: After cold forming the steel balls are subjected to stress relieving by annealing process.

Q33: (d) Solution: Brine solution gives a faster rate of cooling while air cooling has the slowest rate of cooling.

Brine is a high – concentration solution of salt (NaCl) in water.

Order of rate of cooling is Brine > Water > Oil > Air

Q34: (c) Solution: Recrystallization temperature rises with increasing concentrations of impurities.

* The recrystallization temperature for steel is 800°C so the correct answer is option 3.

The constant of proportionality is called the elastic modulus or Young's modulus, E. It has the same units as stress. E is a property of the material used.

Q28: (d) Solution: Plasticity is the property of a material that enables it to retain deformation permanently.

Q29: (c) Solution: The ability of the material to withstand stress (resist fracture due to high impact loads) without fracture is known as toughness.

Q30: (d) Solution: SI unit of Young modulus is Pascal (Pa). It is also equal to newton per square meter (N/m^2).

Q31: (b) Solution: Mild steel is a relatively ductile material as it contains a smaller amount of the hardening alloy-carbon than other carbon steels.

Q32: (c) Solution: ductility: is the physical property of a material to be drawn deformed without fracture.

* Example of ductility: Gold, Silver, Copper.

Malleability is the property of metals through which metals can be converted into thin sheets.

* Examples of malleability: copper, Silver, and Lead.

* Gold and silver are highly malleable.

Viscosity is defined as a liquid's resistance to flow.

* Viscosity comes due to the strong intermolecular forces between the molecules that hold them together.

* It denotes opposition to flow.

* The reciprocal viscosity is called fluidity.

Tensile strength the maximum load that a material can support without fracture when being stretched, divided by the original cross – sectional area of the material.

* Tensile strengths have dimensions of force per unit area.

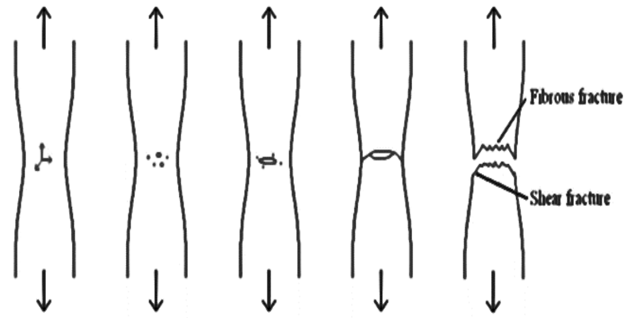
Q33: (d) Solution: The modulus of elasticity (E) is the constant of proportionality which is defined as the intensity of stress that causes unit strain.

Q34: (b) Solution: The property of a material by virtue of which a body returns to its original shape after removal of the load is called elasticity.

Q35: (a) Solution: * Most ductile metals fracture preceded by a moderate amount of necking, followed by the formation of voids, cracks and finally shear.

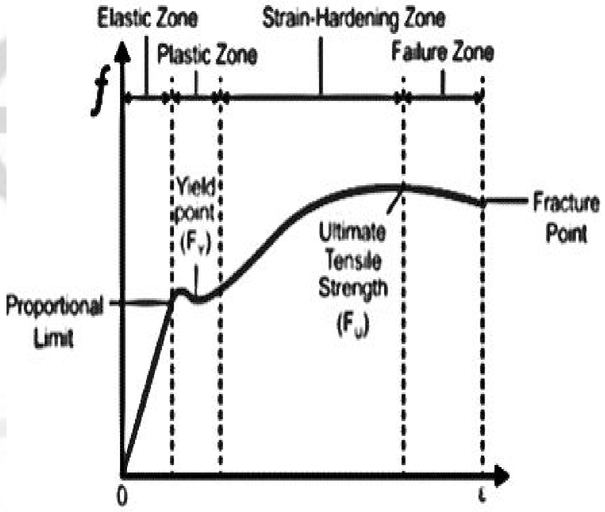
* This gives a characteristic cup – and – cone fracture. In this central interior region has an irregular and fibrous apppearnace, which signifies plastic deformation.

* Different progressive stages of ductile fracture are shown in figure.



Q36: (b) Solution: Young's Modulus is defined as the ratio of Longitudinal stress to longitudinal strain.

Q37: (a) Solution:



The Stress-Strain Curve For Low Carbon Steel

Q38: (a) Solution: Toughness is defined as the ability to absorb energy up to fracture. The energy per unit volume is the total area under the strain-stress curve. It is measured by an impact test. Impact strength is the capability of the material to withstand a suddenly applied load and is expressed in terms of energy.

Q39: (b) Solution: Stiffness of a material is the resistance offered to deformation, below the elastic limit. A material with a high value of Young's modulus E is stiffer than the material with the lower value of Young's modulus.

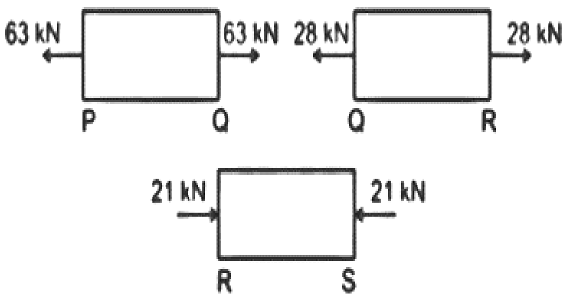
Q40: (a) Solution: Ultimate tensile strength (UTS), often referred to simply as tensile strength, is a measure of the maximum stress a material can withstand without breaking or falling under tension. It's a fundamental

Engineering strain (e) = $\frac{Change\ in\ length}{original\ length}$

$$\epsilon = \frac{200.2 - 200}{200} = \frac{0.2}{200}$$

$$e = 0.001$$

Q29: (a) Solution:



Now for the bar RS

$\sigma_{RS} = \frac{P_{RS}}{A} = \frac{21\times1000}{700} = 30\ MPa$

Q30: (a) Solution: change in length is given by:

$$\delta L = \frac{PL}{AE}$$

Calculation:

Given

$$P = 250kN = 250 \times 1000N, L = 4m = 4000\ mm, E = 250\ GPa = 250 \times 1000\ N/mm^2, A = 40mm \times 40mm$$

$$\delta L = \frac{PL}{AE} = \frac{250 \times 1000 \times 4000}{40 \times 40 \times 250 \times 1000} = 2.5mm$$

Q31: (d) Solution: $\sigma_T = E\alpha\Delta T$, E= young modulus, $\alpha =$ coefficient of thermal expansion, $\Delta T = temperature\ difference$

Q32: (c) Solution: change in temperature $\Delta T = T_2 - T_1$ = 150-30=120℃

coefficient of thermal expansion (α) = 12×10^{-6}/℃

Youngs Modulus(E)= 200 GPa

Thermal Strain = $\alpha\Delta T = 12 \times 10^{-6} \times 120$

= $144\text{x}10^{-5}$

Now thermal strain= $\frac{P}{AE} = \frac{\sigma_T}{E}$

Thermal Stress$(\sigma_T) = 144 \times 10^{-5} \times 200 \times 10^9$

= 288000000

= 288 MPa

Q33: (d) Solution: Elongation in a tapered rod. $\delta = \frac{4PL}{\pi d_1 d_2 E}$

Where, P= applied load, l=length of the tapered rod, $d_1 = dia\ of\ rod\ at\ one\ side, d_2 = dia\ of\ rod\ at\ another\ side$, E= modulus of elasticity.

Q34: (a) Solution: due to the rod has not been restricted in its original position(**Free expansion**), so there will be no stress genrate.

Q35: (c) Solution: Stress =load/area,

Tensile stress=$\frac{20\times10^3}{20\times30} = \frac{33.33N}{mm^2} orMP$

Q36: (d) Solution: Elongation of a uniform bar due to self load is $\frac{WL}{2AE}$,

Where, W=applied load,

L=length of the bar

A=cross section area of bar

E=modulus of elasticity

Q37: (a) Solution: The relationship between the Young's Modulus (E), Bulk modulus (K) and Poisson's ratio μ) is E = 3K(1-2μ)

Q38: (b) Solution: Strain is a dimensionless quantity.

Q39: (a) Solution: For a rigid body, the value of Poisson's ratio is zero. A zero Poisson's ratio means that there is no transverse deformation resulting from an axial strain.

Q40: (d) Solution: given Elongation ε =2.5mm, area A=40 mm × 40 mm, length of bar l=4m=4x1000, modulus of elasticity E=250 GPa=250x1000Mpa

$$\varepsilon = (Pl)/(AE)$$

Load P=$\frac{2.5\times40\times40\times250\times10^3}{4\times10^3}$=$250 \times 10^3$N

=250KN

Q41: (b) Solution: Where E = Young's Modulus of Elasticity, G = Modulus of Rigidity, μ = Poisson's ratio, K = Bulk Modulus of Elasticity

Calculation: Given:

$\mu = 0.25, G = 80\ N/mm^2$

$E = 2G(1 + \mu)$

Q127. In the Taylor's tool life equation, $VT^n = C$, the value of n = 0.5. The tool has a life of 180 minutes at a cutting speed of 18 m/minute. Determine the cutting speed if the tool life is reduced to 45 minutes.

(Where V : cutting velocity, T : tool life,

n : Taylor's tool life exponent and C : constant)

(a) 9m/minute (b) 18m/minute

(c) 36m/minute (d) 72m/minute

Q128. The cutting tool used in spark erosion machining process is called

(a) Arc (b) Capacitor

(c) Electrode (d) Dielectric

Q129. Which part of the cutting tool is prone to crater wear?

(a) Shank (b) Base

(c) Flank (d) Face

Q130. Crater wear occurs due to which one of the following phenomenon

(a) Adhesion (b) Diffusion

(c) Oxidation (d) All of the above

Q131. In metal cutting with a carbide tool, at the maximum recommended speed, the largest % of heat generated goes to be

(a) Tool (b) Chip

(c) Work (d) Tool post

Q132. Taylor's tool life equation is as follows

(a) $TV^n = C$ (b) $VT^{1/n} = C$

(c) $VT^n = C$ (d) $VT = C$

Q133. During the machining operation

(a) The chips experience stresses
(b) The chips experience strains
(c) The values of stresses and strains are always calculated for the conditions at the normal plane
(d) The chips experience stresses and strains

Q134. In a single point turning operation with a cemented carbide and steel combination having Taylor exponent 0.25, if the cutting speed is halved, the tool life will be

(a) Half (b) 2 times

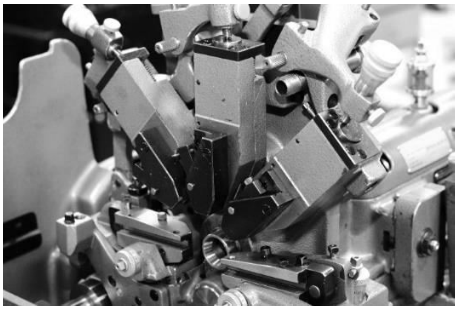
(c) 8 times (d) 16 times

ANSWER KEYS

Q1.	c	Q16.	b	Q31.	a	Q46.	a	Q61.	b	Q76.	c	Q91.	c	Q106.	b	Q121.	c
Q2.	c	Q17.	c	Q32.	d	Q47.	c	Q62.	b	Q77.	d	Q92.	d	Q107.	d	Q122.	b
Q3.	b	Q18.	d	Q33.	b	Q48.	d	Q63.	b	Q78.	a	Q93.	c	Q108.	b	Q123.	c
Q4.	a	Q19.	a	Q34.	c	Q49.	d	Q64.	d	Q79.	a	Q94.	d	Q109.	c	Q124.	b
Q5.	d	Q20.	d	Q35.	a	Q50.	d	Q65.	c	Q80.	a	Q95.	b	Q110.	d	Q125.	c
Q6.	c	Q21.	b	Q36.	c	Q51.	c	Q66.	b	Q81.	b	Q96.	d	Q111.	c	Q126.	d
Q7.	b	Q22.	d	Q37.	a	Q52.	a	Q67.	c	Q82.	b	Q97.	c	Q112.	c	Q127.	c
Q8.	a	Q23.	b	Q38.	d	Q53.	d	Q68.	b	Q83.	a	Q98.	c	Q113.	a	Q128.	c
Q9.	c	Q24.	c	Q39.	d	Q54.	d	Q69.	b	Q84.	c	Q99.	b	Q114.	a	Q129.	d
Q10.	c	Q25.	b	Q40.	d	Q55.	d	Q70.	a	Q85.	d	Q100.	b	Q115.	b	Q130.	b
Q11.	d	Q26.	d	Q41.	c	Q56.	d	Q71.	d	Q86.	c	Q101.	a	Q116.	b	Q131.	b
Q12.	d	Q27.	d	Q42.	b	Q57.	a	Q72.	c	Q87.	c	Q102.	a	Q117.	c	Q132.	c
Q13.	b	Q28.	d	Q43.	c	Q58.	a	Q73.	d	Q88.	a	Q103.	d	Q118.	a	Q133.	d
Q14.	c	Q29.	b	Q44.	d	Q59.	d	Q74.	a	Q89.	c	Q104.	a	Q119.	b	Q134.	d
Q15.	b	Q30.	c	Q45.	a	Q60.	a	Q75.	c	Q90.	d	Q105.	d	Q120.	a		

LATHE SOLUITONS

Q8: (b) Solution: Cutting tools are attached radial slides which slides along.



Q9: (a) Solution: Table speed in mm/minute = $f_t \times Z \times N$

where, N = RPM, Z = no. of teeth, f_t = Feed per tooth

<u>Calculation:</u>

Given:

Z = 10, N = 150 rpm, f_t = ?, f_{m}- 400 mm/min

Table speed in mm/minute = $f_t \times Z \times N$

400 = $150 \times 10 \times f_t$

$f_t = 0.26mm$

Q10: (a) Solution: On taper external threads can be cut conveniently on lathe, but internal threads are difficult to cut on internal taper. On milling it is easy to produce both type of thread and especially on universal milling machine.

Q11: (d) Solution: Compound Indexing: This method of indexing is employed when the number of divisions required on the workpiece cannot be obtained with simple indexing method. This method involves two separate indexing movements that give the name compound indexing method.

Q12: (c) Solution: An universal milling machine has a table that can be swiveled in a horizontal plane (about a vertical axis) to any specified angle (mainly ±45°). This facilitates the cutting of angular shapes and helixes on workparts.

Q13: (d) Solution: During milling and grinding work is held by a vice which is also known as Fixture. Fixtures are used on lathe, milling, grinding, broaching and welding.

Q14: (a) Solution: The milling cutter is mounted onto a milling machine spindle, and the work piece is held in place on the machine table. As the milling cutter rotates at high speeds, the cutting teeth on its periphery come into contact with the work piece, removing material and creating a flat surface or a complex shape.

Q15: (d) Solution: Table speed (V) per minutes is given by,

V = f × N × t

Where, f = feed per tooth, N = Number of rpm, t = Number of teeth.

<u>Calculation:</u>

f = 0.1 mm/tooth, N = 200 rpm, t = 8 teeth.

V = f × N × t

$\therefore V = 0.1 \times 200 \times 8 = 160 mm/minute$

The table speed is 160 mm/minute

Q16: (c) Solution: Down milling/ Climb milling:

• The cutter rotation is in the same direction as the motion of the workpiece being fed.

• The cut starts with the full chip thickness.

• The cutting force is maximum at the beginning and minimum at the end of the cut.

• In down milling, the cutting force is directed onto the work table, which allows thinner parts to be machined without susceptibility to breakage, but it requires the optimum holding device as the cutting tool forces the workpiece in the opposite direction of the tool motion. Therefore the gap between the lead screw and the half nut increases which requires a backlash eliminator.

• A better surface finish is obtained.

Q17: (d) Solution: The engine lathe is a basic machine tool that can be used for a variety of turning, facing, and drilling operations. It uses a single-point cutting tool for turning and boring. Turning operations involve cutting excess metal, in the form of chips, from the external diameter of a workpiece and include turning straight or tapered cylindrical shapes, grooves, shoulders, and screw threads and facing flat surfaces on the ends of cylindrical parts.

Drilling machines also called drill presses cut holes in metal with a twist drill. They also use a variety of other cutting tools to perform the following basic hole-machining operations:

(1) reaming (2) boring

(3) counterboring (4) countersinking

CHAPTER – 5 WELDING

CLASSIFICATION OF WELDING

Q1. Match the following

Welding process	Heat Source
A. Thermit welding	1. Electric arc
B. Projection welding	2. Mechanical work
C. MIG welding	3. Exothermic chemical
D. Friction welding	4. Ohmic resistance

	A	B	C	D
(a)	4	3	2	1
(b)	4	1	3	2
(c)	2	3	1	4
(d)	3	4	1	2

Q2. Match the following

List-I	List –II
A. Welding of aluminium alloy	1. Submerged arc welding
B. Ship building	2. Electron beam welding
C. Joining of HSS drill	3. Friction welding
D. Deep penetration precision welds	4. Gas welding
	5. Tig welding

	A	B	C	D
(a)	1	2	4	3
(b)	5	1	4	2
(c)	3	1	5	2
(d)	4	3	1	2

Q3. Out of the following, which is NOT a type of welding?

(a) AC arc

(b) DC arc

(c) MIG

(d) All of these are different types of weldings

Q4. Consider the following processes:

1. Gas welding 2. Thermit welding

3. Arc welding 4. Resistance welding.

The correct sequence of these processes in increasing order of their welding temperature is

(a) 1,3,4,2 (b) 1,2,3,4

(c) 4,3,1,2 (d) 4,1,3,2

Q5. Which of the following is/are resistance welding?

(a) Seam welding (b) Projection welding

(c) Spot welding (d) All of these

Q6. Which of the following is an example of fusion welding?

(a) Atomic hydrogen welding (b) Flash welding

(c) Seam welding (d) Spot welding

Q7. Match the following

Process	Associated Mechanism
A. Explosive welding	1. Liquid state
B. Brazing	2. Solid state
C. Thermit welding	3. Solid liquid state
D. Manual metal arc welding	4. Liquid state chemical

	A	B	C	D
(a)	5	2	1	4
(b)	4	2	1	3
(c)	4	1	2	3
(d)	2	3	4	1

Q8. The strength of a properly welded joint as compared to base metal would be…….

(a) Same (b) More

(c) Less (d) Unpredictable

Q9. For welding process, which is NOT correct.

(a) Welding size depends on contact area of the face of Electrodes

(d) Ceases to be laminar

Q3. The coefficient of drag and lift are functions of

(a) Froud's number (b) Reynolds number

(c) Weber number (d) Euler number

Q4. The component of the force of the fluid on the body (which is generally inclined to the direction of motion of the body) parallel to the direction of motion is called

(a) Drag (b) Lift

(c) Wake (d) Propelling

Q5. Bluff body is the body of such a shape that pressure drag as compared to friction drag is

(a) Same (b) More

(c) Less (d) Zero

Q6. If a thin plate is held parallel to a fluid stream the pressure drag on it is:

(a) Maximum (b) Minimum

(c) approximate to Zero (d) None of these

Q7. Pressure drag as per boundary layer theory is function of

(a) Shape of body

(b) Dimensions of body

(c) Flow direction

(d) Shape of body and separation of flow

Q8. The region between the separation streamline and the boundary surface of the solid body is known as

(a) Wake (b) Drag

(c) Lift (d) Boundary layer

Q9. How could Magnus effect be simulated as a combination?

(a) Uniform flow and doublet

(b) Uniform flow, irrotational vortex and doublet

(c) Uniform flow and vortex

(d) Uniform flow and line surge

Q10. The total drag on a plate held normal to the flow is equal to

(a) Pressure drag

(b) Viscous drag

(c) Viscous drag/Pressure drag

(d) None of these

Q11. Reynold's Number is.

(a) $\frac{Surface\ force}{Viscous\ force}$ (b) $\frac{Shear\ force}{Inertia\ force}$

(c) $\frac{Viscous\ force}{Inertia\ force}$ (d) $\frac{Inertia\ force}{Viscous\ force}$

Q12. Weber number is the ratio of inertia force to

(a) Gravitational force (b) Surface tension

(c) Elasticity (d) Viscosity

Q13. The coefficient of friction in term or Reynold's number is

(a) 16/Re (b) 32/Re

(c) 8/Re (d) 10/Re

Q14. The boundary layer on a flat plate is called laminar boundary layer, if:

(a) None of the above

(b) Reynolds number is less than 4000

(c) Reynolds number is less than 2000

(d) Reynolds number is less than 5×10^5

Q15. For a linear distribution of velocity in the boundary layer on a flat plate, the ratio of displacement thickness to nominal thickness is

(a) $\frac{1}{4}$ (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) $\frac{2}{3}$

Q16. In the region of boundary layer on a flat plate surface where velocity is not zero, the viscous force is

(a) Less than inertia force

(b) More than inertia force

(c) Equal in magnitude

(d) Not predictable

Q17. A body is called streamline body when

(a) It is symmetrical about the axis along the free stream.

• Job production can be classical craft production by small firms (making railings for a specific house, building/repairing a computer for a specific wedding, etc.), but large firms use job production, too, and the products of job production are often interchangeable, such as machined parts made by a job shop.

Examples include:

○ Designing and implementing an advertising campaign

○ Auditing the accounts of a large public limited company

○ Building a new factory

○ Installing machinery in factory

○ Machining a batch of parts Per a CAD drawing supplied by a customer

○ Building the Golden Gate Bridge

Q16: (c) Solution: The five M's of management are analyzed below:

Q17: (b) Solution: The unit cost in case of batch production is low as compared to jobbing production.

Q18: (a) Solution: • Master production scheduling is a production planning process that creates a central document a master production schedule or MPS that tells you what make-to-stock or sales order you need to manufacture, what quantity of these products your factory needs to produce, and when these products need to be completed.

• As the name implies, a master production schedule determines what products are manufactures, when they are produced, and in what quantities.

• The required raw materials are identified by the finished goods BOM, the data from which is integrated with current inventory data to create the MRP for raw materials procurement.

• The master production schedule forms the basis of communication between sales and manufacturing.

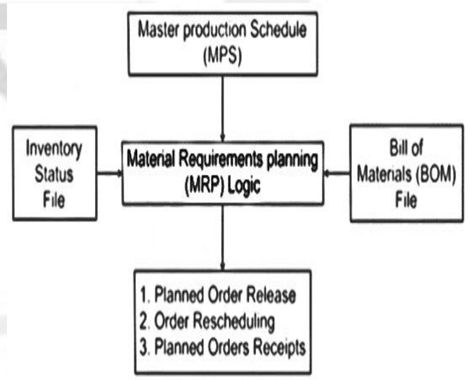
• A master production schedule is a dynamic plan and can be adjusted when there are changes in demand or capacity.

Q19: (a) Solution: • Materials requirements planning is a simple system of calculating arithmetically the requirements of the input materials at different points of time based on the actual production plan.

• It can be seen from the figure that an MRP system has three major input components:

The inputs to the MRP system are:

1. Master production schedule
2. Inventory status file
3. Bill of materials (BOM)



Q20: (c) Solution: Materials requirements planning is a simple system of calculating arithmetically the requirements of the input materials at different points of time based on the actual production plan.

It can be seen from the figure that an MRP system has three major input components: