MODEL ANSWER

SUMMER– 19 EXAMINATION

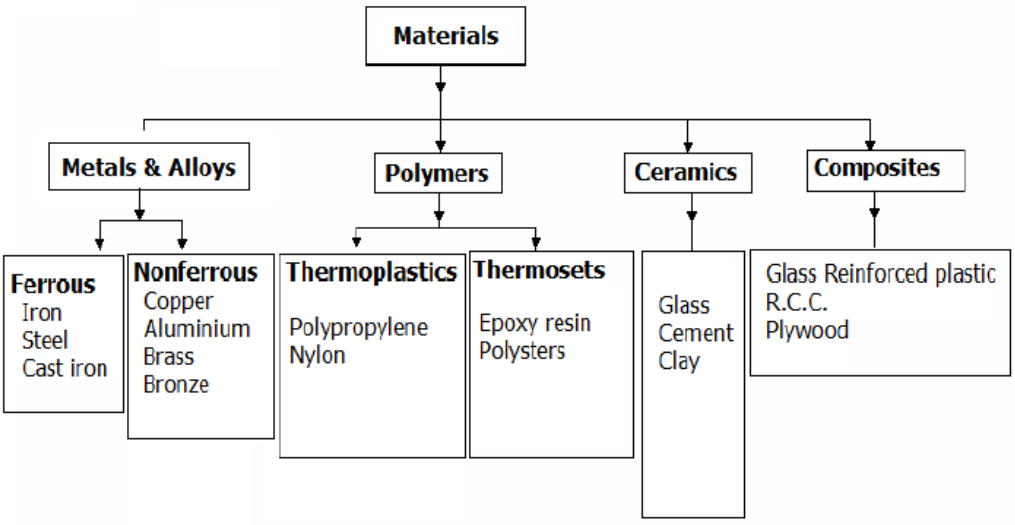
Subject Title: Materials and Manufacturing Processes Subject Code: 22307

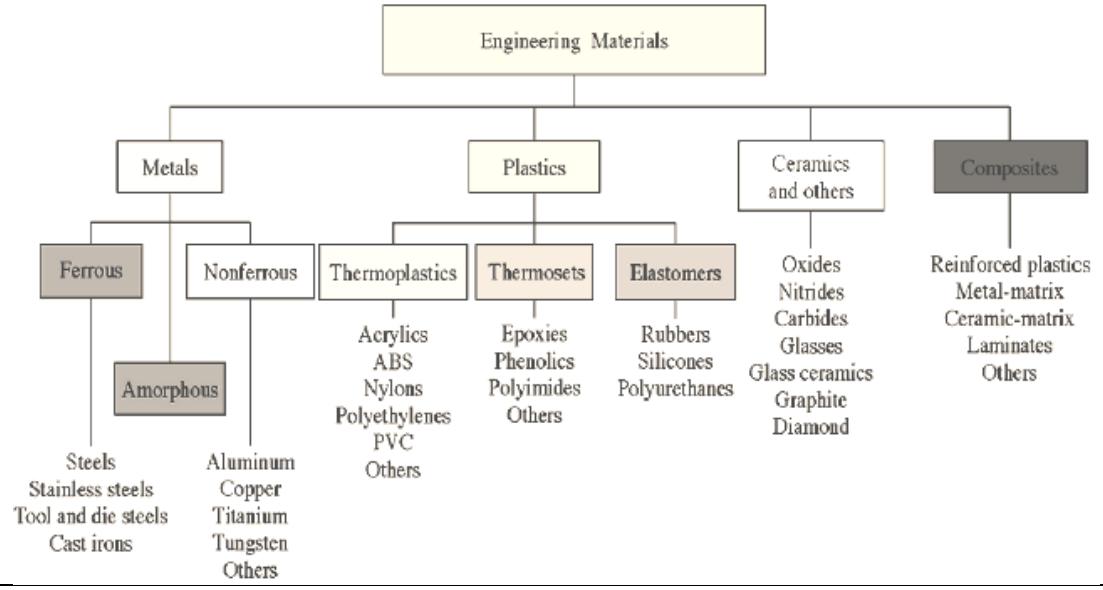
Important Instructions to examiners:

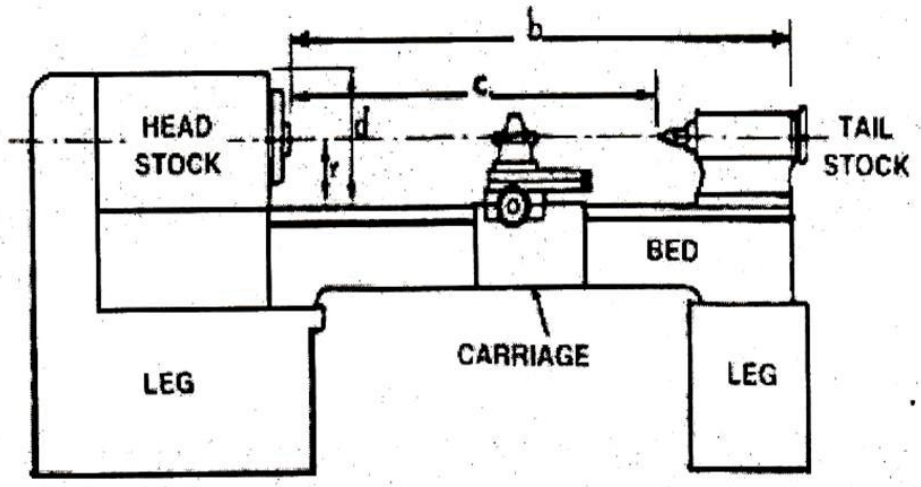
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
01		**Attempt any FIVE of the following**	**10**
	a)	**State the need of advanced material in making of automobile components.**	**02**
		Answer: The general finding highlights the need for developing material systems methodology and for approaching research issues in terms of material life cycles. Improved materials and material processing can and must play a large role in generating productive and effective responses to the forces that will drive the automotive industry in future. For example : Aluminum alloys can be used to reduce vehicle weight, thereby reducing emissions and improving fuel economy, but the added materials costs currently offset these advantages for many applications. Material life cycle: Modeling of material system. Materials system research, Lightweight material for body structure.	**02**
	b)	**Define phase and phase diagram**	**02**
		Phase : A phase is defined as a homogeneous part of a system that has uniform physical and chemical properties. Pure metal is considered to be a phase. **Phase diagrams** are the diagrams which indicate the phase existing in the system at any temperature and composition. Y- axis of phase diagram indicates temperature and X-axis indicates weight percent of second element as abscissa. These diagrams are used to find out the amount of phases existing in a given alloy with their	**01** **01**

		composition at any temperature. It also helps in understanding the phenomenon that occur during rapid heating and cooling of the alloy.	
	c)	**State any two advantages and disadvantages of foundry process**	**02**
		Ans: **Following are the advantages of foundry process: (Any Two – 1 mark each)** i. It one of the most versatile manufacturing process. ii. Castings provide uniform directional properties. iii. Intricate shaped parts can be produced. iv. Very complicated parts can be cast in one piece. **Following are the disadvantages of foundry process: (Any Two – 1 mark each)** i. It is only economical for mass production. ii. Sand casting process cannot produce parts in accurate sizes. iii. Special casting processes are expensive. iv. In some casting process, skilled operators are required. v. Internal defects are not identified easily.	**01** **01**
	d)	**Define cutting speed and feed in metal cutting process.**	**02**
		Cutting Speed: Cutting speed is defined as the speed at which the work moves with respect to the tool (usually measured in feet per minute). **Feed :** Feed is defined as the distance the tool travels during one revolution of the part.	**01** **01**
	e)	**State any four properties of cutting fluid.**	**02**
		Properties of cutting fluid: *(Any 04- ½ mark each)* 1. High heat absorption 2. Good lubricating qualities to produce low coefficient of friction 3. Low viscosity to permit free flow of liquid 4. Non-corrosive to the work or the machine 5. High flash point so as the eliminate the hazards of fire 6. Odorless ,so as not to produce any bad smell 7. Harmless to the skin of operator 8. Transparency so that the cutting action of the tool may be observed	**02**
	f)	**Define machine tool.**	**02**
		A machine tool is a power driven machine form making articles of a given shape , size and accuracy(according to blueprints) by removing metal from workpieces in the form of chips. Most machine tools perform the following functions: 1. Hold the job 2. Hold the cutting tool 3. Move one or both of these(1 and 2) 4. Provide a feeding motion to one of these.	**02**
	g)	**List any four drilling machine used in industrial sector.**	**02**
		Classification of drilling machine: *(Any four -2 marks)*	

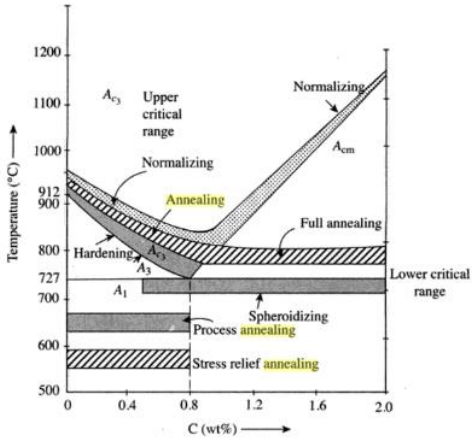
		1. Portable drilling machine 2. Bench drilling machine 3. Sensitive drilling machine 4. Upright or column drilling machine 5. Radial drilling machine 6. Gang drilling machine 7. Multi-spindle drilling machine 8. Vertical drilling machine 9. Automatic drilling machine 10. Deep hole drilling machine	**02**
02		**Attempt any THREE of the following:**	**12**
	a)	**Classify engineering material with the examples.**	**04**
		Answer:  **OR**	**04**

			
	b)	**State any four objectives of heat treatment.**	**04**
		Following are the objectives of Heat Treatment:*(Any four - 1 Mark each)* 1. To improve machinability 2. To improve mechanical properties e.g. tensile strength, ductility, hardness, shock resistance, resistance to corrosion etc. 3. To relieve internal stresses induced during hot or cold working. 4. To change or refine grain size. 5. To improve magnetic and electrical properties. 6. To improve heat resistance, wear resistance. 7. To improve weldability. 8. Remove gases, Harden and strengthen the metal. 9. Homogenize the structure. 10. Change the chemical composition of metal components	**04**
	c)	**Describe the steps in sand casting process.**	**04**
		(Correct Answer = 04 Marks) Following steps are used in the casting process; 1. **Pattern Making:** Patterns are the replica of casting. Patterns are manufactured using wood, metals, wax, plaster of Paris etc. For preparation of patterns various tools and equipments are used. 2. **Moulding and Core making:** Prepare a mould cavity by using patterns and use the core for making hollow parts in casting. 3. **Melting and Casting:** Melt the metal in the furnace and pour it in the mould cavity. Wait until it solidifies. As the casting get solidify, remove the casted part from the sand. 4. **Cleaning of Casting:** After removing the casting from the sand cut the runners and risers, also trim the flash appears at parting line of mould. 5. **Testing of Casting:** Test the casting for various defects.	**04**
	d)	**Explain the lathe specification or size of lathe.**	**04**

		Answer: *Description – 02 Marks, 02 marks for Sketch* The size of a lathe is expressed or specified by the following items and illustrated in Fig. • The height of the centers measured from the lathe bed. • The swing diameter over bed. This is the largest diameter of work that will revolve without touching the bed and is twice the height of the centre measured from the bed of the lathe. • The length between centers. This is the maximum length of work that can be mounted between the lathe centers. • The swing diameter over carriage. This is the largest diameter of work that over bed. • The maximum bar diameter. This is the maximum diameter of bar stock that will pass through hole of the headstock spindle.  **Fig. : SPECIFICATION OF A LATHE** **r** - Centre height **c** - Length between centres **d** - swing diameter over bed **b** - Length of bed.	**02** **02**
3		**Attempt any THREE of the following:**	**12**
	a)	**Discuss the properties and applications of Ti-6Al-4V titanium alloy.**	**04**
		Properties of Ti-6Al-4V 1. The high strength 2. Low weight ratio 3. Outstanding corrosion resistance 4. Good machinability 5. Excellent mechanical properties **Applications:** Ti6Al4V is typically used for: – 1. Direct Manufacturing of parts and prototypes for racing and aerospace	**02** **02**

		industry 2. Biomechanical applications, such as implants and prosthesis 3. Marine applications 4. Chemical industry 5. Gas turbines Powder	
	b)	**State the effects of alloying elements on properties of steel.**	**04**
		Effects of Alloying Element on steel:*(Any 04 - 01 Mark each)* **1) Nickel:** i) It improves Toughness ii) It improves Tensile Strength iii) It improves Ductility iv) It improves Corrosion Resistance **2) Chromium:** i) It improves Ductility ii) It is added in different proportions upto 18 % iii) Below 1.5 % addition increases Tensile Strength iv) 12 % addition gives high Corrosion Resistance v) It improves Hardenability & Toughness simultaneously **3) Cobalt:** i) It improves Corrosion Resistance ii) It improves Thermal Resistance iii) It improves Magnetic Properties iv) It is act as a Grain Refiner **4) Manganese:** i) Lower proportions from 1.0 to 1.5 % improves Strength & Toughness ii) Higher proportions upto 5 % improves Hardness iii) Very Higher proportions from 11 to 14 % improves very degree of Hardness **5) Silicon:** i) It is act as a Ferritic Strengthener ii) It improves Elastic Limits iii) It improves Magnetic Property iv) It decreases Hysteresis Losses **6) Molybdenum:** i) It improves Hardness ii) It improves Wear Resistance iii) It improves Thermal Resistance iv) It gives ability to maintain Mechanical Properties at Elevated Temperatures **7) Tungsten:** i) It improves Hardness ii) It improves Wear Resistance iii) It improves thermal Resistance	**04**

		iv) It improves shock Resistance v) It improves Magnetic Properties vi) It gives ability to maintain Mechanical Properties at Elevated Temperatures **8) Vanadium:** i) It improves Elastic Limit ii) It improves Shock Resistance iii) It act as a Degasser when added to Molten Metal **9) Boron:** i) It improves Toughness ii) It improves Tensile Strength iii) It improves Ductility iv) It improves Corrosion Resistance v) It improves Hardenability vi) It is very useful when alloyed with Low Carbon Steels **10) Aluminium:** i) It improves Tensile Strength ii) It improves Corrosion Resistance iii) It is used as a Deoxidizer iv) It improves growth of Fine Grains v) It improves Hardness by Nitriding to form Aluminum Nitrides **11) Titanium:** i) It improves Corrosion Resistance ii) It is good Deoxidizer iii) It forms titanium carbides means improves hardness **12) Copper:** i) It improves Toughness ii) It improves corrosion Resistance iii) It improves Strength iv) Its proportions varies from 0.2 % to 0.5 % **13) Niobium:** i) It deceases Hardenability ii) It improves Impact Strength iii) It improves Fine Grain Growth iv) It is also called as „ Columbium “	
	c)	**Describe full annealing process with its significance.**	**04**
		Full annealing Process: In full annealing process the steel workpiece is heated to about 30 to 50^0 above the critical temperature AC_3, is held there until the temperature of the workpiece is uniform throughout and finally cooling the work piece at a controlled rate so that the	**02**

		temperature of the surface and that of the center of the workpiece is approximately the same.  Fig. Heat Treatment Process **Significance:** Full annealing process wipes out all traces of the previous structure, refines the crystalline structure, soften the metal and relieves the internal stresses previously set up in the metal.	**02**
	d)	**Describe shell moulding process with its applications.**	**04**
		Answer: **Shell Moulding:** It is a process in which the sand mixed with a thermosetting resin is allowed to come into contact with a heated metallic pattern plate, so that a thin and a strong shell of mould is formed around the pattern. Then the shell is removed from the pattern and the cope and drag are removed together and kept in an flask with the necessary back up material and the molten metal is poured into the mould. Generally dry and fine sand which is completely free from clay is used for preparing the shell moulding sand . The first step in preparing the mould is the preparation of sand mixture in such a way that each of the sand grain is thoroughly coated with resin. Only metal patterns with the associated gating are used. The metallic pattern is heated to a temperature of 200 to 350^0 C. The heated pattern is securely fixed to a dump box, as shown in fig. a, wherein the coated sand in an amount larger than required to form the shell of necessary thickness is already filled in. Then the dump box is rotated as shown in fig. b, so that coated sand falls on the heated pattern. The heat from the pattern melts the resin adjacent to it thus causing sand mixture to adhere to the pattern. When a desired thickness of shell is achieved, the dump box is rotated backwards by 180^0 so that the excess sand falls back into the box, leaving the formed shell intact with the pattern as shown in fig.d.	**02**

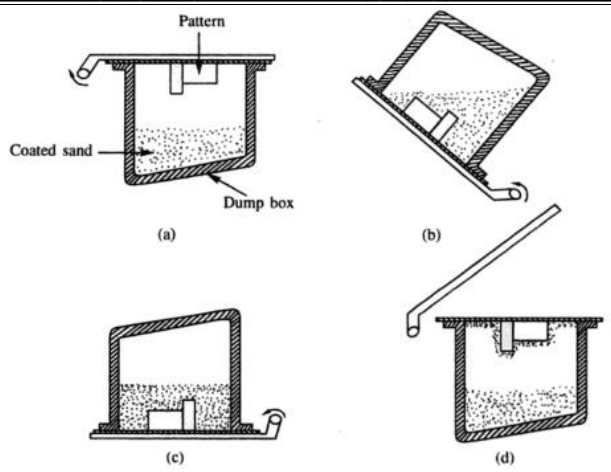


Fig. Shell Moulding Process

Applications of shell moulding:(Any Two Applications)

1. Cylinders and cylinder heads for air cooled IC engines
2. Automobile transmission parts
3. Cast tooth bevel gears
4. Brake beam
5. Transmission plannet carrier
6. Gear blanks
7. Small crank shafts
8. Refrigerator valve plate
9. Chain seat bracket

01

01

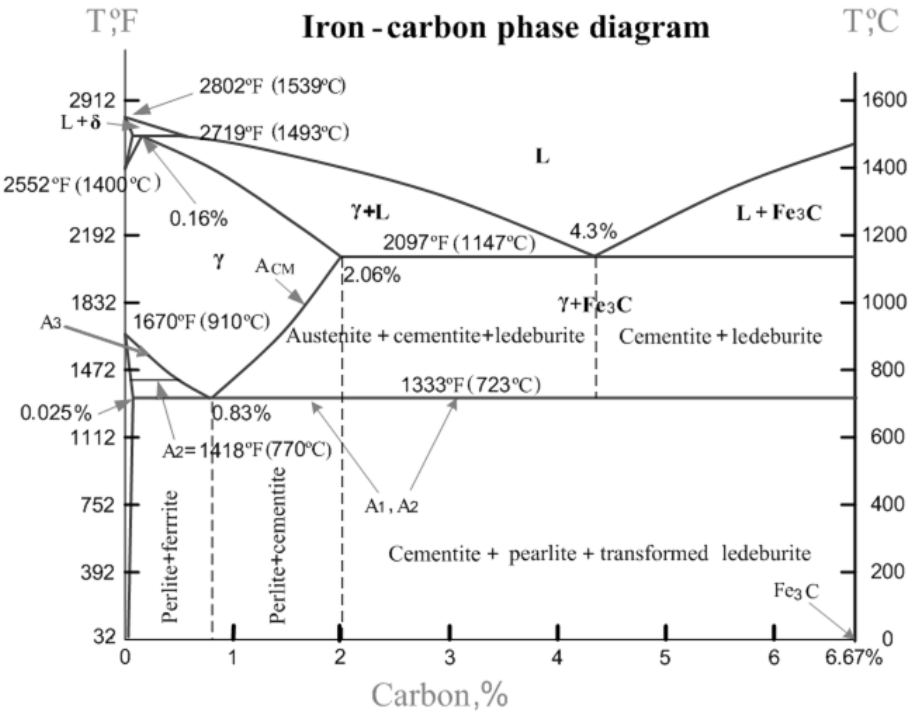
4		**Attempt any THREE of the following:**	**12**
	a)	**Differentiate thermoplastic and thermosetting polymers.**	**04**

Answer: Difference between thermoplastic and thermo-setting plastic: *(Any 04 – 01 mark each)*

Sr. No.	Thermoplastics	Thermosetting
01	They can be repeated softened by heat and hardened on cooling	once hardened and set they do not softened with application of heat
02	They are formed by addition polymerization only	They are formed by condensation polymerization
03	They consist of long chain linear polymers	They have three dimensional network structure
04	They are usually soft, weak and less brittle	They are usually hard, strong and more brittle
05	They are usually soluble in some organic solvents	They are insoluble in almost all organicsolvents
06	These can be repeatedly used and have resale value	They cannot reused and do not have resale value.
07	They cannot be used at higher temperature as they will tends to soft under heat	They can be used at comparatively higher temperature without damage.

04

	b)	**Illustrate the iron-carbide (Fe-Fe3 C) diagram showing critical temperature on it.**	**04**



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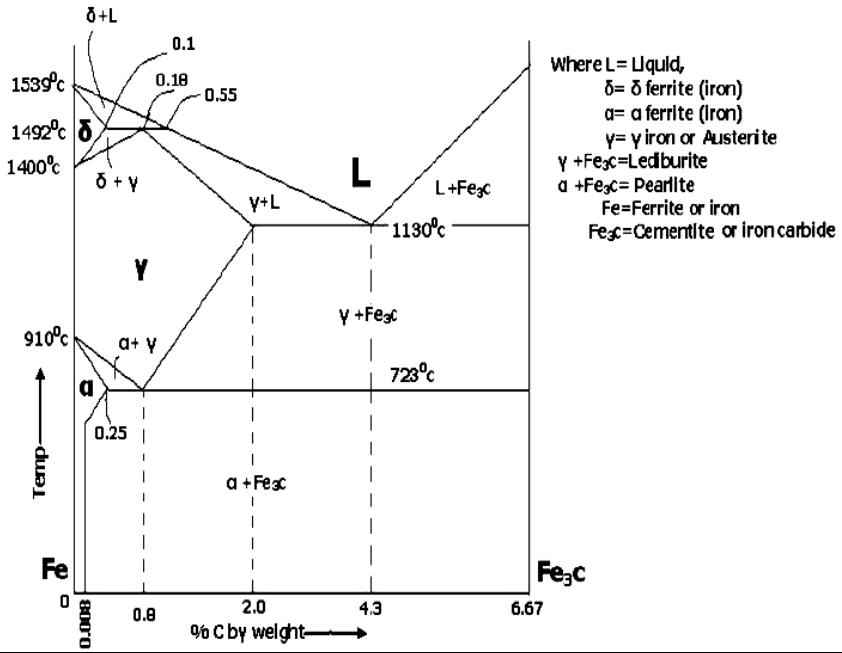
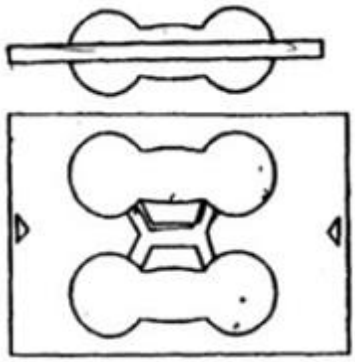
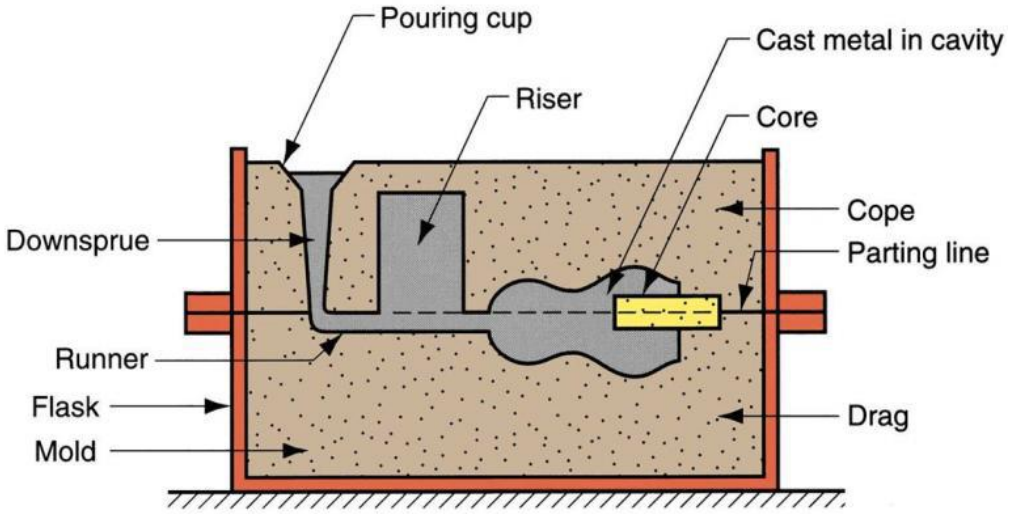
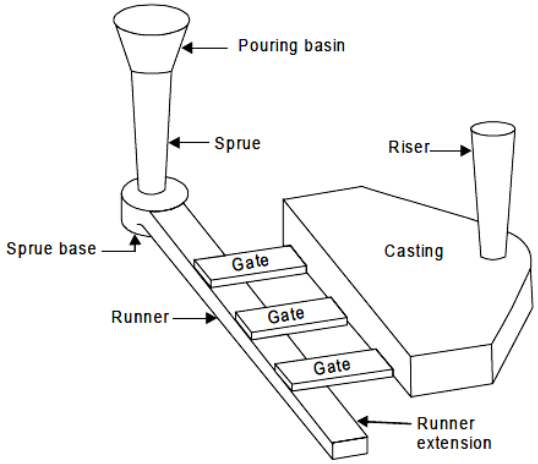


04

	c)	**Explain match plate pattern with its significance.**	**04**
		Match plate pattern with significance: In Match plate pattern the cope and drag patterns along with the gating and the risering are mounted on a single matching metal or wooden plate on either side as shown in Figure. On one side of the match plate the cope flask is prepared and on the other, the drag flask. After moulding when the match plate is removed, a complete mould with gating is obtained by joining the cope and the drag together.	

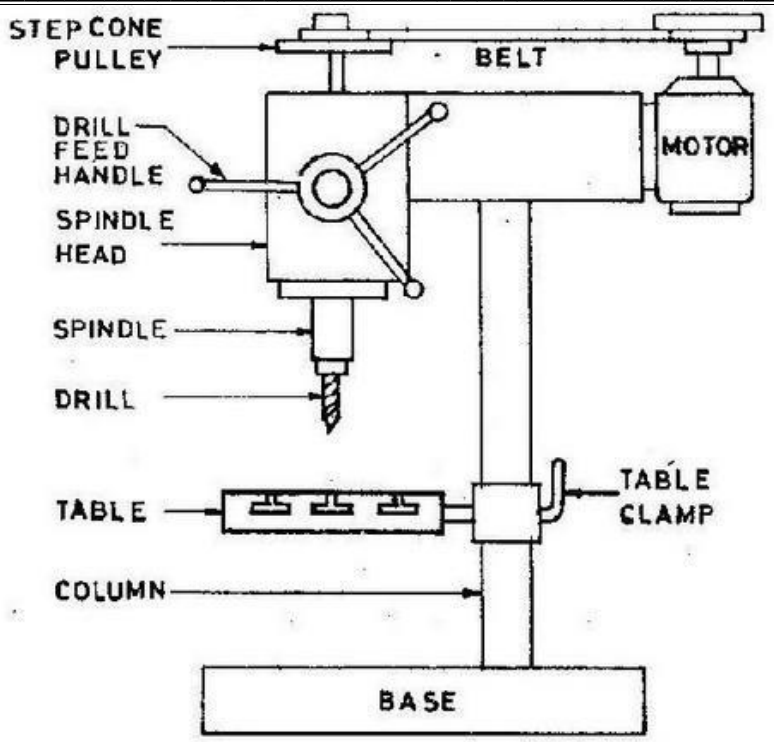
		The complete pattern with match plate is entirely made of metal, usually aluminum for its light weight and machinability. But when dimensions are critical, the match plate may be made of steel with necessary case hardening of the critical wear points. The pattern and gating are either screwed to the match plate in the case of a flat parting or are made integral in case of an irregular parting plane. This pattern is shown in figure. These are generally used for small castings with higher dimensional accuracy. The gating system is already made and attached to the match plate. Several patterns can be fixed to a single match plate, if they are sufficiently small in size. These patterns are used for machine moulding. They are expensive but since they increase productivity, the additional cost is justified.  **Fig. Match Plate Pattern**	**04**
	d)	**Use suitable pattern allowance to compensate the shrinkage problem during casting process.**	**04**
		Shrinkage Allowance: As metal solidifies and cools, it shrinks and contracts in size. To compensate for this, a pattern is made larger than the finished casting by means of a shrinkage or contraction allowance. To provide an allowance, a patternmaker uses shrink or contraction rule which is slightly longer than the ordinary rule of the same length. Different metals have different shrinkages; therefore, there is a shrink rule for each type of metal used in a casting. It is also called as contraction allowance When liquid metal starts to cool , metal gets shrink & reduces size of the component To reduce above problem, allowance are provided on the pattern Patterns are made larger than actual size Different metal have different shrinkage It has three forms (a) Liquid Contraction (b)Solidifying Contraction (c)Solid Contraction • First two are reduced by gates & risers • Solid contraction can be reduced by providing more allowance on pattern	**04**
	e)	**Explain the significance of gating system in casting process with the sketches.**	**04**
		Significance of Gating system in casting process: The term gating system refers to all passageways through which the molten metal passes to enter the mold cavity. It provides continuous, uniform feed of molten metal, with as little turbulence as	**02**

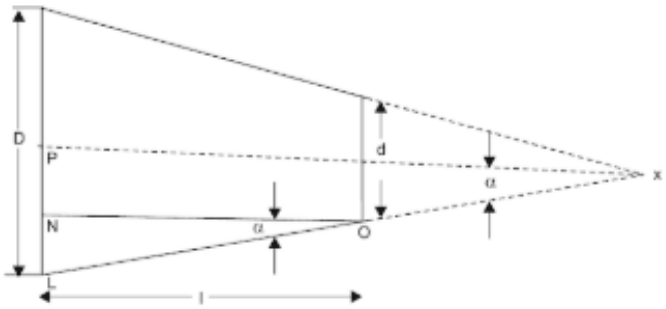
		possible to the mould cavity. It supplies the casting with liquid metal at best location to achieve proper directional solidification and optimum feeding of shrinkage cavities. It fills the mould cavity with molten metal in the shortest possible time to avoid temperature gradient. It provides with a minimum of excess metal in the gates and risers. Inadequate rate of metal entry, on the other hand, will result many defects in the casting. It prevents erosion of the mould walls. It prevents slag, sand and other foreign particles from entering the mould.  **OR**  **Fig. Gating system**	**02**
5		**Attempt any TWO of the following:**	**12**
	a)	**Write type of chip formed with following factors.** **(i) High rake angle** **(ii) High cutting speed** **(iii) Small depth of cut** **(iv) Low cutting speed**	

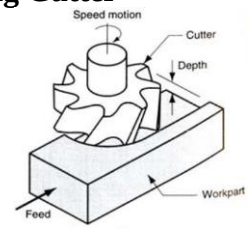
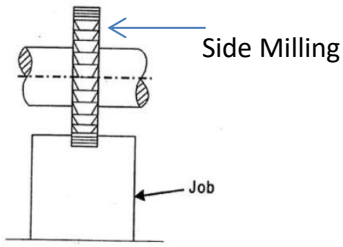
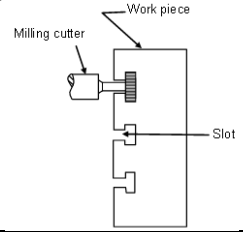
		(v) Large depth of cut **(vi) Low rake angle**	
		Answer:(1 mark each) **(i) High rake angle : Continuous chips** **(ii) High cutting speed : Continuous chips** **(iii) Small depth of cut : Continuous chips** **(iv) Low cutting speed :Continuous chips with built up edge** **(v) Large depth of cut : Continuous chips with built up edge** **(vi) Low rake angle :Continuous chips with built up edge**	**06**
	b)	**Explain the nomenclature of a single point cutting tool.**	**06**
		1. Back Rake Angle: Back rake angle is the angle between the face of the single point cutting tool and a line parallel with base of the tool measured in a perpendicular plane through the side cutting edge. If the slope face is downward toward the nose, it is negative back rake angle and if it is upward toward nose, it is positive back rake angle. Back rake angle helps in removing the chips away from the workpiece. **2. Side Rake Angle:** Side rake angle is the angle by which the face of tool is inclined side ways. Side rake angle is the angle between the surface the flank immediately below the point and the line down from the point perpendicular to the base. Side rake angle of cutting tool determines the thickness of the tool behind the cutting edge. It is provided on tool to provide clearance between workpiece and tool so as to prevent the rubbing of workpiece with end flake of tool. **3. End Relief Angle:** End relief angle is defined as the angle between the portion of the end flank immediately below the cutting edge and a line perpendicular to the base of the tool, measured at right angles to the flank. End relief angle allows the tool to cut without rubbing on the workpiece. **4. Side Relief Angle:** Side relief angle is the angle between the portion of the side flank immediately below the side edge and a line perpendicular to the base of the tool measured at right angles to the side. Side relief angle is the angle that prevents the interference as the tool enters the material. It is incorporated on the tool to provide relief between its flank and the workpiece surface. **5. End Cutting Edge Angle:** End cutting edge angle is the angle between the end cutting edge and a line perpendicular to the shank of the tool. It provides clearance between tool cutting edge and workpiece. **6. Side Cutting Edge Angle:** Side cutting edge angle is the angle between straight cutting edge on the side of tool	**01** **01** **01** **01** **01** **01**

		and the side of the shank. It is responsible for turning the chip away from the finished surface.	
	c)	**Explain properties and applications of GRP/CRP and CRP composites.**	**06**
		Answer: (Explanation of any three properties= 3 marks) **Properties of GRP(Glass Reinforced Plastic)/CRP (Carbon Reinforced Plastic):** **1.High corrosion resistance:** Offering exceptional corrosion resistance, GRP/CRP is highly tolerant of the most aggressive of environments. Its total resistance against chloride ion attacks demonstrates its durable nature and ability to withstand harsh conditions. Unlike traditional alternatives, such as steel, aluminium and timber, GRP/CRP delivers a long-term practical solution that overcomes the inherent corrosion challenges facing industry today. **2.High strength** GRP/CRP's superior tensile strength is equal to or greater than equivalent steel profiles. Despite its lightweight properties, GRP/CRP offers impressive strength-to-weight load-bearing performance. The high glass-to-resin ratios used in our technically advanced formulation ensure our GRP/CRP products outperform and outlast traditional materials. **3.Lightweight** 75% lighter than steel equivalents, GRP/CRP significantly reduces transport costs and eliminates the need for heavy lifting equipment. As it can be easily cut and manoeuvred onsite, the risk of manual handling injuries is mitigated. **4.Non-conductive, inert and non-sparking** The non-conductive properties of GRP/CRP make it ideally suited for use on electrically hazardous sites. A highly effective electromagnetic and thermal insulator, it is electronically transparent and not affected by electromagnetic fields or radio wave frequencies. The non-sparking qualities of GRP/CRP make it suitable for locations where combustible gases may be present. **5.High impact resistance** GRP/CRP resists sudden and severe point loading and avoids permanent distortion. If the GRP/CRP is deformed due to impact, it will return to its original shape	**03**

		without contractors having to incur costly repairs or replacements. **6.Easy to fabricate** GRP/CRP can be easily fabricated and cut onsite to accommodate precise specifications and complex layouts. Using standard hand tools, such as circular saws, contractors can easily cut the product without compromising any of its advantageous properties. **7.Low maintenance** GRP/CRP is an incredibly resilient and durable material that delivers outstanding cost benefits. GRP/CRP, in all its forms, offers a low maintenance solution with little need for renovation or refurbishment during its fifty year lifespan. **Applications of (GRP/CRP):(Any six Applications)** Aerospace Engineering Automobile Engineering (Racing Cars) Civil Engineering Carbon-fiber Microelectrodes Sports goods Musical instruments High-performance drone Lightweight poles such as tripod legs etc Denstistry	**03**
6		**Attempt any TWO of the following:**	**12**
	a)	**Sketch the block diagram of bench drilling machine showing its different parts.**	**06**
		Answer: (Sketch 03 marks, Labeling 03 Marks)	**06**



	b)	**Explain taper turning operation for a job having following dimensions.** **(D) Diameter of work piece = 50 mm** **Reduced diameter (d) = 30 mm** **Taper length (L) = 60 mm**	**06**
		Answer: **(D) Diameter of work piece = 50 mm** **Reduced diameter (d) = 30 mm** **Taper length (L) = 60 mm**	
		 **Fig. Elements of taper**	**01**
		Taper turning operation can be done using compound rest. For taper turning operation to be performed, we have to find out (i) Taper in mm/meter and in degrees. (ii) Angle to which compound rest should be set (iii) Tail stock set over 1. Taper = (D-d)/L = (50-30)/60 = 20:60	**01**

		It means that for a length of 60mm, taper is 20mm, then taper in mm/meter = (20/60) X 1000 = 333.33 mm/meter 2. Taper angle for compound rest setting $\alpha = \tan^{-1} \frac{(D-d)}{2L}$ $= \tan^{-1} \frac{(50-30)}{2\ X\ 60}$ $= 9.46^0$ Compound rest should be set at angle $\alpha = 9.46^0$ 3. Tail stock set over Assuming length of bar is equal to length of taper Tail stock set over = (D-d)/2 = (50-30)/2 = 10 mm	**02** **02**
	c)	**Suggest and sketch a milling cutter for following milling operation.** **(i) Face milling** **(ii) Key-way milling** **(iii) 'T' slot**	**06**
		(i) Face milling :Face Milling Cutter  Face milling **(ii) Key-way milling:**side milling cutters or end mills.  (iii) **'T' slot:** plain milling cutter, metal slitting saw or side milling cutter.  	**01** **01** **01** **01** **01** **01**