Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

I Mid Term Examination, Dec.-2022

Semester:	B. Tech I Semester	Branch:	AI+ IT+IOT+EC+EE
Subject:	BME	Subject Code:	1FY3-07
Time:	1.5 Hours	Maximum Marks:	20
Session (I/II/III): II			

Part-A (Attempt *All* questions: 02 Marks Each)

Q.1 Define any two laws of thermodynamics. **[1+1]**

Q.2 Define the following:

a. Hardness. **[1]**

b. Ductility. **[1]**

Q.3 What is "pattern" in metal casting process? Write names of any four types of patterns used in metal casting processes. **[1+1/4*4]**

Part-B (Attempt *Any Two* questions: 04 Marks Each)

Q.4 What is heat treatment process? Explain any three types of heat treatment processes. **[1+3]**

Q.5 What is pattern allowance? Explain any three types of pattern allowances. **[1+3]**

Q.6 In Gupta Machine Tools Pvt. Ltd., a flat belt is running over a pulley of diameter 100 cm at 300 rpm. The angle of contact is 150° and coefficient of friction between the belt and pulley is 0.3. Maximum tension in the belt is 3000 N. Find the power transmitted by the belt. **[4]**

Part-C (Attempt *Any One* question: 06 Marks Each)

Q.7 Derive the expression for length of belt in cross belt drive system. **[6]**

Q.8 What is extrusion process? Explain any four types of extrusion processes with neat diagrams. **[2+4]**

Swami Keshvanand Institute of Technology, Management & Gramothan, Ramnagaria, Jagatpura, Jaipur-302017

Solution of Question Paper

I Mid-Term Examination, Sept. -2022

Branch/Semester: B.tech. I sem	**Subject: BME**	**Subject Code:1FY3-07**
Duration: 1.5 hours	**Date:22-12-2022 Session (I/II/III):II**	**Max Marks:20**
Submitted By: SAURABH GUPTA		

Q.1 Define any two laws of thermodynamics? **[2]**

Sol. 1 Zeroth law

The zeroth law of thermodynamics provides for the foundation of temperature as an empirical parameter in thermodynamic systems and establishes the transitive relation between the temperatures of multiple bodies in thermal equilibrium. The law may be stated in the following form: If two systems are both in thermal equilibrium with a third system, then they are in thermal equilibrium with each other. Though this version of the law is one of the most commonly stated versions, it is only one of a diversity of statements that are labeled as "the zeroth law". Some statements go further, so as to supply the important physical fact that temperature is one-dimensional and that one can conceptually arrange bodies in a real number sequence from colder to hotter.

First law

thermodynamic system in an equilibrium state possesses a state variable known as the internal energy(E). Between two systems the change in the internal energy is equal to the difference of the heat transfer into the system and the work done by the system. The first law of thermodynamics states that the energy of the universe remains the same. Though it may be exchanged between the system and the surroundings, it can't be created or destroyed. The law basically relates to the changes in energy states due to work and heat transfer. It redefines the conservation of energy concept. The First Law of Thermodynamics states that heat is a form of energy, and thermodynamic processes are therefore subject to the principle of conservation of energy. This means that heat energy cannot be created or destroyed. It can, however, be transferred from one location to another and converted to and from other forms of energy.

Second law

The second law of thermodynamics indicates the irreversibility of natural processes, and in many cases, the tendency of natural processes to lead towards spatial homogeneity of matter and energy, especially of temperature. It can be formulated in a variety of interesting and important ways. One of the simplest is the Clausius statement, that heat does not spontaneously pass from a colder to a hotter body. It implies the existence of a quantity called the entropy of a thermodynamic system. In terms of this quantity it implies that When two initially isolated systems in separate but nearby regions of space, each in thermodynamic equilibrium with itself but not necessarily with each other, are then allowed to interact, they will eventually reach a mutual thermodynamic equilibrium. The sum of the entropies of the initially isolated systems is less than or equal to the total entropy of the final combination. Equality occurs just when the two original systems have all their respective intensive variables (temperature, pressure) equal; then the final system also has the same values.

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Q.2 Define following:

a. Hardness. [1]

b. Ductility. [1]

Sol. 2(a) Hardness: Hardness is **the ability of a material to resist deformation**, which is determined by a standard test where the surface resistance to indentation is measured. The most commonly used hardness tests are defined by the shape or type of indent, the size, and the amount of load applied. (1)

2(b) Ductility is **the ability of a material to be drawn or plastically deformed without fracture**. It is therefore an indication of how 'soft' or malleable the material is. The ductility of steels varies depending on the types and levels of alloying elements present. (1)

Q.3 What is pattern in metal casting process? Write name of any four types of pattern used in metal casting process. [1+1/4*4]

Sol.3 Pattern: In casting process, pattern is a replica of the object to be cast. It is used to prepare the cavity into the mould and to which molten material will be poured. Patterns used in sand casting may be made of wood, metal, plastics or other materials. (1)

Types of patterns:

1. Single Piece or solid pattern
2. Loose-piece Pattern
3. Match plate pattern
4. Gated Pattern (1)
5. Sweep Pattern

Q.4 What is heat treatment process? Explain any three types of heat treatment processes. [1+3]

Sol.4 Heat treatment is defined as an operation or combination of operations that involve heating and cooling of a metal/ alloy in solid state to obtain desirable condition as to relieve stress or to obtain properties as better machine ability, ductility or homogenous structure. (1)

Different types of heat treatment process are:

1. Annealing

2. Normalizing

3. Hardening

4. Tempering

5. Case hardening

1. **Annealing**: The process is the opposite of hardening. Objective: to relieve internal stresses, soften the metal, increase ductility, and refine grain structures. The process includes: heat the metal to a specific temperature (750 to 950°c), hold it at a temperature for a set length of time, allowed it to cool in furnace. (1)

2. **Normalizing**: Normalizing applies to ferrous metals only, Objective: to remove internal stresses induced by heat treating, welding, casting, forging, forming, or machining. The process includes the metal is heated to a temperature (750 to 975°c), hold it at a temperature for a set length of time but then it is removed from the furnace and allowed for air cooling. (1)

3. **Hardening:** The purpose of hardening is to increase hardness and strength of the steel. It makes steel brittle and less ductile. To remove some of the brittleness, tempering is followed after hardening. The process includes heating of steel to a temperature (750 to 950°c), holding it for a set length of time and then cool at a faster rate in a quenching medium such as water, or oil. (1)

Q.5 What is pattern allowance? Explain any three types of pattern allowances. [1+3]

Sol.5 pattern allowance: The size of a pattern is never kept the same as that of the desired casting because of the fact that during cooling the casting is subjected to various effects and hence to compensate for these effects, corresponding allowances are given in the pattern. These various allowances given to pattern can be enumerated as, allowance for shrinkage, allowance for machining, allowance for draft, allowance for rapping or shake, allowance for distortion and allowance for mould wall movement. (1)

1. **Shrinkage allowance**: Almost all metals shrink or contract volumetrically after solidification to obtain a particular size of casting an amount is equal to the shrinkage or contraction. The metal which undergo shrinkage during solidification and contract further on cooling to room temperature. To compensate this, the pattern is made larger than the required casting. This extra size is given on the pattern for metal shrinkage is called shrinkage allowance. (1)

2. **Draft or taper allowance**: When the pattern is to be removed from the sand mold, there is a possibility that any leading edges may break off, or get damaged in the process. To avoid this, a taper is provided on the pattern, so as to facilitate easy removal of the pattern from the mold, and hence reduce damage to edges. The taper angle provided is called the Draft angle. (1)

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3. **Machining allowance**: The surface finish obtained in sand castings is generally poor (dimensionally inaccurate), and hence in many cases, the cast product is subjected to machining processes like turning or grinding in order to improve the surface finish. During machining processes, some metal is removed from the piece. To compensate for this, a machining allowance (additional material) should be given in the casting.

4. **Raping or shaking allowance**: A patter is shaken or rapped by striking the same with a wooden piece from side to side. This is done so that the pattern a little is loosened in the mold cavity and can be easily removed. In turn therefore, rapping enlarges the mould cavity which results in a bigger sized casting.

Q.6 In Gupta machine tools limited, a flat belt is running over a pulley of diameter 100 cm at 300 rpm. The angle of contact is 150° and coefficient of friction between the belt and pulley is 0.3. Maximum tension in the belt is 3000 N. Find the power transmitted by the belt. [4]

Sol. 6

Given: D = 100 cm,

N= 300 rpm,

μ= 0.3,

θ =150°,

T_1 = 3000 N

Here $v = \pi DN$

$$v = \frac{\pi \times 100 \times 300}{100 \times 60}$$

$$= 15.7 \text{ m/s}$$

And, $\theta = 150 \times \frac{\pi}{180}$

θ = 2.62 radian

since $T1/T2 = e^{\mu.\theta}$.

And T_1 = 3000 N,

So, T_2 = 3000/ 2.19

T_2 = 1369.86 N

And $P = (T_1 - T_2)\, v$

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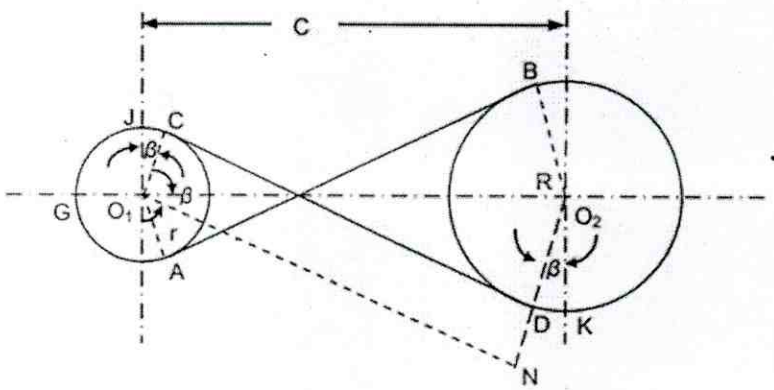
$P = (3000\text{-}1369.8) \times 15.7$

$\boxed{P = 25593 \text{ W} = 25.6 \text{ kW}}$

Q.7 Derive the expression for length of belt in cross belt drive system. [6]

Sol. 7

The crossed-belt drive is shown in Figure. Draw $O_1 N$ parallel to the line CD which meets extended $O_2 D$ at N.



2

$\angle CO_1 J = \angle DO_2 K = \angle O_2 O_1 N$

1

$L = \text{Arc } AGC + AB + \text{Arc } BKD + CD$

Arc $AGC = r(\pi + 2\beta)$, and Arc $BKD = (\pi + 2\beta) R$

$\sin\beta = \dfrac{R+r}{C}$ or $\beta = \sin^{-1}\dfrac{(R+r)}{C}$

1

For small value of β

$\beta = \dfrac{R+r}{C}$

$\cos\beta = \sqrt{1+\sin^2\beta} = \left(1 - \frac{1}{2}\sin^2\beta\right) = \left[1 - \frac{1}{2}\frac{(R+r)^2}{C^2}\right]$

1

$L = r(\pi + 2\beta) + 2C\cos\beta + R(\pi + 2\beta)$

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For approximate length

$$L = \pi (R + r) + 2\frac{(R + r)^2}{C} + 2C\left[1 - \frac{1}{2}\frac{(R + r)^2}{C^2}\right]$$

$$= \pi (R + r) + \frac{(R + r)^2}{C} + 2C$$ (1)

Q.8 What is extrusion process? Explain any four types of extrusion process with neat diagram. [2+4]

Extrusion is a metal forming process in which metal or work piece is forced to flow through a die to reduce its cross section or convert it into desire shape. This process is extensively used in pipes and steel rods manufacturing. (1)

Hot Extrusion

The hot extrusion is the most popular method for developing objects with a fixed cross-sectional profile. The extrusion process is performed at an increased temperature, which maintains the materials from process hardening along with making the procedure of pushing the material through the die simpler. (½)

Cold Extrusion

With the help of extruders and extrusion machines, the process of cold extrusion is carried out at room temperature or at moderately high temperatures. These devices/machines have been specially developed based on innovative extrusion technology. (½)

Direct Extrusion:

In this type of extrusion process, metal is forced to flow in the direction of feed of punch. The punch moves toward die during extrusion. This process required higher force due to higher friction between billet and container. (½)

Indirect Extrusion:

In this process, metal is flow toward opposite direction of plunger movement. The die is fitted at opposite side of punch movement. In this process, the metal is allowed to flow through annular space between punch and container. (½)

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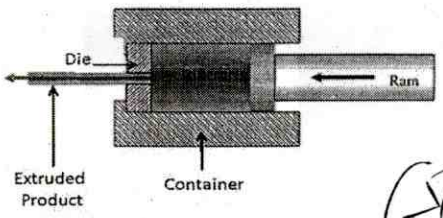


Fig: Direct Extrusion

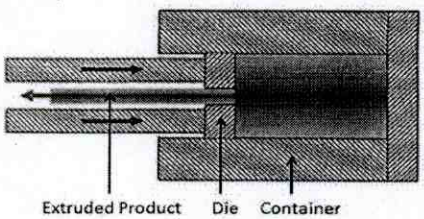
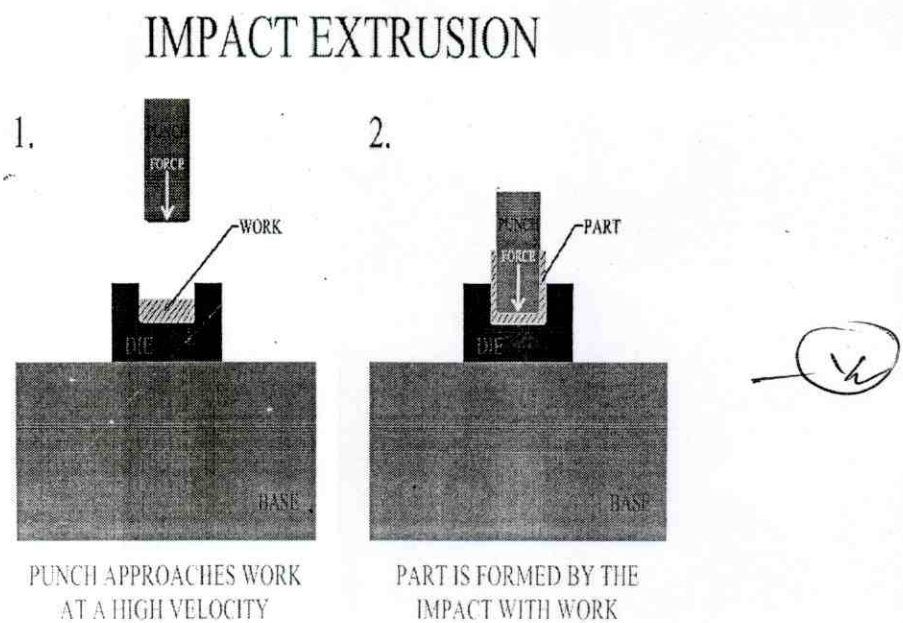


Fig: Indirect Extrusion

Impact Extrusion:

Impact extrusion is **a manufacturing process similar to extrusion and drawing by which products are made with a metal slug**. The slug is pressed at a high velocity with extreme force into a die or mold by a punch.



Hydrostatic Extrusion:

Hydrostatic extrusion is a process in which the billet is completely circumscribed by a pressurized liquid in all the cases, with the exception being the case where billet is in the contact with die. This process can be carried out in many ways including warm, cold or hot but due to the stability of the used fluid, the temperature is limited. Hydrostatic extrusion has to be carried out in a completely sealed cylinder for containing the hydrostatic medium. The fluid may be pressurized in following two ways:

1. Constant-Rate Extrusion: A ram or plunger is used for pressurizing the fluid in the container
2. Constant-Pressure Extrusion: A pump with a pressure intensifier is used for pressurizing the fluid, which is then pumped into the container