L-4/T-2/MME **Date: 29/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2001

Sub : **MME 443** (Physical Metallurgy of Steel and Heat Treatment)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Do you think the benefits of phosphorous in steel outweigh its harmful effects? Justify your answer. **(10)**

(b) The addition of small amounts of niobium is said to increase the tensile strength, toughness and fatigue properties of steel. Explain the underlying mechanism. **(10)**

(c) Alloying elements in steel can be classified into two broad groups; carbide forming and non-carbide forming. Give some examples of alloying elements of both groups and mention the effects that those elements have on steel. **(15)**

2. (a) Which annealing method is commonly utilized during metal fabrication to negate the effects of cold work and make further cold working easier? Explain the impact of this method on the underlying microstructure of steel. **(10)**

(b) Consider a plain carbon steel with 0.28 % C. Make an approximate prediction on its yield strength and ultimate tensile strength. Explain the difference in the annealed and normalized microstructures of this steel. What variations in property will arise out of these microstructural differences? **(25)**

3. (a) "Hardening a high carbon steel part by quenching is almost always immediately followed by tempering"-Do you agree with the statement? Justify your answer. **(10)**

(b) When a metallic component is quenched, how many distinct stages of cooling can be observed? Differentiate between them with an emphasis on the heat transfer mechanisms of each stage. Now, if this quenching media is agitated, will it be beneficial or detrimental to the overall quenching process? **(20)**

(c) What are the characteristics of an ideal quenching medium? **(5)**

4. (a) What are the strategies to increase the hardenability of steel? **(8)**

(b) How are the ferrite and pearlite phases of steel oriented after hot rolling? What effect does this orientation have on the property of the steel? How does this microstructure and its corresponding properties change as a result of normalizing heat treatment? **(20)**

(c) Explain the relationship between hardenability and hardening depth. **(7)**

Contd P/2

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Why do carburized steel parts require hardening? With the help of schematic diagrams, show how you can design various modules of hardening for carburized steel parts to avoid cracking or warping. **(18)**

   (b) Suppose you are a materials engineer in a surface treatment plant. Peak carburizing is utilized in your plant, and the management is considering introducing the vacuum gas carburizing technology. Evaluate the usefulness of introducing this new technique in your plant. What if propane is used instead of methane for the thermal decomposition process during vacuum carburizing? **(17)**

6. (a) Compare and contrast the annealing practices for nodular cast iron with the annealing treatment of gray cast iron. Using suitable microstructures, differentiate between as-cast and annealed nodular cast iron. **(20)**

   (b) Consider yourself a materials engineer, and you annealed a pearlitic ductile iron containing 3.2% carbon and 2.1% silicon. After the completion the annealing process, you obtained 12% pearlite with an average ferrite grain size of 120 μm. Calculate the yield strength and ultimate tensile strength of the annealed ductile iron. **(15)**

7. (a) "Carbides formed in tool steel show quite different structures". Justify the assertion. **(15)**

   (b) Discuss the transformation steps that occur during tempering of tool steel depending on the alloying and evaluate the effects of tempering temperature on the hardness of quenched tool steels. **(20)**

8. (a) What is precipitation hardenable stainless steel? Why do we need this different class of stainless steel? How does the hardening occur in this alloy? **(18)**

   (b) A product was made from austenitic stainless steel by cold deformation, but the product became magnetic. Explain the reason for this change. **(7)**

   (c) With schematic diagram, illustrate the effects of carbon and chromium on the gamma phase portion of Fe-C-Cr ternary diagram. **(10)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **MME 445** (Metallic Alloys and Materials Selection)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Elastic beams of three different loading conditions are shown in figure 1, 2 & 3. The deflection δ of a beam of length, L under an end load, F is denoted by $\delta = \frac{FL^3}{3EI}$, and the deflection of a beam under a distributed load f per unit length is denoted by $\delta = \frac{FL^4}{8EI}$. For a self-loaded beam $f = \rho\, Ag$, where ρ is the density of the material of the beam, A its cross-sectional area, and g the acceleration due to gravity. The failure load F_f of a beam of length, L under an end load, F is denoted by $F_f = \delta = \frac{I\sigma_f}{y_m L}$ where, y_m is the distance between the neutral axis of the beam and its outer filament. **(18)**

   (i) Determine the material index for a cantilever beam of a given length L and given square cross-section (t x t) that will deflect least under a given end load F (Neglect self-weight).

   (ii) Determine the material index for the lightest cantilever beam of a given length L and square section (not given, i.e., the area is a free variable) that will not deflect by more than δ under its own weight.

   (iii) Determine the material index for selecting materials for a beam of length L, specified strength, and minimum weight.

   (b) The energy cost of one firing cycle of a large pottery kiln (Fig. 4) is considerable. Part is the cost of the energy that is lost by conduction through the kiln walls; the rest is the energy cost used to raise the kiln to its operating temperature.

   Find an optimum choice of materials using the material property charts (Fig 5) based on the following design requirement as shown in the table. (Attach fig. 5 with scripts) **(17)**

Function	Thermal insulation for kiln (cyclic heating and cooling)
Constraints	Maximum operating temperature 1000°C Possible limit on kiln-wall thickness for space reasons
Objective	Minimize energy consumed in the firing cycle
Free variable	Kiln wall thickness, *w* Choice of material

2. (a) Compressed air cylinder (Fig. 6) used for braking and other power-actuated systems in trucks are usually made of low-carbon steel, and they are heavy. The task is to explore the potential of alternative materials for lighter air tanks, recognizing that there must be a trade-off between mass and cost. The table summarizes the design requirements. **(25)**

Contd P/2

MME 445

Contd...Q.No. 2(b)

Function	Air cylinder for truck
Constraints	Must not fail by yielding Diameter 2R and length L specified
Objective	Minimize mass, m Minimize material cost, C
Free variable	Wall thickness, t Choice of material

(i) Show that the mass and material cost of the tank relative to one made of low carbon steel are given by $\frac{m}{m_0} = \left(\frac{\rho}{\sigma_y}\right)\left(\frac{\sigma_{y.0}}{\rho_0}\right) and \frac{C}{C_0} = \left(\frac{C_m \rho}{\sigma_y}\right)\left(\frac{\sigma_{y,0}}{C_{m,0}\rho_0}\right)$

Where ρ is the density, σ_y the yield strength, C_m the cost per kg of the material, and the subscript "o" indicates values for mild steel.

(ii) Explore the trade-off between relative cost and relative mass, considering the replacement of a mild steel tank with one made, first, of low alloy steel and, second, one made of filament-wound CFRP, using a relative exchange constant a* for 1 and 100 and the material properties in the table below:

Material	Density, ρ (Kg/m^3)	Yield Strength, σ_c (MPa)	Price/Kg, C_m ($/Kg)
Mild Steel	7850	314	0.66
Low alloy steel	7850	775	0.85
CFRP	1550	760	42.1

(b) Explain the concepts of a penalty function and exchange constant. When do you use the relative penalty functions? What changes happen to the exchange constant when relative penalty function is used? **(10)**

3. (a) The stalk for a lightweight display stand (Fig. 7) must support a mass m of 100 kg, to be placed on its upper surface at a height ***h***, without failing by elastic buckling. **(20)**

It is to be made of stock tubing and must be as light as possible

(i) Derive a material index for the tubular material of the stand that meets these requirements, and that includes the shape of the section, described by the shape factor $\phi_B^e = 12\frac{I}{A^2}$, where, I is the second moment of area and A is the section area. The table summerises the requirements:

Function	Light weight column
Constraints	Specified buckling load ***F*** Specified height ***h***
Objectives	Minimum mass ***m***
Free variables	Choice of material Choice of section and shape

Contd P/3

MME 445

Contd...Q.No. 3(a)

(ii) Cylindrical tubing is available from stock in the following materials and sizes. Use this information and the material index to identify the best stock material for the column of the stand. Given that, the shape factor of thin-walled tube is $\phi_B^e = \frac{3r}{\pi t}$,

Material	E, GPa	ρ, kg/m^3	r, mm	(t/r) ratio
Aluminium alloys	71	2700	25	0.07 – 0.25
Steel	210	7900	30	0.045 – 0.10
Various wood	8–16	500 – 800	40	Solid circular section only

(b) Calculate the gain in bending efficiency, Ψ_B^e, when a solid is formed into small, thin walled tubes of radius ***r*** and wall thickness ***t*** that are then assembled and bonded into a large array, part of which is shown in the figure. Let the solid of which the tubes are made have modulus **Es** and density ρ_s. Express the result in terms of ***r*** and ***t***. **(15)**

4. (a) A chart (Fig. 8) for exploring stiff composites with light alloy or polymer matrices is attached. The criteria of excellence (the indices E/ρ, $E^{1/2}/\rho$ and $E^{1/3}/\rho$) for light, stiff structures) are shown; they increase in value towards the top left. Use the chart to compare the performance of a titanium-matrix composite reinforced with (i) Zirconium carbide, ZrC, (ii) Saffil alumina fibers, and (iii) Nicalon silicon carbide fibers [Attach Fig. 8 with the answer] **(15)**

(b) Derive the shape-efficiency factor ϕ_B^e for stiffness-limited design for a beam loaded in bending with each of the three sections in Fig. 9. Do not assume that the thin-wall approximation is valid. **(15)**

(i) a closed circular tube of outer radius 5t and wall thickness ***t***.

(ii) a channel section of thickness ***t***, overall flange width 5***t*** and overall depth 10***t***, bent about its major axis; and

(iii) a box section of wall thickness ***t***, and height and width $h_1 = 10t$

(c) A material is required for a heat exchanger to extract heat from geothermally heated, saline water at 120°C (and thus under pressure). Translate these requirements into a prescription of Function, Constraints, Objectives and Free variables. **(5)**

Contd P/4

MME 445

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define and classify design. Using a flow chart, explain the essential steps of a design process. **(15)**

   (b) Define materials index. Explain how a material index is developed and used in the materials selection process. **(20)**

6. (a) A furnace is required to sinter powder-metal parts. It operates continuously at 650°C while the parts are fed through on a moving belt. You are asked to select a material for furnace insulation to minimize heat loss and thus make the furnace as energy efficient as Possible. For reasons of space the insulation is limited to a maximum thickness of x = 0.2 m. List the function, constraints, objective, and free variable. **(10)**

   (b) Derive the material index for selecting materials for a beam of square cross-section of specific length L, of specified strength and minimum weight, where the beam is secured at one end as in a cantilever. The equation for the failure load of a beam is **(25)**

$$F_f = \frac{t^3 \sigma_f}{6L}$$

   If the cantilever is part of a mechanical system, it is important that it have also, fracture toughness value of no less than 15 MPa $\sqrt{m}$ to survive accidental impact loads. From the following list of materials having met the fracture toughness requirement, identify the first three candidates most suitable for manufacturing the beam; Mg alloys, Ni alloys, Al alloys, CFRP, and carbon steels.

7. (a) Obtain suitable expressions for material indices with shape factor during elastic bending and failure in bending of beam. **(20)**

   (b) Use the 4-segment chart for stiffness-limited design of Figure 10 to compare the mass per unit length, m/L, of a section with EI = 10^5 N.m^2 made from (i) structural steel with a shape factor ϕ_B^e of 20, modulus E = 210 GPa and density ρ = 7900 kg/m^3 (ii) carbon fibre reinforced plastic with a shape factor ϕ_B^e of 10, modulus E = 70 GPa and density ρ = 1600 kg/m^3, and (iii) structural timber with a shape factor ϕ_B^e of 2, modulus E = 9 Gpa and density ρ = 520 kg/m^3. [You should attach the 4-segment chart to the answer script if used]. **(15)**

8. (a) Explain the classification of steels based on composition, strength, and quality descriptors. **(15)**

   (b) Using suitable diagrams, discuss the selection procedure of heat treatable alloy steels. **(20)**

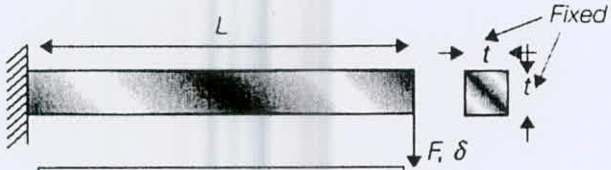


Figure 1 for question 1(a)

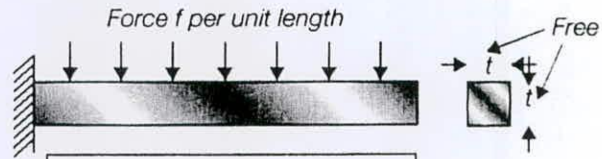


Figure 2 for question 1(a)

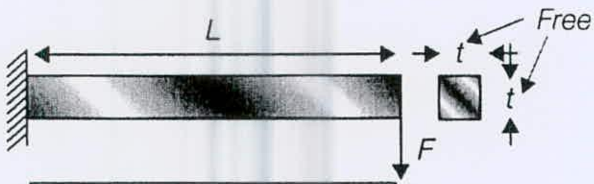


Figure 3 for question 1(a)

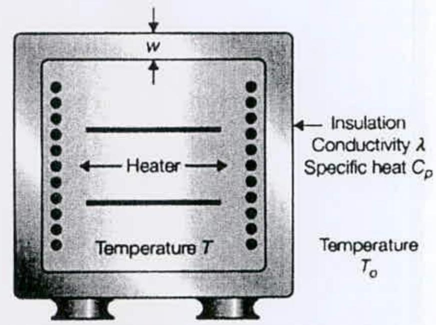


Figure 4 for question 1(b)

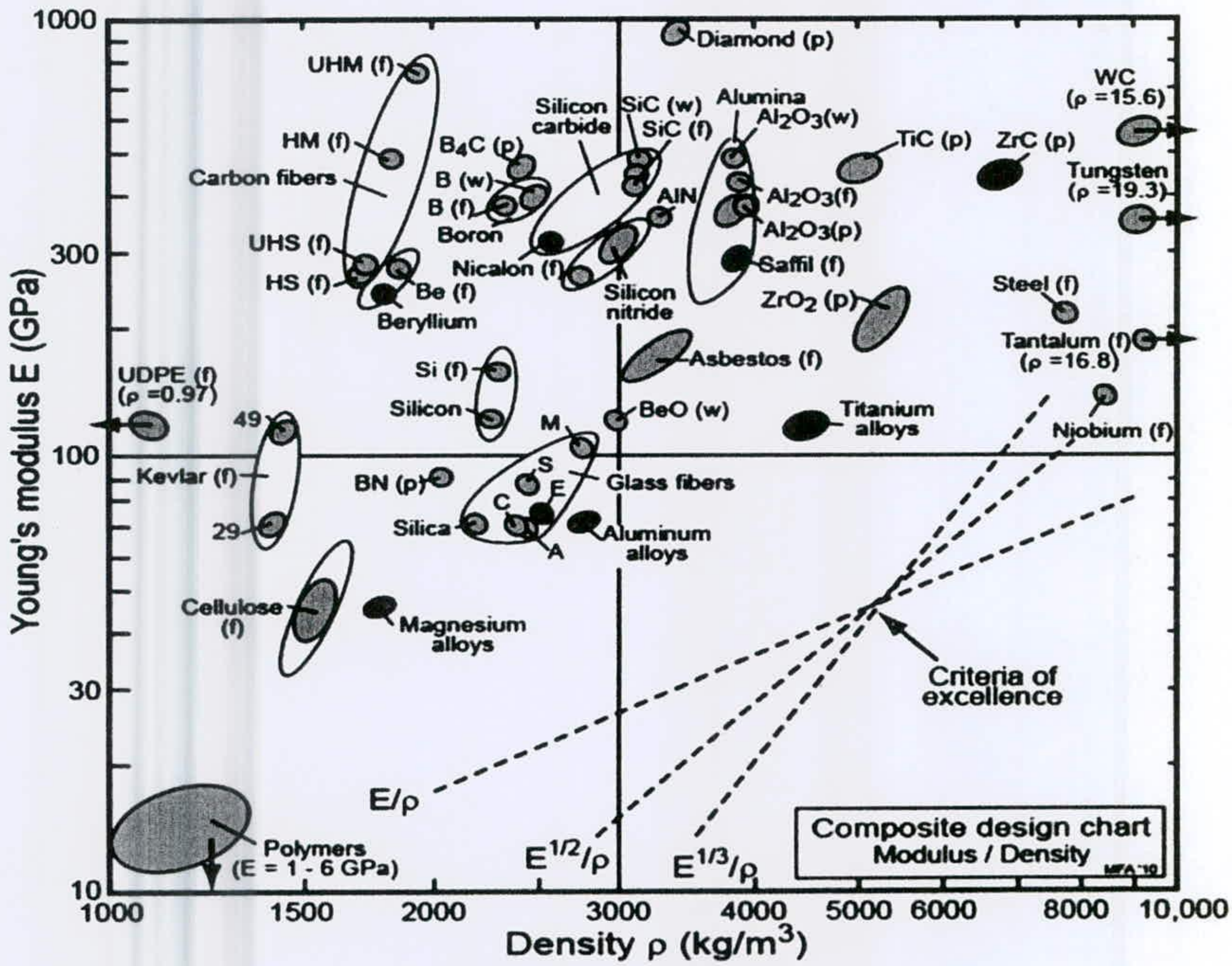


Figure 8 for question 4(a)

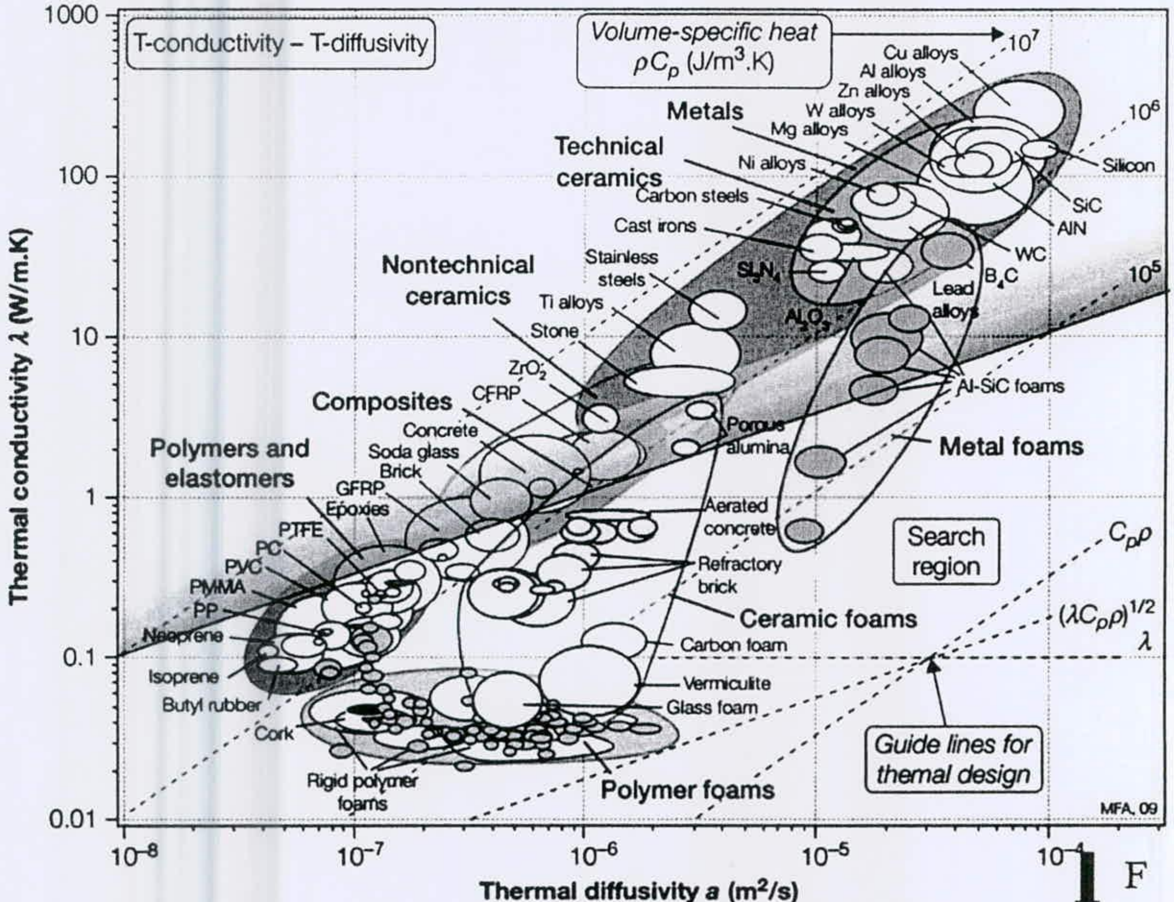


Figure 5 for question 1(b)

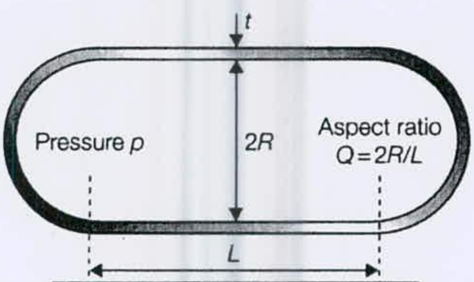


Figure 6 for question 2(a)

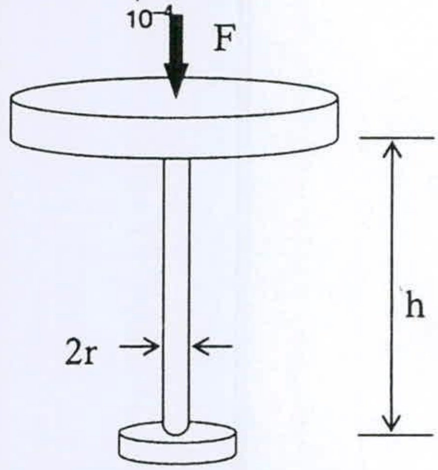


Figure 7 for question 3(a)

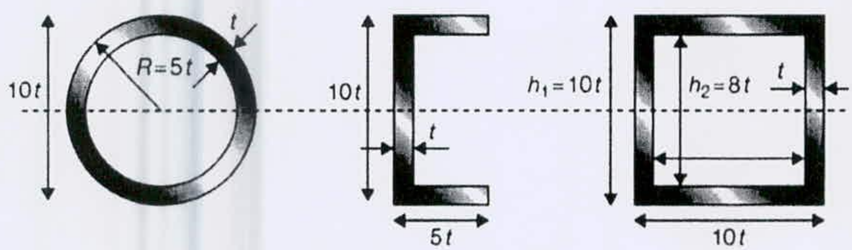


Figure 9 for question 4(b)

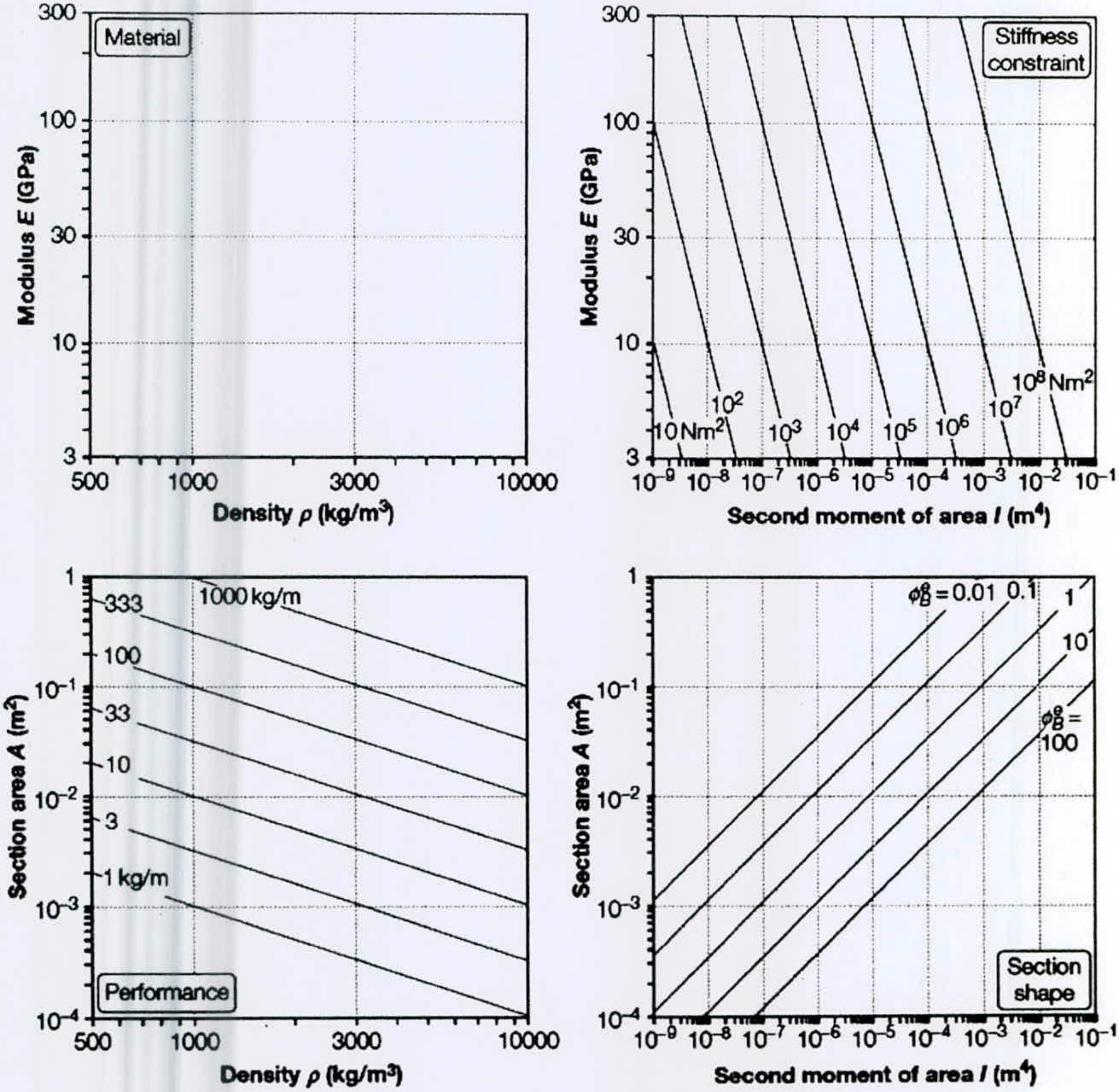


Fig. 10 for Q. 7(b) : 4-segment chart for selecting structured section.

L-4/T-II/MME **Date : 27/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **MME 447** (Industrial Metal Working Processes)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.
The Questions are of equal value.

1. At a certain level of straining, strength co-efficient is used to express the deformation behaviours of materials. Clarify the situation. The stress-strain diagrams of two AISI steels are shown in Figure for Question No. 1. Based on these diagrams, determine the strength coefficient and strain-hardening exponent for these two steels.

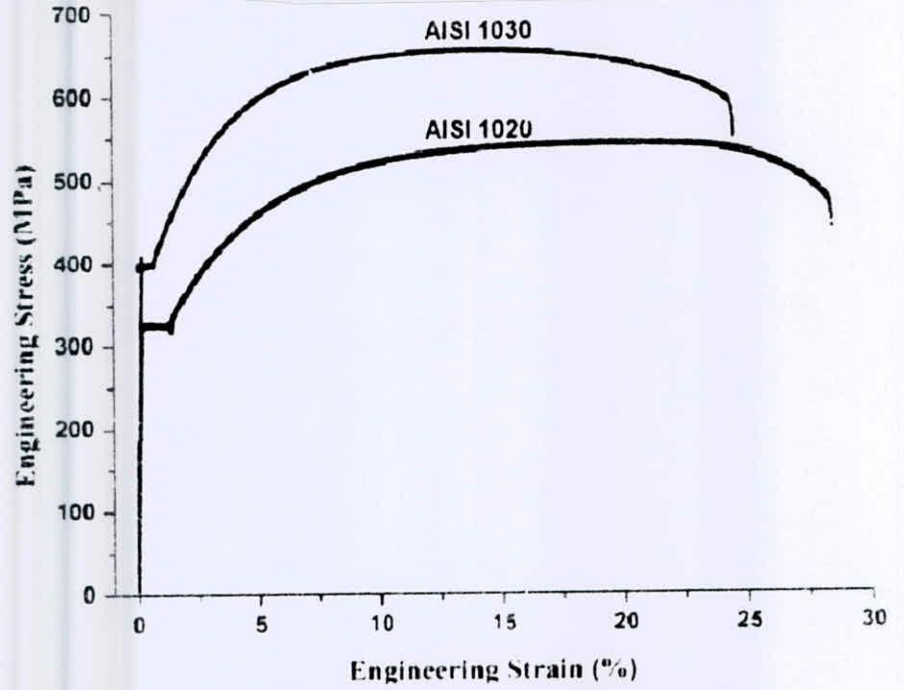


Figure for Question No.1.

2. Products manufactured by following TMCP condition can serve in much more severe environment. How? Mention and explain some important parameters whose close control is prerequisite for successful bake hardenable steel sheet production by TMCP route.

3. For any rolling mill what should we check before production of any thin metal sheet of close gauge tolerance and how can we perform it quantitatively? A strip (200MPa yield strength) 200 mm wide, 2.5 mm thick is reduced 30% in a cold rolling mill with 650 mm diameter rolls. For doing this the consumed power is 600 kW. What is the coefficient of friction of the rolls used? How much more power will be consumed if the rolling mill operation is fully under sticking friction condition? Assume reasonable value for any missing data.

Contd P/2

MME 447

4. High speed rolling mill is a great concern for quality rolled product. How can you ensure product quality without any major change in productivity? A 0.15% carbon content square bloom of minimum section area (length 20 m) is being used to produce 12 mm QAT square bar. Before final pass the section area of semi-finished product was reduced to 360 mm^2 having body temperature of 790°C. Time for completing the final pass rolling is set for 55sec. Do you think that roll pass design used is optimum for production of QAT bar with fully tempered martensitic structures in the hardened surface area? Why? Assume reasonable valuable for any missing data.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
All the symbols have their usual meaning.

5. (a) As a materials engineer, you work in a plant where steels are hot forged to make different components. The management is interested in increasing revenue by introducing cold-working processes, as cost of reheating furnaces and high-temperature-resistant dies would not be required.
For parts made by impression-die forging process, you predicted this idea would not be a sustainable one, since you would require reducing flash thickness. You proved your point based on forging load vs stroke plots. Formulate the reasons. **(17)**
(b) "The control of fibre flow is the principle advantage of forging over all other working processes." Evalute this assertion. **(10)**
(c) By inspecting some forged products (such as a pipe wrench or coins), you can see that the lettering on them is raised rather than sunk. Offer an explanation as to why they are made that way. **(8)**

6. (a) Using schematics, illustrate (i) homogenous, (ii) frictional and (iii) redundant work in wiredrawing. Why does a shorter die increase the redundant deformation? Validate how you may get curling in a drawn wire. **(10+7)**
(b) Calculate the maximum theoretical reduction possible during wire drawing of an interstitial-free plain carbon steel (assume n=0). Consider process efficiency is 70%. **(10)**
(c) Explain why the maximum reduction per pass in drawing should increase as the strain-hardening exponent, n, increases. **(8)**

7. (a) To make an aluminium-ceramic cladded panel for building exterior applications, which extrusion process would you choose? Provide design of that process, including process parameters to be considered. **(17)**

MME 447

Contd...Q. No. 7

(b) To produce a seamless plain carbon steel pipe of inner diameter 4 mm, would you recommend extrusion process? Support your answer with proper plan of the extrusion process or alternate process. **(10)**

(c) What is Chevron marking in extruded products? How would you prevent these defects in extrusion? **(8)**

8. (a) Explain why and how various factors influence spring-back in bending of sheet metals. **(10)**

(b) Elongation to failure values of a magnesium alloy are 100% at 250°C, 250% at 280% at 350°C at a very low rate (10^{-4} s^{-1}). Can you declare this alloy a superplastic alloy based on this information? Develop your judgment for this HCP alloy. **(10)**

(c) To produce a deeper cup from an aluminum alloy blank, what extra processes would you suggest? Draw the schematics of those processes. **(10)**

(d) Explain the principle of operation for SPD/DB technique for a titanium alloy. **(5)**

L-4/T-II/MME Date : 03/05/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **MME 457** (Powder Metallurgy)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Aluminium based alloys and metal matrix composites are used in energy absorber parts of automotive. Compare performance of these parts prepared via powder metallurgy route versus casting. **(10)**

   (b) Controlled reducing or neutral atmosphere is employed while sintering cermet. What are the probable reasons for it? Explain four applications of oxide-based cermets. **($13\frac{1}{3}$)**

2. (a) Explain the lubrication mechanisms for high porosity bearing materials. What type of lubricant is used for bearings in food production industry? **($10\frac{1}{3}$)**

   (b) Illustrate the production process of cemented carbide material. What types of application are they used for? **(13)**

3. (a) Explain super elasticity observed in nitinol. What advantages does PM offers over ingot metallurgy to produce nitinol and superalloys? **($10\frac{1}{3}$)**

   (b) Suggest one titanium alloy to be used in bone implant ensuring no stress-shielding effect and embrittlement. Performance of PM produced such alloy depends on close control of the composition through alloying element addition, controlled phase ratio and avoiding contamination. Justify this statement. **(13)**

4. (a) Outline properties of different types of ferrites. How does PM route control grain orientation and bloch walls in them while production? **(13)**

   (b) How does upset forging acts to close or reshape pores in preforms during densification? Mention the effect of lubrication during repressing. **($10\frac{1}{3}$)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Write down the processing steps that should be followed in gear manufacturing by powder metallurgy method. **(10)**

   (b) Discuss the advantages and limitations of powder metallurgy process? **($7\frac{1}{3}$)**

   (c) List the basic characteristics of metal powders. How does the shape of powders influence the apparent density and flow rate? **(6)**

Contd P/3

MME 457

6. (a) Explain how cobalt powders are precipitated by hydrometallurgical method. **(8)**

   (b) How are powder size and shape controlled during manufacturing of powder by atomization process? **(8 $\frac{1}{3}$)**

   (c) If powders are of different specific gravities, the heavier one will be separated and fall to the bottom of the mixture. Explain how you will obtain a uniform mixture of powders having different specific gravities. **(7)**

7. (a) Compare stress states in unidirectional compaction with isostatic compaction processes. **(8)**

   (b) Analyze explosive forming process. **(5)**

   (c) Suggest a pressing process that is suitable for the compaction of alumina powder. **(3)**

   (d) Compare between hot pressing and isostatic pressing. **(7 $\frac{1}{3}$)**

8. (a) List the pre-requisites of a sintering furnace. "It is necessary to have three distinct zones in a continuous sintering furnace" – Explain. **(12)**

   (b) 'Smaller particles undergo sintering at lower temperature in comparison to large particles' – Explain. **(8)**

   (c) Write down the three main criteria of an additive for activated sintering. **(3 $\frac{1}{3}$)**

L-4/T-II/MME **Date : 03/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **MME 467** (Ceramics for Advanced Applications)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) 'In a stable ionic structure, the valence of each anion is exactly or nearly equal to the sum of the strengths of the electrostatic bonds to it from the adjacent cations'-validate the assertion with an appropriate example. **(12)**

   (b) Write the defect reactions for the following events: **(4+4=8)**

   (i) Doping ZrO_2 with CaO

   (ii) Doping BaO with $BiFeO_3$

   (c) Suppse, you synthesized ZnO and CuO nanoparticles and annealed them separately in an atomophsere having low oxygen partial pressure to enhance their conductivity. However, after measuring their conductivity, you observed that even though the conductivity of ZnO increased significantly, the conductivity of Copper Oxide was almost unaffected. With proper defect reactions, explain the probable mechanisms that are responsible for such findings. **(15)**

2. (a) Demonstrate the influence of Oxygen partial pressure on the conductivity of non-stoichiometric ceramics using appropriate examples. **(12)**

   (b) 'Meissner effect is responsible for magnetic levitation' – Explain the assertion by taking magnetic levitated train as an example. **(13)**

   (c) A good solid electrolyte should have an ionic conductivity of at least 0.01 $(\Omega.\text{cm})^{-1}$ with an electronic transference number that should not exceed 10^{-4}. At 1000K, show that the minimum band gap for such a solid would have to be $\approx$4eV. Assume that the electronic and hole mobilities are equal and that each is 100 $cm^2/V.s$. State all other assumptions. **(10)**

3. (a) Demonstrate that gradual increase of theoretical magnetic moments of $Ni_{1-x}Cd_xFe_2O_4$ ferrites with nonmagnetic Cd substitution (where x = 0, 0.2, 0.4, 0.6, 0.8 and 1). Explain why experimental values decrease when x ~ 0.5 with the help of Yafet-Kittel model. Atomic number of Cd, Ni, Fe is 48, 28 and 26 respectively. **(18)**

   (b) Calculate the lattice parameters of $Cu_{1-x}Zn_xFe_2O_4$ mixed spinal ferrite for x = 0, 0.1, 0.2, .03, 0.4 0.5. [Here, r_{zn}^{2+} =0.083 nm, r_{cu}^{2+} = 0.076 nm, r_{Fe}^{3+} =0.067 nm and R_c=0.132 nm] **(17)**

Contd P/2

MME 467

4. (a) Describe the polarization mechanisms which exist in a typical dielectric such as $BaTiO_3$ at a temperature below the Curie point. Draw a curve of dielectric constant and loss factor as a function of frequency from 10 to 10^{20} Hz. **(10)**

(b) Suppose you have to make a simple parallel plate capacitor that can store 4×10^{-5}C at a potential of 10000 V. The separation between the plates is to be 0.2 mm. Calculate the area of the plates required if the dielectric is (i) vacuum, (ii) polyethylene, (iii) water, and (iv) $BaTiO_3$. [Value of k′ of polyethylene, water and $BaTiO^3$ are 2.26, 78.3 and 3000 respectively] **(13)**

(c) Analyze the suitability of using ceramic materials for biological applications. List different types of biocaramics based on their chemical reactivity in the body. **(8+4=12)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Formulate some steps to solve the problem of high temperature use and weak interface bonding for the fiber reinforced glass matrix composites. **(15)**

(b) "The fiber reinforced ceramic matrix composites does not show catastrophic fracture mode which is more common in whisker/particulate reinforced ceramic composites"- explain the phenomena. **(10)**

(c) Illustrate the sequence of toughness enhancement of the self-reinforced Si_3N_4 composites. **(10)**

6. (a) Interpret the influence of viscosity and microstructure on creep of polycrystalline ceramic. **(15)**

(b) Recommend some protocols to arrest accelerated static fatigue in ceramics. **(10)**

(c) Comment on the procedure of having optimum microstructure for partially stabilised zirconia (PSZ) ceramics. **(10)**

7. (a) Design a high temperature heating element for oxidizing atmosphere. **(10)**

(b) Asses the applicability of Si_3N_4 as a stator material for gas turbine engine. **(13)**

(c) For most of the electronic devices, polymer is the best choice as a substrate material. Review the factors for choosing ceramic material over polymers as a substrate. **(12)**

8. (a) "The deformation of ceramic materials is difficult and complex"-Explain. **(15)**

(b) How do pre-stressing and crack-deflection contribute to strengthen ceramics? **(10)**

(c) Does increasing K_{IC} of a truly brittle material increase Weibull modulus? Justify your answer. **(10)**

L-4/T-II/MME Date : 10/04/2023

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **IPE 483** (Production Planning Control)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

Assume appropriate value for any missing data.

1. (a) What are main building blocks of JIT? Briefly explain with appropriate examples. **(10)**

(b) Explain any 4 important factors associated with location selection for constructing a warehouse facility for a retail superstore brand. **(15)**

(c) A clothing manufacturer produces women's clothes at four locations in Mexico. Relative locations have been determined, as shown in the table below. The location of a central shipping point for bolts of cloth must now be determined. Weekly quantities to be shipped to each location are also shown in the table. Determine the coordinates of the location that will minimize distribution costs. **(10)**

Location	(x,y)	Weekly Quantity
A	5,7	15
B	6,9	20
C	3,9	25
D	9,4	30

2. (a) Are PERT and CPM similar? Briefly discuss the major differences between these two methods. **(7)**

(b) What are the functions of inventory? **(8)**

(c) Two independent methods of forecasting based on judgment and experience have been prepared each month for the past 10 months. The forecasts and actual sales are as follows: **(20)**

Month	Sales	Forecast 1	Forecast 2
1	770	771	769
2	789	785	787
3	794	790	792
4	780	784	798
5	768	770	774
6	772	768	770
7	760	761	759
8	775	771	775
9	786	784	788
10	790	788	788

IPE 483(MME)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) In balancing Demand and Capacity, you need to choose the alternative that best satisfies your objectives, not the one with lowest cost – why? **(10)**

(b) "Process quality is directly proportional to quantity"- do you think the statement is correct? How? If not, what should be the correct statement and why? **(8)**

(c) From the following table and data, decide the machine you want to buy and explain the reason to support your decision. **(17)**

Machine	Fixed Cost (Tk)	Capacity (unit)
1	10000	500
2	15000	750
3	20000	1000

Revenue, R = Tk. 30/unit
Variable cost, V = Tk 10/unit
Total Demand D = 650~850 unit

Conditions to be applied:

(i) No loss allowed

(ii) Need to satisfy market demand

6. (a) Master Production Schedule (MPS) is exactly opposite to Aggregate Planning – Discuss with examples. **(8)**

(b) Do you think Standard time can be smaller than observed time? If yes, how? If no, why? **(7)**

(c) Complete the following cost table: **(20)**

	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
Beginning Inventory	300						
Demand Forecast	1560	1700	1640	1600	1680	1550	
Safety Stock (0.25 X Demand)							
Production Requirement							
Working days per month	22	19	21	21	22	20	
Ending Inventory							

Plan 1: Constant workforce - Vary inventory & Stockout

	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
Beginning Inventory	300						
Working days per month	22	19	21	21	22	20	
Available hrs per month (8hrs/day)							
Actual Production (5hrs/unit)							
Demand Forecast							
Ending Inventory							
Shortage cost ($5/unit)							
Safety stock							
Unit excess							
Inventory cost ($1.5/unit)							
Straight time cost ($4/hr)							

(i) Compute the MSE and MAD for each forecast. Does either forecast seem superior? Explain.

(ii) Compute MAPE for each forecast.

(iii) Prepare a naïve forecast for periods 2 through 11 using the given sales data. Compute each of the following; (1) MSE, (2) MAD. How do the naive results compare with the other two forecasts?

3. (a) Explain the significance of the Re-order point. **(5)**

(b) Explain 4 quantitative methods of forecasting. Show their relative efficiency in dealing with the "lagging effect". **(15)**

(c) A company makes bicycles. It produces 450 bicycles a month. It buys the tires for bicycles from a supplier at a cost of \$20 per tire. The company's inventory carrying cost is estimated to be 15% of material cost and the ordering is \$50 per order. **(15)**

Find

(i) The EOQ;

(ii) The number of orders per year;

(iii) The average annual ordering cost;

(iv) The average annual carrying cost; and

(v) The cycle length in days.

4. (a) "The cellular layout can be termed as a miniature version of product/process layout"- justify. **(5)**

(b) What are the classes of production systems based on customer ordering policy? Briefly explain with appropriate examples. **(15)**

(c) Given the operation times provided: **(15)**

(i) Using Johnson's algorithm , find the order of the jobs.

(ii) How many hours will it take to finish all the jobs?

(iii) How many hours is Center 1 idle?

(iv) How many hours is Center 2 idle?

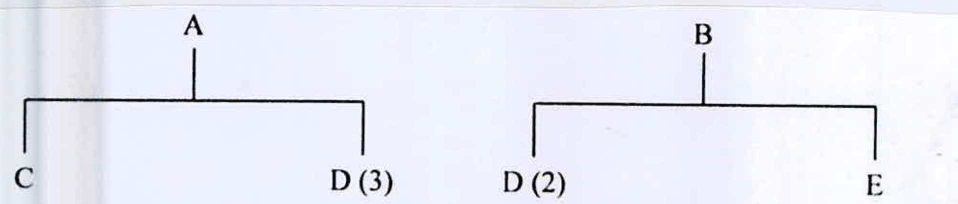
	JOB TIMES (minutes)					
	A	B	C	D	E	F
Center 1	20	16	43	60	35	42
Center 2	27	30	51	12	28	24

IPE 483(MME)

7. (a) Briefly describe the alternatives in developing capacity plan. **(10)**

(b) Matured and new products need to be produced alternatively – Justify with appropriate example. **(7)**

(c) Complete the following MRP table: **(18)**



Week No.	**1**	**2**	**3**	**4**	**5**	**6**
Gross requirements A					60	
Gross requirements C				75		

For A (LT = 1 wk; Lot for lot)

Week No.	**1**	**2**	**3**	**4**	**5**	**6**
Gross requirements						
Scheduled receipt	55					
Projected on-hand inventory (17)						
Planned receipt						
Planned order release						
Gross requirements						

For B (LT = 1 wk; Lot size = 80)

Week No.	**1**	**2**	**3**	**4**	**5**	**6**
Gross requirements						
Scheduled receipt	80					
Projected on-hand inventory						
Planned receipt						
Planned order release						
Gross requirements						

For D (LT = 1 wk, Lot size = 100)

Week No.	**1**	**2**	**3**	**4**	**5**	**6**
Gross requirements						
Scheduled receipt	100					
Projected on-hand inventory (25)						
Planned receipt						
Planned order release						
Gross requirements						

IPE 483(MME)

8. (a) Do you think JIT is applicable to a service organization? How? **(7)**

(b) How can you distinguish a push system from a pull system in a manufacturing environment? Provide examples for both. **(8)**

(c) The following table contains information related to the major activities of a research project: **(20)**

Task	Precedence	Time
A	---	20
B	---	20
C	---	10
D	A	15
E	B, C	10
F	B, C	14
G	B, C	4
H	C	11
I	G, H	18
j	D, E	8

Use the information to do the following:

(i) Draw the AON network diagram

(ii) Find the project completion time

(iii) Find the critical path

(iv) Find Early Start (ES) / Eealty Finish (EF) and late Start (LS) / late Finish (LF) for each of the activities

(v) If you reduce the time required for acitivity D & E by 2 days each, find the project completion time and critical path is well.
