L-4/T-1/MME  Date: 12/09/2018

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-1  B. Sc. Engineering Examinations 2017-2018

Sub: **MME 443** (Physical Metallurgy of Steel and Heat Treatment)
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 figures in the margin indicate full marks.

1. (a) Why selection of Nitriding temperature and time are critical – explain.  
(b) Describe the effects of temperature, wt. percentages of carbon and other elements on the diffusivity of carbon in steel.  
(c) Define the depth of hardened layer for induction hardening method. By controlling which parameter penetration depth can be controlled precisely for induction hardening – explain. Between induction and laser hardening methods, which one results sharp change in hardness with the depth of hardened layer?  

2. (a) What is tool steel? List the purpose of heat treatment of tool steel.  
(b) Describe the characteristics of various types of carbides in tool steel.  
(c) Tempering of tool steel consists of several transformation steps – briefly discuss.

3. (a) What is bright annealing? What is the mechanism of martensitic transformation of a fully solution treated austenitic stainless steel?  
(b) A case study shows, in a foundry, martensitic stainless steel was successfully made with Cr content up to 14 wt. %. For higher Cr content the steel was found to be ferritic on quenching. Explain the possible reasons with necessary diagram(s).  
(c) What is intergranular corrosion? Describe all the remedies for such corrosion in austenitic stainless steel.

4. (a) With a schematic phase diagram, explain the precipitation strengthening mechanism of light alloys.  
(b) What are the important criteria to be considered to select ageing temperature for precipitation hardening of these alloys – explain with example.  
(c) Unlike Al-Cu binary system, Al-Si binary system is not suitable for precipitation strengthening – explain why?

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SECTION – B
There are EIGHT questions in this Section. Answer any SIX questions. The questions are of equal value.

5. What are the main inducible properties in tungsten added steels through various heat treatment routes? Discuss the importance of weathering steels for structural applications in Bangladesh.

6. Compare and contrast the M and T type high speed steels. Select suitable alloying elements to enhance the following properties of steel components.
   (a) Corrosion resistance along with high temperature strength
   (b) Ductility and toughness
   (c) Abrasion resistance

7. Full annealing heat treatment is usually selected for hypo eutectoid steel – why? Calculate the full annealing temperature of an AISI 1140 steel having the following chemical compositions: C = 0.44%, Mn = 1.0%, Si = 0.1% and S = 0.1%.

8. Normalized hyper eutectoid steel (1.5%C) is harder, but tougher than the annealed steel – why? Explain with necessary diagrams. What are the possible reasons of the presence of cluster like pearlite around well grown ferrite grains in normalized hypoeutectoid steel?

9. An AISI 1090 steel having 0.6% Mn is to be heat treated to get microstructures composed of 50% bainite (both upper and lower bainite) and 50% martensite. Suggest a suitable heat treatment schedule mentioning austenitizing temperature, cooling rate and cooling time at different stages. The continuous cooling curve of the steel is given in Figure 1.

10. Discuss how various factors influence the hardenability of steels and arrange the alloying elements C, Si, Mn, Ni, Mo and Cr as per their hardenability effects (from highest towards the lowest) in steels.

11. For controlling the amount of pearlite in the microstructures of grey cast iron, Mn plays a very important role – why? Discuss the underlying mechanism of controlling the pearlite content in grey cast iron by Mn additions and various service related advantages of this cast iron.

12. Among grey, white, malleable and nodular cast irons, which one will you suggest for economic and mass production of high strength agricultural tools and why? A typical nodular cast iron component having 1.4% silicon was austenitized at 780°C for hardening heat treatment. Find out the combined carbon content expected in the cast iron component after the prescribed heat treatment.

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Figure 1 for Question No. [ ] [ ]
SECTION - A

There are FOUR questions in this Section. Answer any THREE.

1. (a) Compare between continuous spectrum and characteristic spectrum X-ray radiation. Explain how characteristic X-ray is produced in the X-ray machine. (5+8)
   (b) Monochromatic X-ray radiation is required for X-ray diffraction analysis of materials. Explain how monochromatic X-ray can be obtained from X-ray radiation. (10)
   (c) Discuss how Bragg law is applied for the identification of crystal plane of a material. (12)

2. (a) Explain possible reasons for the shift of diffraction peaks of a crystalline solid from their standard peak positions. Why does peak widening occur in X-ray diffraction? (8+4)
   (b) Differentiate between ideal and non-ideal conditions of X-ray diffraction. Explain how you will measure the crystal size of materials using non-ideal condition of X-ray diffraction. (5+10)
   (c) Calculate the structure factor for a material having face centred cubic (FCC) crystal structure and show the five planes from where reflection may occur. (8)

3. (a) A low alloy carbon steel contains some nano sized second phase particles. Explain how you will prepare the sample to identify the second phase particles using TEM investigation. Mention the steps that are followed for the indexing of cubic crystal from a TEM diffraction pattern. (8+7)
   (b) What happens when high-energy electrons strike a specimen? How will you remove the charging effect of sample for SEM investigation? (8+3)
   (c) Discuss a suitable method that you can use to investigate the grain orientation of a poly-crystalline material. (9)

4. (a) Why is an ultrahigh vacuum environment often necessary for operation of a scanning tunneling microscope (STM)? (8)
   (b) For an industrial application that requires fast identification of elements, which XRF system (WDS or EDS) would you choose? What are the benefits and disadvantages of your choice? (10)
   (c) What change in the EDS spectrum do you expect when a specimen is tilted to the face of detector in an SEM? (10)
   (d) Explain the importance of analyzing crystals in wavelength dispersive (WDS) spectroscopy. (7)

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SECTION – B

There are FOUR questions in this Section. Answer any THREE.

5. (a) Classify the basic types of molecular vibration with neat sketches. (10)
   (b) In Raman spectroscopy, explain the effects of wavelength of laser light source on the signal intensity using suitable diagram. (12)
   (b) Explain the working principle of a photo multiplier detector in UV-Vis spectroscopy. (13)

6. (a) "Good thermogravimetric (TG) results can only be ensured with temperature calibration technique." – Justify the statement along with mentioning the factors affecting for better temperature calibration in TG analysis. (10)
   (b) Suppose a polymer undergoes two types of thermal events (i.e. glass transition and curing). How can you identify those events by a typical differential scanning calorimetry (DSC) technique? (10)
   (c) Illustrate the effect of heating rate on DSC curve. (8)
   (d) Explain why differential thermal analysis (DTA) is more suitable for examining high temperature thermal events. (7)

7. (a) In X-ray photoelectron process for surface elemental analysis the binding energy of a photoelectron depends on the work function ($\phi$) of the material. In that case for every elemental analysis with XPS do we need to know the work function for each material beforehand? Explain how. (8)
   (b) How would you distinguish XPS peaks from AES peaks in an XPS spectra? (10)
   (c) Illuminate the problem associated with insulating material for AES analysis. How do you overcome this problem for better analysis? (12)
   (d) Suggest an analytical technique for elemental analysis of a tri-layered (i.e. three layers) metallic thin film (each 50 nm thick). (5)

8. (a) Elucidate the functions of a developer in dye penetrant testing. (8)
   (b) Explain how a subsurface crack whose length parallel to thickness direction of a 100 mm $\times$ 100 mm $\times$ 3 mm non-ferrous sheet can be detected by a suitable NDT Technique. (9)
   (c) Explain the purposes of pre-discharge phase for the chemical composition analysis with optical emission spectrometer. (9)
   (d) Illustrate the secondary ion generation process during the collision of primary ion with a typical solid. (9)
1. (a) Outline the main features of extrusion process with an aid of a schematic diagram. (13)
(b) Design and describe an injection molding process suitable for simultaneous PVC plates production. (22)

2. (a) Differentiate between branched polymer and cross-linked polymer. (12)
(b) Two monomers of same proportions are polymerized to form a block co-polymer and a graft co-polymer separately. Among these two co-polymers, which one has higher density? Justify your answer. (9)
(c) Discuss the factors that influence melting and glass transition temperatures of polymer. (14)

3. (a) Compare and contrast vacuum forming process with pressure forming process. (18)
(b) How does crazing control fracture of a plastic? (8)
(c) Explain the importance of reciprocating screw type injection molding machine. (9)

4. (a) Select and outline a manufacturing process suitable for hollow plastic article production. (17)
(b) What is sandwich injection molding? Why is sandwich injection molding preferred for plastic production? (10)
(c) Mention the role of vulcanization in enhancing mechanical properties of elastomers. (8)

SECTION – B

There are FOUR questions in this Section. Answer any THREE.

5. (a) What are the characteristic properties that should be kept in mind in designing a composite material of a particular application? (7)
(b) Suppose, you have designed a composite containing a matrix of tensile strength 400 MPa and a volume fraction $f = 0.2$ of fiber reinforcement with tensile strength 600 MPa. Calculate the strength of the composite assuming similar properties of the matrix and reinforcement. When do you consider the reinforcement acting efficiently under the application of an external load? (8)

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(c) What is a laminate? To meet the best properties, design a laminate composite stacked with ten (10) plies in terms of ply orientation and mid-plane symmetry. Also, give reasoning to your design. (20)

6. (a) What do you understand by fiber flexibility? Which parameters control fiber flexibility? Mention the importance of this property in composite processing operations. (10)
(b) What is Kevlar? Mention some uses and properties of Kevlar? (12)
(c) Discuss the crack deflection mechanism to improve the toughness of ceramic matrix composites. (13)

7. (a) Describe the suitable composite fabrication technique for the construction of large tanks and pipe-work used in the chemical industry. (15)
(b) Draw the modes of fatigue crack growth in fiber reinforced composite materials. (8)
(c) Briefly describe the fatigue damage mechanism of composites. (12)

8. (a) For loading in a transverse direction of continuous (long) fiber reinforced composites, derive the following relationship for predicting transverse stiffness:

\[ E_{ct} = \left[ \frac{E_m E_f}{(1 - V_f) E_f + V_f E_m} \right] \]

where all the symbols have their usual meanings. (20)

What is the limitation of this equation? How can the limitation be overcome?

(b) Suppose, you are a materials engineer and you are in-charge of the testing division of the aircraft 787 Dreamliner. You have to inspect a small sized aircraft part that is made with CFRP. Choose and explain a suitable nondestructive testing to inspect that aircraft part. (15)
L-4/T-1/MME

Date: 30/09/2018

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-1 B. Sc. Engineering Examinations 2017-2018
Sub: IPE 491 (Engineering Management)
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) Explain different types of trends in forecasting. (10)
    (b) Quarterly demand of a product from 2016 to 2018 is given below. Predict demand of that product for the year 2019 using appropriate technique. (25)

    | Year    | Demand | Year | Demand | Year     | Demand |
    |---------|--------|------|--------|---------|--------|
    | 2016    | 620    | 2017 | 1040   | 2018     | 1320   |
    | 1st Quarter | 620    | 1st Quarter | 1040    | 1st Quarter | 1320   |
    | 2nd Quarter | 720    | 2nd Quarter | 1080    | 2nd Quarter | 1500   |
    | 3rd Quarter | 830    | 3rd Quarter | 1230    | 3rd Quarter | 1610   |
    | 4th Quarter | 1340   | 4th Quarter | 1750    | 4th Quarter | 2150   |

2. (a) A shipyard wants to purchase a computer controlled sheet metal cutting and bending machine to replace a manual cutting machine. There is an offer under consideration for the machine. The company wants to study the financial feasibility of the offer. The associated financial data are as follows: Purchase and installation cost = Tk. 90 lacs; Annual savings in maintenance cost = Tk. 2 lacs; Annual increase in profit = From year 1 to 8: Tk. 16 lacs, From year 9 to 15: Tk. 12 lacs, From year 16 to 20: Tk. 8 lacs; Repair cost at 8th and 15th year = Tk. 5 lacs each; Salvage value = Tk. 10 lacs; Required rate of return = 12%. Decide whether the company should accept the offer or not. (22)
    (b) Define leader and leadership. Explain some qualities of a leader. (5+8=13)

3. (a) Define different types of inventory costs. (7)
    (b) Differentiate fixed order and fixed time period inventory model. (8)
    (c) Weekly demand of a product is 2000 units. The supplier takes 12 days to deliver an order. It costs Tk. 90,000 to carry out 2 orders. Monthly holding cost is 1.2% of the cost per unit of the product. Per unit cost depends on ordering quantity and is given as follows: Tk. 1000 if order quantity is 0 to 5000 units; Tk. 900 if order quantity is 5001 to 8800; Tk. 750 if order quantity is 8801 or more. Determine the economic order quantity and the re-order point. (20)

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4. (a) What are the findings of different behavioral studies of leadership? (10)

(b) Write short note on the following:
   (i) Cost to achieve good quality (ii) Cost of poor quality. (15)

(c) Explain the following terms: internal rate of return, payback period, and net present value. (10)

SECTION – B

There are FOUR questions in this Section. Answer any THREE.

5. (a) What are different managerial levels? Discuss the skills needed at different managerial levels. (5)

(b) What are the motivators and hygiene factors according to Herzberg's theory? (10)

(c) How "Expectancy theory" can be implemented to motivate students towards good grades? Explain. (8)

(d) What is Management by Objectives (MBO) introduced by Peter Drucker? Discuss the advantages and disadvantages of MBO. (12)

6. (a) Write briefly about "Taylor's Four Principles of Management". (8)

(b) What are the propositions of equity theory? Discuss the employee responses to perceived inequities. (12)

(c) Describe the functions and roles of managers. (10)

(d) Suppose you have been appointed as a production manager in a re-rolling mill. How are you going to motivate your subordinate workers? Discuss in light of McGregor's theory X and theory Y. (5)

7. (a) What is Hawthorne experiment? Describe the experimental findings and research conclusion obtained from it. (8)

(b) Describe different ways of designing appropriate rewards programs to motivate employees in a workplace. (12)

(c) What are the reasons behind conducting performance appraisals? How performance appraisals should be scheduled? (10)

(d) Differentiate "Efficiency" and "Effectiveness" with examples. (5)

8. (a) Discuss briefly about "Maslow's hierarchy of needs theory" with illustration. (10)

(b) What are the types of rating errors in performance appraisal? (5)

(c) How public transport drivers can be motivated to drive safely using "Reinforcement theory"? (5)

(d) Who conduct the performance appraisal in a workplace? How their performance appraisals are done? Discuss. (15)