

SECTION – A

There are **EIGHT** questions in this section. Answer any **SIX**

The questions are of equal value.

1. Define residual elements of steels. Mention at least four residual elements that are totally detrimental for the properties of steels and discuss their effects.
2. In relation to iron-carbon diagram specify eutectoid reaction. Is it possible to change the parameters of eutectoid reaction with the addition of alloying elements in plain carbon steel? Discuss with necessary diagrams.
3. A standard size sample of a fully annealed plain carbon steel results yields strength to be 310 MPa. If the yield strength of this steel is 60% of the ultimate tensile strength what will be the carbon content and full annealing temperature of the sample? Assume reasonable value for any missing data.
4. Mention and discuss the problems related to the hardenability behaviours of high carbon steels. Metallographic observation on a cross-section of a 20 mm diameter steel part revealed that the microstructures at surface, 5 mm from surface and at the center are, respectively, composed of 100, 90 and 50% martensite. Draw the hardness profile for the transverse section of the steel. Consider the bar as AISI 1040 steel. Assume reasonable value for any missing data.
5. Two low alloy steel parts have carbon content respectively, 0.4 and 1.4%. If these two steel bars are fully annealed and normalized, which heat treatment will result better toughness and why? Discuss the underlying mechanisms of toughening with the help of detail microstructural morphologies.
6. A steel component has the following chemical compositions: C = 0.4%, Mn = 0.6%, Cr = 1.0%, Ni = 1.5%, Si = 0.4%, S = 0.004% and P = 0.003%. Calculate the martensite transformation temperature. With the help of CCT diagram given in Figure 1 for Question No. 6. Determine the critical cooling rate for this steel. After hardening treatment, the microstructures of the steel show 90% martensite, 9% retained austenite and 1% undissolved carbide. What will be the volumetric expansion/contraction of the steel component?
7. Do you think that plasma carburizing is a green surface hardening with multidimensional advantages? Discuss the underlying reasons.
8. One low alloy steel contains 5% nickel and another one contains 5% Cr. Between these two steels which one will accelerate the carburizing rate and why? Mention some unique advantages of liquid carburizing over pack carburizing process.

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SECTION-B

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

The figures in the margin indicate full marks.

9. (a) How are ferritic and pearlitic malleable cast irons produced from white cast iron? (10)
- (b) Suggest a heat treatment process that is employed to improve the strength with some ductility of nodular cast iron and discuss the process. (15)
- (c) A 3.2% carbon and 2.1% silicon containing pearlitic ductile iron is annealed and obtained 12% pearlite with the ferrite grain size of 120 μm . Calculate the yield strength and ultimate tensile strength of the annealed ductile iron. (10)
10. (a) List the eight important properties of tool steels. Why is hardenability equally important as hardness of tool steels? (4+6)
- (b) With the help of schematic diagram, explain the variation of hardness with the carbon percentage of various tool steels. (10)
- (c) Write down the purposes of normalizing tool steel. Show the range of normalizing temperature of tool steel in a diagram and discuss the microstructural changes that occur during normalizing operation of tool steel. (5+10)
11. (a) "The austenitizing temperature is particularly important for tool steels in hardening operation." Explain this assertion. (7)
- (b) Is it possible to heat-treat the all nonferrous alloys? Justify your answer. (4)
- (c) With the help of phase diagram, explain the hardening mechanism of Al-4.5 Cu alloy. (16)
- (d) For certain application one needs at least 12% elongation along with YS to UTS ratio to be 1.1 for age hardenable 25 Cu-Be alloy. Using the curves given in Figure 2, suggest a suitable heat treatment schedule. (8)
12. (a) A product was made from austenitic stainless steel by cold deformation, but the product became magnetic. Explain the reason for this change. (7)
- (b) What is duplex steel? Discuss the behavior of the formation of precipitates in duplex steel. (15)
- (c) Stable structure of martensitic stainless steel at high temperature is austenite and at room temperature is ferrite and carbide. How can the martensitic structure be obtained for this steel at room temperature? (13)

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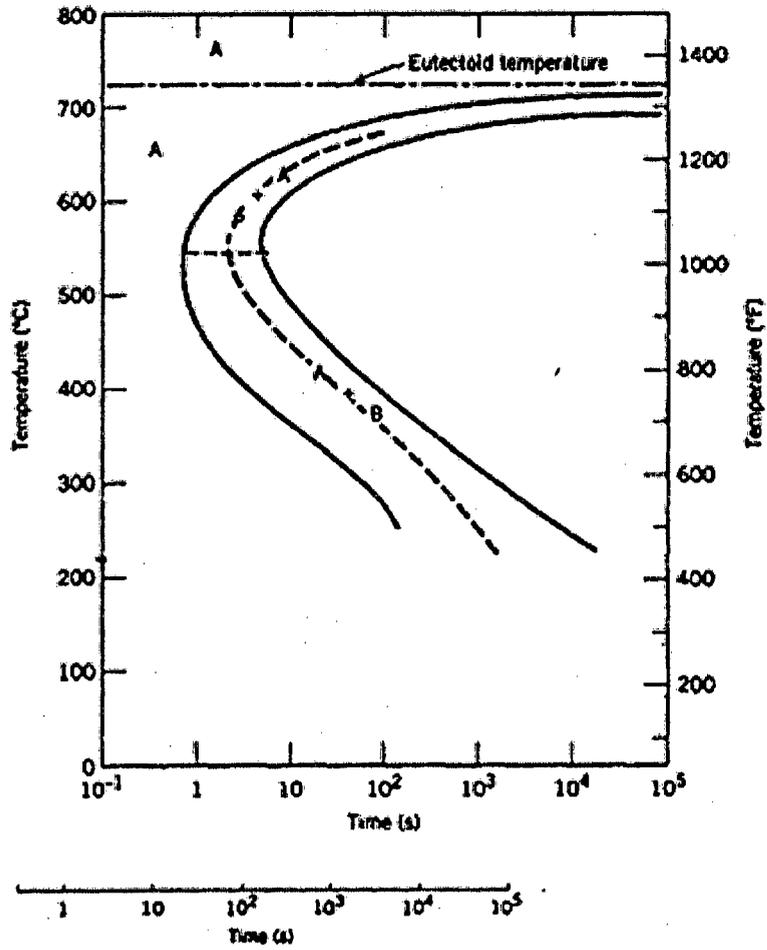
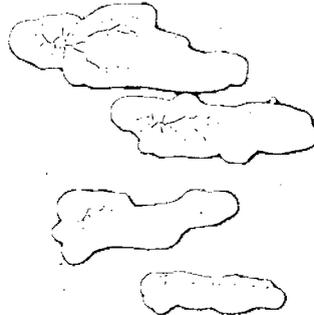


Figure 1, for question no. 6



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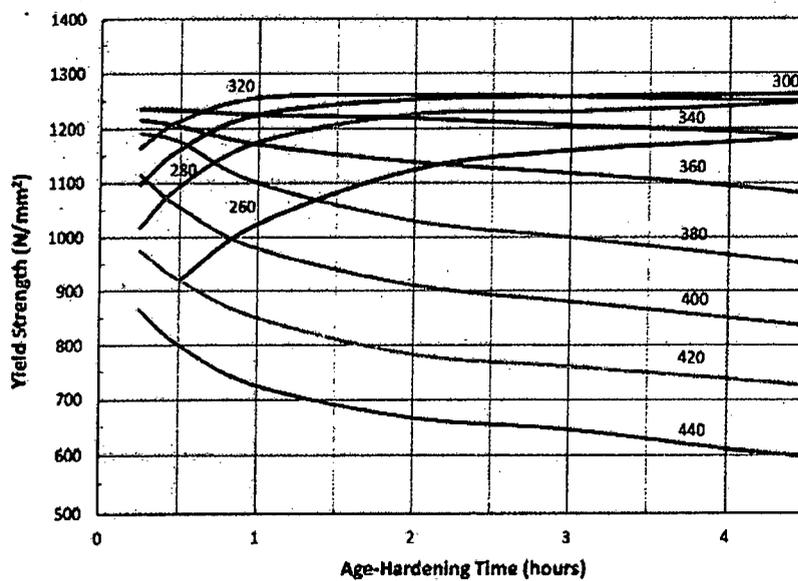
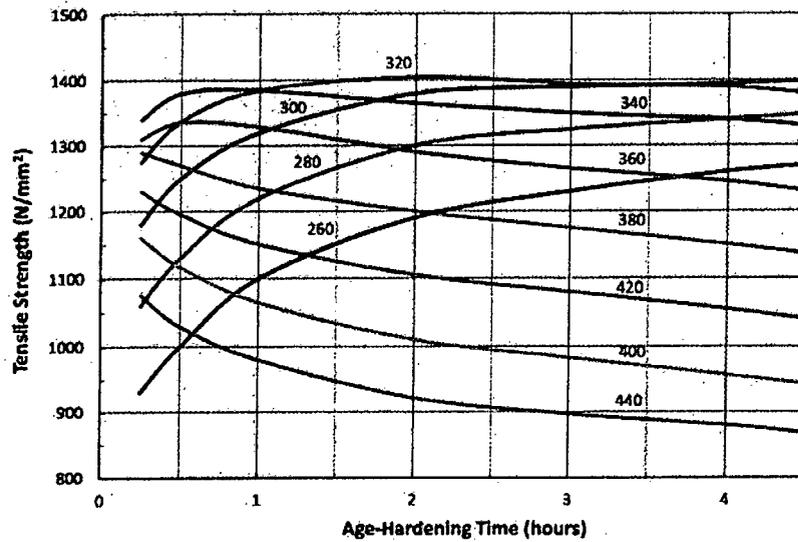
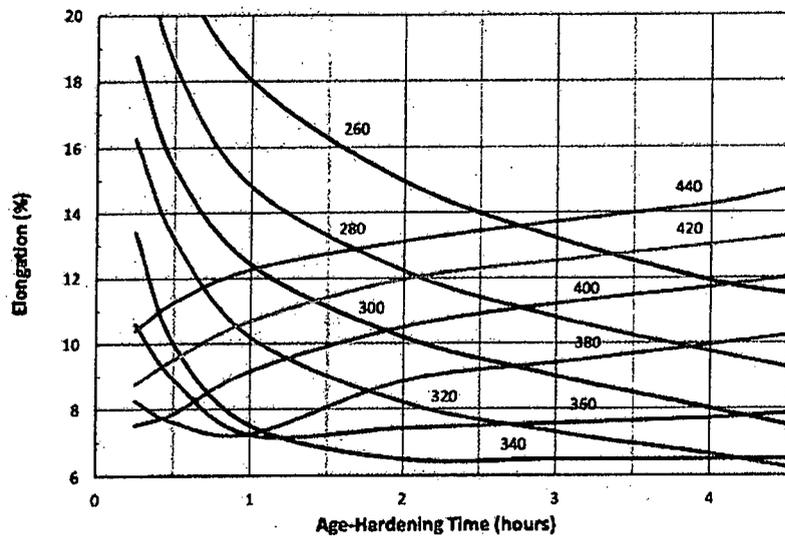


Fig. 2 for question (d)



SECTION – A

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

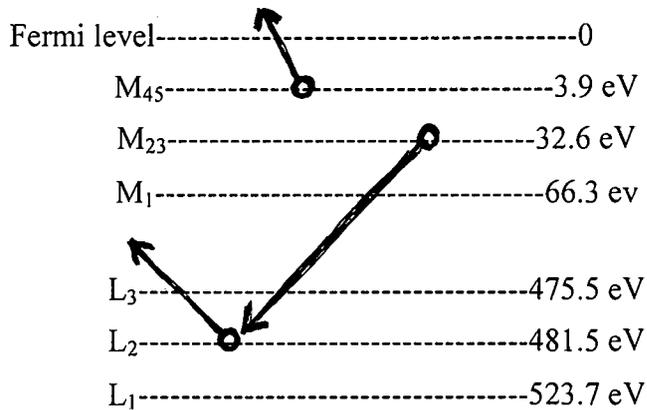
1. (a) Sketch typical X-ray emission spectra (intensity vs. wavelength) and define λ_{SWL} , continuous spectrum and characteristic spectrum. Calculate λ_{SWL} if voltage across the electrodes is 25 kV. (9+3)
 (b) Explain how you will obtain monochromatic $K\alpha$ radiation from the continuous X-rays and other characteristic X-rays. (13)
 (c) Crystal of cobalt (Co) is analysed using $Cu K\alpha$ ($\lambda = 1.5418 \text{ \AA}$) X-ray radiation. Calculate the angle of reflection, 2θ , of the (111) plane. The lattice parameter (a) of FCC cobalt is 3.544 \AA . (10)
2. (a) What is structure factor? Calculate the structure factor for a face centered cubic cell and show five planes from where reflection may occur. (3+12)
 (b) Derive an equation that is used to determine the particle size of crystalline materials. (13)
 (c) Full width at half maximum (FWHM) B of an X-ray diffraction peak of copper sample at $2\theta = 68^\circ$ is found 0.18° . Calculate the crystal size. X-ray diffraction test was conducted using $Mo K\alpha$ ($\lambda = 0.721 \text{ \AA}$) radiation. (7)
3. (a) Compare bright-field (BF) and dark field (DF) imaging in TEM. Explain how BF and DF images are formed. (5+7)
 (b) What type of detector you will choose for Scanning Electron Microscopic (SEM) analysis if you want to make compositional contrast of a sample? Discuss the effect of probe diameter and current on the resolution of SEM image. (3+7)
 (c) Discuss the incident electron beam and sample interaction in SEM. (10)
 (d) Choose a characterization technique that is used to determine the crystalline orientations of individual grains of a polycrystalline specimen. (3)
4. (a) Differentiate between scanning tunneling microscopy (STM) and atomic force microscopy (AFM). Briefly discuss the working principle of STM. (5+7)
 (b) How does wavelength dispersive spectroscopy (WDS) of XRF differ from X-ray diffractometer? Briefly explain the working principle of WDS type XRF. Why is large atomic spacing analysing crystal used to detect the light elements in WDS technique? (4+7+4)
 (c) Select a characterization technique for microanalysis of a sample. What are the differences between energy dispersive spectroscopy in XRF and energy dispersive spectroscopy in electron microscope? (3+5)

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SECTION-B

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

5. (a) Draw the energy level diagram and write down the kinetic energy equation for Auger electron spectroscopy. Determine the Auger electron energy from the following diagram. (15)



- (b) How the problem of low signal in Auger spectrum is minimized. (8)
- (c) Explain the working principle of cylindrical mirror analyzer (CMA) in Auger spectroscopy. (12)
6. (a) The harmonic oscillator model is a good approximation of atomic stretching. Use an energy level diagram to explain typical vibration absorbance in observed IR spectroscopy. (12)
- (b) The IR spectrum for acetylene ($\text{H-C} = \text{C-H}$) contains a strong absorbance at 3423cm^{-1} . (12)
- (i) What are the number of vibrational modes for acetylene.
- (ii) Explain, in detail, the sources of the differences in the IR and Raman spectra.
- (c) How does ligands affect the energy levels of transition metals. (11)
7. (a) "SIMS spectra appears more complicated than those of AES and XPS"—Explain why? (7)
- (b) State criteria for the probe selection for ultrasonic testing. (8)
- (c) Discuss the various parameters influencing the radiographic imaging. (10)
- (d) Describe the instrumentation for eddy current testing in detail. (10)
8. (a) compare and contrast the TGA (Thermo gravimetric Analysis) and DTA (Differential Thermal Analysis) in terms of: (15)
- (i) Their thermograms
- (ii) Quantity measured
- (iii) Instrument used
- (iv) Nature of sample and reference.
- (b) Why is the atmospheric control a more critical factor in TGA than in DTA analysis? (8)
- (c) Discuss the effects and possible corrections for the factors that influence DTA heating curves. (12)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2015-2016

Sub : IPE 491 (Engineering Management)

Full Marks: 210

Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – AThere are **FOUR** questions in this section. Answer any **THREE**.

Assume reasonable values for any missing data.

1. (a) Explain forward and backward scheduling. (5)
- (b) Consider the following data on jobs waiting to be processed on a single machine in a job shop. They are listed here in order of arrival at the machine: (15)

Job	Processing time (days)	Due date (Days hence)
A	5	8
B	3	5
C	4	12
D	7	14
E	2	11

Develop a schedule for these jobs based on the rules namely FCFS, SOT, and EDD. In each schedule, list the flow time and lateness for each job as well as the mean for each measure.

- (c) Demand for stereo headphones and MP3 players for joggers has caused Nina Industries to grow almost 50% over the past year. The numbers of joggers continues to expand, So Nina expects demand for headsets to also expand, because, as yet, no safety laws have been passed to prevent joggers from wearing them. Demand for these stereo units for last year was as follows: (15)

Month	Demands (units)	Month	Demands (units)
January	4200	July	5300
February	4300	August	4900
March	4000	September	5400
April	4400	October	5700
May	5000	November	6300
June	4700	December	6000

Using least-square regression method, what would you estimate demand to be for the month of January, February, and March 2017? Show all necessary calculations.

2. (a) How can you apply cause-and-effect diagram to identify root causes of shrinkage defect in metal casting process? (7)
- (b) Define a project with realistic examples? What is meant by project management? (3+3=6)

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Contd... Q. No. 2

(c) A project of establishing a glass manufacturing factory has been defined to contain the following list of activities, along with their required times for completion.

Activity	Time (Days)	Immediate successors
A	1	B,C,D
B	4	E
C	3	F
D	7	F,H
E	6	G
F	2	G
G	7	I
H	9	I
I	4	-

Required:

- (i) Draw the network diagram. Show the early start, early finish, late start and late finish times. **(10)**
 - (ii) Mention the critical path. **(5)**
 - (iii) If activity F takes four days to complete instead of two days, does it has any impact on the critical path? How? **(3)**
 - (d) What is affixed position layout? Give an example. **(4)**
3. (a) Suppose some students from the Department of Materials and Metallurgical Engineering (MME) establish an automobile oil change company named as Fast Drive at Polashi Bazar Dhaka. Mr. Anwar, the class captain of MME 4/1, assumes the position of procurement manager of the company. The company buys car oil in bulk at \$3 per gallon. The company services approximately 150 cars per day and each oil change takes 1.25 gallons. Fast drive stores bulk oil at the cost of \$0.02 per day. Also, the cost of placing an order for bulk oil is \$20. There is a 2-day lead time for delivery. How would you suggest the optimal inventory policies to the procurement manager? **(15)**
- (b) How can maintenance activities assist in smooth operations of a glass factory? Explain condition based maintenance (CBM) with examples? **(6+6=12)**
- (c) What is the significance of ABC inventory classification? **(4)**
- (d) Why is Delphi method preferred over Panel Consensus to predict product/service demand forecasting? **(4)**
4. (a) There are basically four types of production strategy-what are those? Compare any three of them based on the criteria namely customization, types of inventory, volume, and process. **(4+12=16)**

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Contd... Q. No. 4

- (b) Suppose, you want to analyze demand of ceramic bricks in Dhaka city. Name the common types of trends that may appear for the demand of ceramic bricks. Show them graphically. **(8)**
- (c) Mention some dimensions of quality. **(7)**
- (d) How can you define hazard and risk for a ceramic factory? **(4)**

SECTION-B

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

5. (a) How can you distinguish efficiency from effectiveness in management? Give examples to support your answer. **(7)**
- (b) Mention Henry Fayol's 10 principles of management. Justify your views to apply these principles to a manufacturing firm in Bangladesh. **(10+8=18)**
- (C) Describe Henry Mintzberg's managerial roles. **(10)**
6. (a) Discuss four building blocks of an organization with reference to a steel manufacturing company in Bangladesh. **(12)**
- (b) Illustrate different types organizational structure with appropriate examples and diagrams. **(15)**
- (c) How can you distinguish narrow span of control from wide span of control? **(8)**
7. (a) Explain Hesrey and Blanchard's situational leadership model. **(10)**
- (b) Differentiate between the approaches of a manager and a leader. **(10)**
- (c) How can you link Abraham Mashlow's need theory to McGregor's theory X and theory Y? **(10)**
- (d) What is the contingency approach to management? **(5)**
8. (a) How does the Expectancy theory of motivation work in a web development firm? Explain in your own words. **(15)**
- (b) What do you understand by straight-day work and piece work? **(5)**
- (c) In a sweater manufacturing factory, a worker is given to produce 25 pieces of sweaters. The standard task for manufacturing sweater is 5pcs/hr and Guaranteed base rate is 65tk/hr. Low task would be 80% of the standard task. Percentage of the workers' share in gain above the task is 30%. If the worker takes 5hrs to complete the given task, according to Halsey's plan find- **(15)**
- (i) The wage for the job.
- (ii) The rate of incentive per hour for the worker.
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SECTION – A

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

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 sheets production. (22)
2. (a) Differentiate between linear polymer and branched polymer. (14)
(b) “Localized strengthening is important during tensile loading of a polymer”- explain. (5)
(c) Discuss the factors that influence the melting and glass transition temperatures of polymer. (16)
3. (a) Compare and contrast vacuum forming process with pressure forming process. (18)
(b) Why is crazing important to polymer? (10)
(c) Write a short note on liquid crystal polymer. (7)
4. (a) Select and outline a manufacturing process suitable for plastic bottle production. (18)
(b) What is structural foam injection molding? Why is structural foam injection molding preferred for plastic production? (10)
(c) Mention the role of vulcanization in enhancing mechanical properties of elastomers. (7)

SECTION-B

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

5. (a) Analyze the general differences in strengthening mechanism between large-particle and dispersion-strengthened particle-reinforced composites. (10)
(b) Examine and compare the suitability of using whiskers, fibres and wires as reinforcing particles and the degree of property improvement they infer to a composite. (15)
(c) Estimate the maximum and minimum thermal conductivity values for a cermet that contains 85 vol.% titanium carbide (TiC) particles in a cobalt (Co) matrix. Assume thermal conductivities of 27 and 69 W/m-K for TiC and Co, respectively. (10)

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6. (a) Analyze the stress distribution pattern in discontinuous fibre in different fibre-matrix conditions. (15)
- (b) Obtain a relation for the stress in composite reinforced with discontinuous fibre of critical length size and prove that the capability of a discontinuous fibre reinforced composite is lesser than that of continuous fibre reinforced composite. (20)
7. (a) Cite several reasons why fiberglass-reinforced composites are utilized extensively. Cite several limitations of these types of composites. (10)
- (b) What is hybrid composite? List two important advantages of hybrid composites over normal fibre composites. An aluminium-7Silicon-0.6Magnesium alloy (A357) is mixed with graphite and silicon carbide particles in a stir cast process. Examine and compare the expected improvement in properties of this hybrid composite over those of normal A357 alloy. (15)
- (c) Write an expression for the modulus of elasticity for a hybrid composite in which all fibre of both types are oriented in the same direction. Using this expression, compute the longitudinal modulus of elasticity of a hybrid composite consisting of aramid and glass fibre in volume fractions of 0.30 and 0.40, respectively, within a polyester resin matrix. The elastic modulus of polyester resin, aramid fibre and glass fibre are 2.5, 131 and 72.5 GPa, respectively. (10)
8. (a) Explain why bonding between carbon fibres and an epoxy matrix should be excellent, whereas bonding between silicon nitride fibres and a silicon carbide matrix should be poor. (10)
- (b) What is a nanocomposite? How can steels containing ferrite and martensite be described as composite? Explain. (7)
- (c) Discuss the manufacturing process of Kevlar fibre and SiC whisker. (18)
-

SECTION - A

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

1. (a) For a P-n junction describe how the width of the depletion region varies under the following condition. (25)
- (i) Forward Bias
- (ii) Reverse Bias
- (b) An abrupt Si p⁺ n junction diode has a cross-sectional area of 1 mm², an acceptor concentration of 5 × 10¹⁸ boron atoms cm⁻³ on the p-side and a donor concentration of 10¹⁶ arsenic atoms cm⁻³ on the n-side. The life time of holes in the n-region is 417ns, whereas that of electrons in the p-region is 5ns due to a greater concentration of impurities (recombination centers) on that side. Mean thermal generation life time (τ_g) is about 1 μs. The length of the p- and n- regions are 5 and 100 microns, respectively. (10)
- (i) Calculate the minority diffusion lengths and determine what type of a diode that is.
- (ii) What is the built-in potential across the junction.
- [Assume any missing data]
- [Hint: For drift mobility determination use Fig.1]
2. (a) Show that the Fermi energy in the intrinsic semiconductor can be given as (25)
- $$E_{Fi} = E_v + \frac{1}{2} E_g$$
- Where all the notations have their usual meanings.
- (b) Given that the density of states related effective masses of electrons and holes in Si are approximately 1.08 m_e and 0.60 m_e, respectively, and the electron and hole drift motilities at room temperature are 1350 and 450 cm²v⁻¹s⁻¹, respectively. Calculate the intrinsic concentration of Si. (10)
3. (a) Sketch the basic structure of a junction field effect transistor (JFET) and explain its I-V characteristics. (18)
- (b) For the JFET circuit shown in the Figure 2, V_p = 8.0 V and I_{DSS} = 12.0 mA. (12)
- (i) Determine the value of V_{DS} when pinch-off begins.
- (ii) If the gate is grounded, what is the value of I_D for V_{DD} = 12.0V when V_{DS} is above pinch-off?
- (c) Draw a typical I_D versus V_{DS} characteristics of an enhancement n-channel MOSFET device for V_{th} = 4V. (5)

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4. (a) Derive an equation that relates microscopic electronic polarization, α_e to the macroscopic relative permittivity ϵ_r . (18)
- (b) Consider a pure Si crystal that has $\epsilon_r = 11.9$. (17)
- (i) What is the electronic polarizability due to valence electrons per Si atom?
- (ii) Suppose that a Si crystal sample is electroded on opposite faces and has a voltage applied across it. By how much is the local field greater than the applied field?

$$\text{Given } \alpha_e = \frac{3\epsilon_0 \epsilon_r - 1}{N \epsilon_r + 1}$$

$$\text{and } E_{loc} = E + \frac{1}{3\epsilon_0} P$$

All symbols have their usual meanings. Assume any missing data.

SECTION-B

There are **EIGHT** questions in this section. Answer any **SIX**

5. (a) Define relaxation time for a free electron. 'A materials Engineer interested in controlling electrical conductivity should usually focus on controlling charge carrier density if working with non metals and on controlling mobility if working with metals.' – Explain. (17 ½)
6. State and prove Wiedemann-Franz law. (17 ½)
7. Briefly describe the use of tunneling effect in the scanning tunneling microscope. (17 ½)
8. What are the boundary condition often used in solving the Schrodinger equation? Draw the curve that depicts the relationship between stopping voltage and frequency of light in a photoelectric experiment. (17 ½)
9. Derive an expression for the density of states. (17 ½)
10. What do you understand by Fermi-Dirac function? Calculate the Fermi energy E_{FO} at 0K for copper and estimate the average speed of conduction electrons in Cu. The density of Cu is 8.96 g/cm^3 and the relative atomic mass is 63.5. (17 ½)
11. Describe briefly the E-K behavior of an electron inside a one dimensional crystal. (17 ½)
12. Derive the time independent Schrodinger equation for one dimension. (17 ½)

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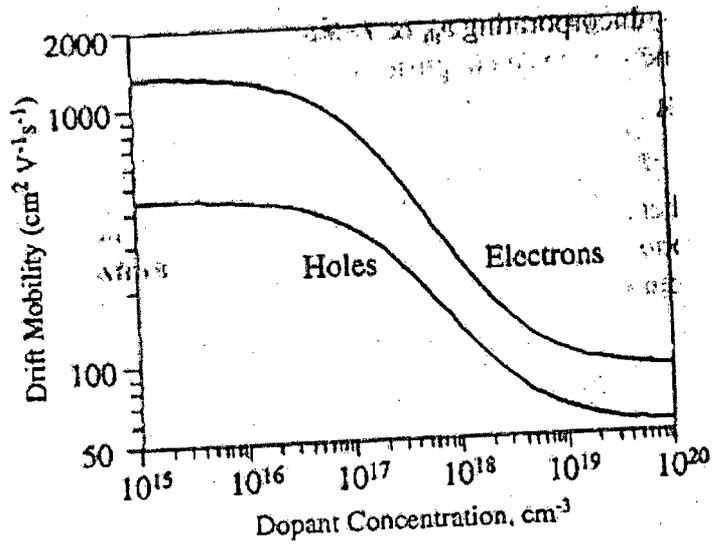


Figure 1 for Question No. 1b

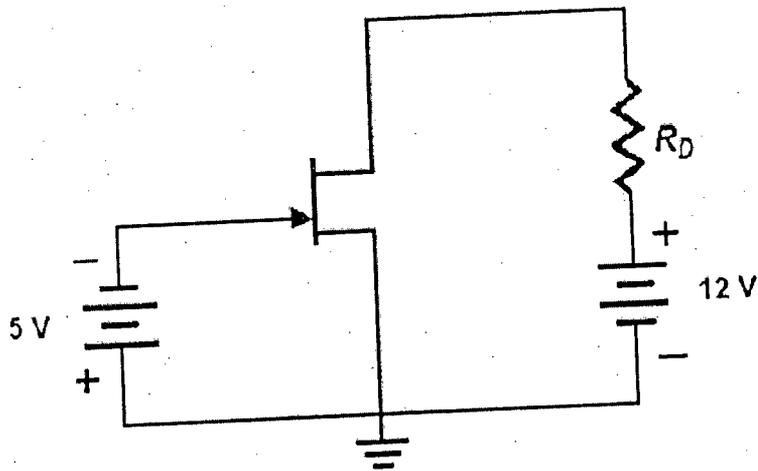


Figure 2 for Question No. 3b