L-4/T-1/MME **Date : 16/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2014-2015

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

The questions are of equal value.

1. Discuss the effect of niobium additions on various mechanical properties of steels. What are the effects of silicon on the strength of normalized and hardened structural steel bars?

2. Having relatively lower interstitial free space austenite can accommodate a very high level of carbon – why? Briefly discus the microstructural changes that take place when a hypereutectoid steel is slowly cooled from a high temperature (single phase γ) to room temperature.

3. For a particular application a 0.045% carbon steel plate is normalized following a standard heat treatment procedure. If the tensile strength of this steel after full annealing is 450 MPa, what will be the theoretical tensile and yield strength of the normalized steel plate? Use the graphical relationship presented in the figure for Q. No. 3 for any necessary information.

4. Discuss the effects of heating rate on the microstructures and properties of hardened steel part. A helical spring is made from a steel having the following chemical compositions:

   C : 0.9%, Mn : 2.0%, Si : 0.3%, Ni : 1.5% and Mo : 0.3%

   Calculate the austenitizing temperature for hardening heat treatment and also give suggestion whether preheating is necessary for the spring or not.

5. Briefly discuss the benefits of practice of continuous cooling over isothermal cooling for hardening of steel. An AISI 4140 steel (C : 0.4%, Mn : 0.75%, Si : 0.25%, Cr : 1.0%, Mo : 0.2%) is to be hardened to get retained austenite free microstructures. Given that the M_f temperature of the steel is 330°C lower than the M_s temperature. With the help of the CCT diagram of the steel given in the figure for Q. No. 5, design the heat treatment schedule for the basic requirement.

6. What are the benefits of vacuum carburizing over the conventional gas carburizing? Discuss various practical situations for selection of the four available heat treatment modules of hardening for carburized steel parts.

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7. Mention the limitations of surface hardening by induction process. A laser heater of 1.5 kW capacity with convergent lens is to be used for transformation hardening of a steel surface within a very short time (1 sec). The focal length, spot size and wave length of the laser beam are, respectively, 300 mm, 1.5 mm and 10 μm. With the help of the diagram presented in the figure for Q. No. 7 comment on the selection of this laser heater parameters for the targeted purpose. Also calculate laser beam size and M factor.

8. With the help of necessary diagrams discuss why selection of proper temperature and time is very important for successful nitriding operation.

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
The figures in the margin indicate full marks.

9. (a) Explain the term hardenability and the variables that control depth of hardening of steels. Using Grossmann's method, demonstrate how you would determine the hardenability of plain carbon steel. **(10+10=20)**

   (b) A gear made from 9310 steel, which has an as-quenched hardness at a critical location of HRC 40, wears at an excessive rate. Tests have shown that an as-quenched hardness of at least HRC 50 is required at that critical location. Select a steel that would be the most appropriate and cost-effective for this purpose and then design a quenching process to produce a minimum hardness of HRC 55 at the centre of a 1.5-in. diameter of a bar made of the selected steel. **(7+8=15)**

10. (a) What are austempered ductile irons? How are these irons manufactured? Compare and contrast the structures and properties obtained in ADIs with those obtained in quench an tempered ductile irons. **(3+5+12=20)**

    (b) Using suitable Al-Mg_2Si phase diagram, analyse the age hardening mechanism of Al-7Si-0.3Mg alloy. **(15)**

11. (a) Indicate the typical as-quenched microstructure of tool steels and discuss the types of transformations that take place during different stages of its tempering. **(11)**

    (b) With the help of schematic diagram, explain the variations in hardness of different tool and die steels tempering temperature. **(13)**

    (c) "Tool steels are always at least double tempered". Analyse this assertion. **(10)**

12. (a) What is a Jominy test and how is it performed? Examine critically the information one can muster from a Jominy end quench hardenability test. How do you apply such information in comparing hardenability of different heats of the same steel grade? **(4+8+8=20)**

    (b) Using neat sketch discuss the usefulness and limitations of Schaeffer's constitution diagram for stainless steels. **(5+10=15)**

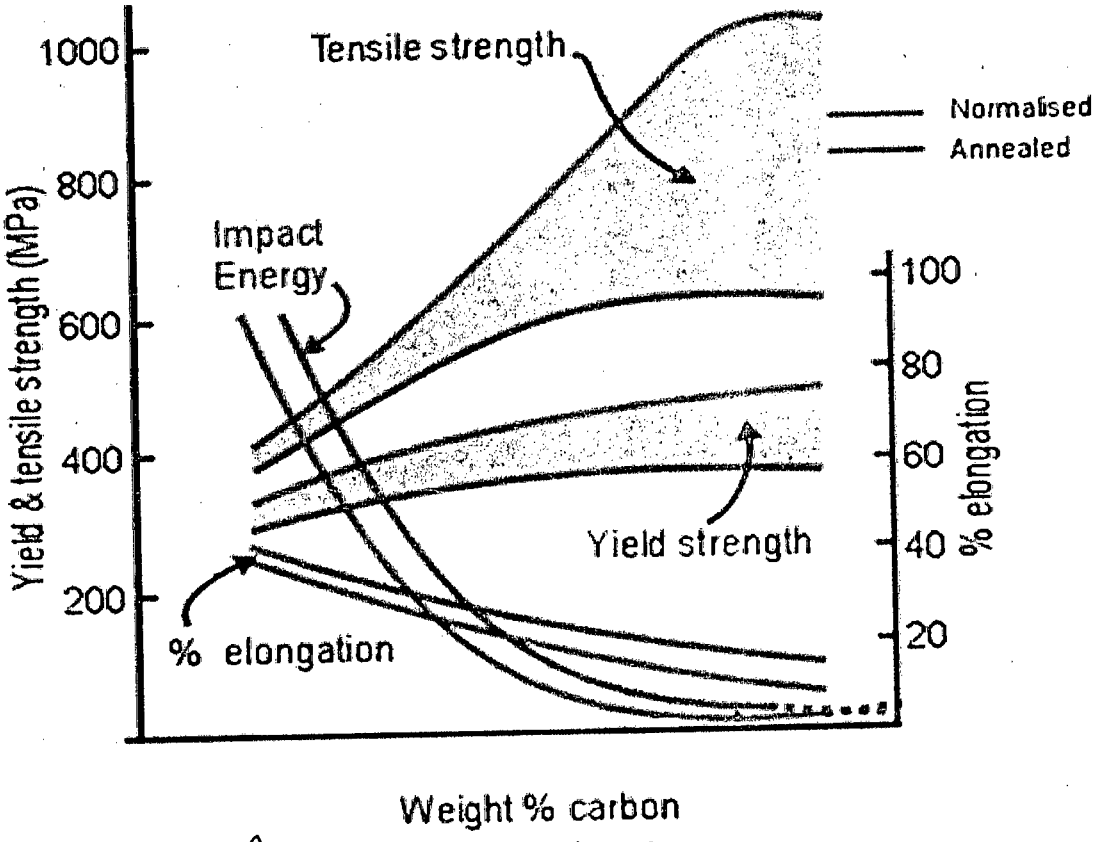


Figure for Question No. 3

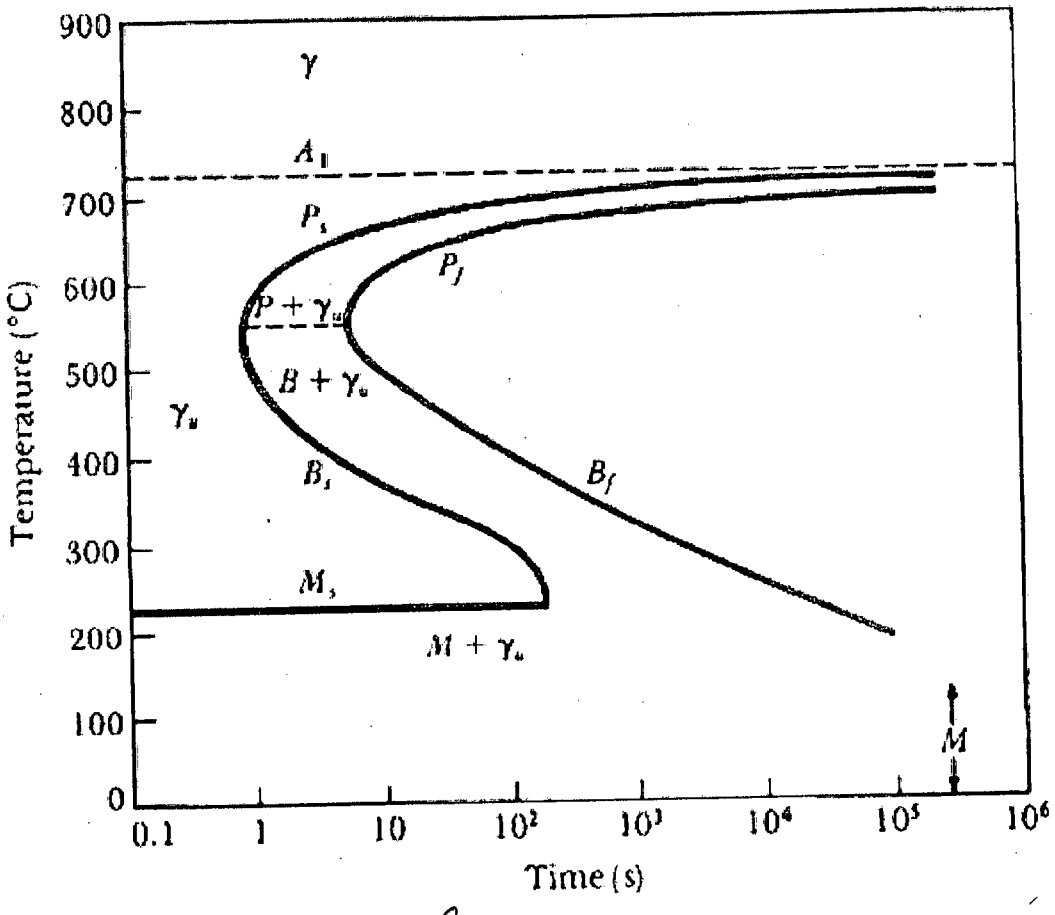


Figure for Question No. 5

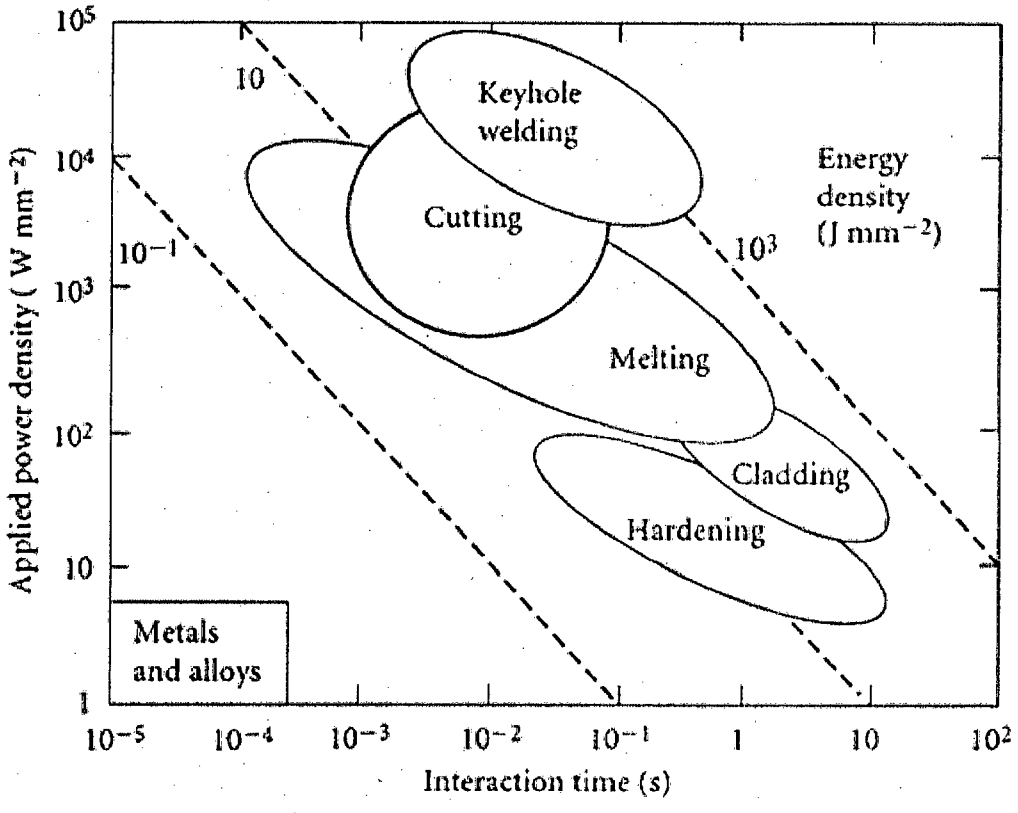


Figure for Question No.: 7

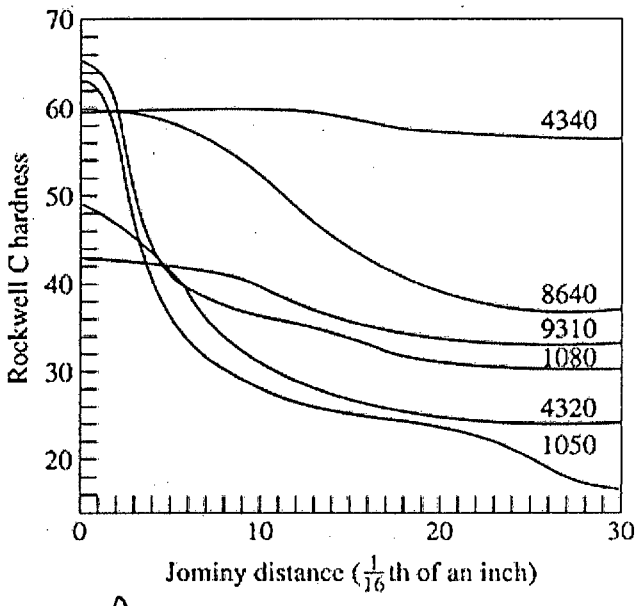
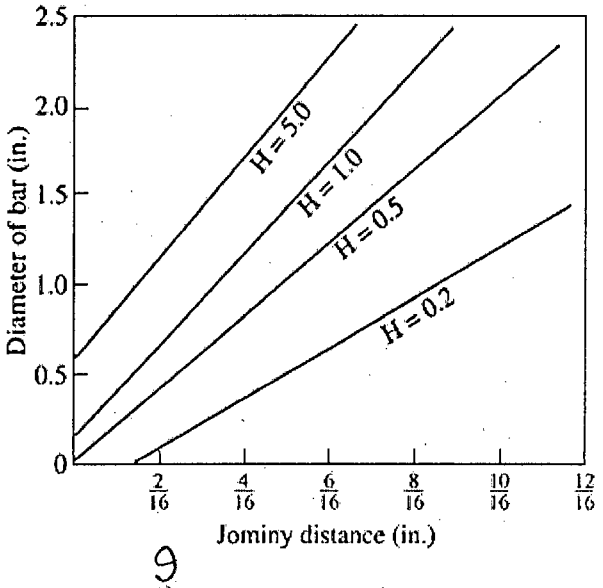


Fig 1 for Q.9(b): The hardenability curves for several steels



Quenching Medium	H Coefficient
Oil (no agitation)	0.25
Oil (agitation)	1.00
H_2O (no agitation)	1.00
H_2O (agitation)	4.00
Brine (no agitation)	2.00
Brine (agitation)	5.00

Fig 2 for Q.9(b): The Grossman chart for determining the hardenability at the centre of a steel bar for different quenchant medium

Table 1 for Q.9(b): Chemical composition of selected AISI-SAE steels

AISI-SAE No.	%C	Mn%	%Ni	%Cr	% Others
1050	0.48 – 0.55	0.60 – 0.90			
1080	0.75 – 0.88	0.60 – 0.90			
4320	0.17 – 0.22	0.45 – 0.65	1.65 – 2.00	0.40 – 0.60	0.20 – 0.30 Mo
4340	0.38 – 0.43	0.60 – 0.80	1.65 – 2.00	0.70 – 0.90	0.20 – 0.30 Mo
8640	0.38 – 0.43	0.75 – 1.00	0.40 – 0.70	0.40 – 0.60	0.15 – 0.25 Mo
9310	0.08 – 0.13	0.45 – 0.65	3.00 – 3.50	1.00 – 1.40	0.08 – 0.15 Mo

L-4/T-1/MME **Date : 20/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2014-2015

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) Define dependent and independent demand. Why accurate demand forecasting of a product is very important for the concerned business organization? **(4+6)**

   (b) Define adaptive forecasting concept. Explain different types of trend. **(5+5)**

   (c) The exponentially smoothed forecast for the month of July was 8540 units. Trend effect for July was 320 units. But, the actual demand turned out to be 9020 units. Calculate forecast including trend for the month of August ($\alpha = 0.70$, $\delta = 0.40$). **(15)**

2. (a) Briefly discuss purposes of inventory. **(8)**

   (b) Differentiate fixed order and fixed time period inventory models. **(7)**

   (c) Production plan of Product "Z" is developed based on quarterly forecasted demand. Past demand data are used to predict the future demand. The actual sales of a product for the last 12 quarters are as follows: **(20)**

Year 2013	Sales	Year 2014	Sales	Year 2015	Sales
1st Quarter	550	1st Quarter	1090	1st Quarter	1890
2nd Quarter	520	2nd Quarter	1240	2nd Quarter	1980
3rd Quarter	740	3rd Quarter	1480	3rd Quarter	2240
4th Quarter	920	4th Quarter	1620	4th Quarter	2460

   Predict the demand of the product in each quarter of the year 2016 using linear regression technique.

3. (a) Describe the human resource planning process including its importance. **(10)**

   (b) Determine the expected project completion time, critical path, slack time for each activity, and the probability to complete the project within 80 days for the following information: **(25)**

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Contd ... Q. No. 3(b)

Activity	Immediate Predecessor	Minimum Time (Weeks)	Average Time (Weeks)	Maximum Time (Weeks)
A	None	6	8	11
B	None	9	12	15
C	A	5	7	9
D	B	3	5	8
E	C, D	5	7	9
F	C, D	10	12	14
G	E	4	7	10
H	F	6	8	10
I	A, B	20	24	30
J	G, I	8	11	14
K	G, J	4	6	8
L	J, K	5	8	11
M	L	5	7	9
N	L	7	10	13

4. (a) The per unit purchase price of a product varies with the order size. In XYZ company Ltd., the consumption rate of Product "D" is 3500 per week. The holding cost of the product is 0.5% of the cost per unit. The ordering cost is Tk. 25000 to carry out each order. The per unit purchase price is as follows: Tk. 600 if the order size is 0 to 10000 units, Tk. 575 if the order size is 10001 to 14000 units, Tk. 550 if the order size is more than 14000 units. Lead time is 6 days. Determine the re-order point and the economic order quantity. **(15)**

(b) Show different inventory costs curve and prove that $Q_{opt} = \sqrt{\frac{2DS}{H}}$, where the symbols have their usual meaning. **(4+8)**

(c) Why it is important to know the critical path of a project before implementing the project? What information is needed to determine the critical path of a project? **(5+3)**

SECTION – B

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

5. (a) What are the essential functions of a manager? **(8)**

(b) What are different managerial levels? Explain which skills are essential at each of those levels. **(12)**

(c) Explain the strategic management process. **(15)**

Contd P/3

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6. (a) Define "Contingency Approach" of management. **(7)**

   (b) What are the five forces that determine the long-run attractiveness of a market segment? Explain with suitable example. **(10)**

   (c) Suppose, you want to buy a new mobile phone for your daily use. Select the best alternative using the decision making process. **(18)**

7. (a) Explain S-curve of technological progress. **(10)**

   (b) What is expectancy theory? How will an individual feel motivation according to this theory? **(10)**

   (c) Define leader and leadership. Explain Fiedler's contingency model of leadership. **(15)**

8. (a) Explain the importance of line balancing. **(5)**

   (b) The estimated weekly demand of a product is 5000 units. The manufacturing plant will operate 16 hours per day and 6 days a week. The list of the processes required and time required to complete each process is given below: **(22)**

Process	Immediate Predecessor	Time (Sec)
A	None	50
B	None	10
C	A, B	40
D	A, B	25
E	C, D	26
F	C, D	40
G	E, F	25
H	E, F	36
I	A, B	60
J	G, I	20
K	G, J	25
L	J, K	15

   Determine the minimum number of workstations required, assign the processes to the workstations, and calculate the line efficiency.

   (c) Explain the significance of orientation and socialization for the career development of a newly selected employee. **(8)**

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.50000	.50399	.50798	.51197	.51595	.51994	.52392	.52790	.53188	.53586
0.1	.53983	.54380	.54776	.55172	.55567	.55962	.56356	.56749	.57142	.57535
0.2	.57926	.58317	.58706	.59095	.59483	.59871	.60257	.60642	.61026	.61409
0.3	.61791	.62172	.62552	.62930	.63307	.63683	.64058	.64431	.64803	.65173
0.4	.65542	.65910	.66276	.66640	.67003	.67364	.67724	.68082	.68439	.68793
0.5	.69146	.69497	.69847	.70194	.70540	.70884	.71226	.71566	.71904	.72240
0.6	.72575	.72907	.73237	.73565	.73891	.74215	.74537	.74857	.75175	.75490
0.7	.75804	.76115	.76424	.76730	.77035	.77337	.77637	.77935	.78230	.78524
0.8	.78814	.79103	.79389	.79673	.79955	.80234	.80511	.80785	.81057	.81327
0.9	.81594	.81859	.82121	.82381	.82639	.82894	.83147	.83398	.83646	.83891
1.0	.84134	.84375	.84614	.84849	.85083	.85314	.85543	.85769	.85993	.86214
1.1	.86433	.86650	.86864	.87076	.87286	.87493	.87698	.87900	.88100	.88298
1.2	.88493	.88686	.88877	.89065	.89251	.89435	.89617	.89796	.89973	.90147
1.3	.90320	.90490	.90658	.90824	.90988	.91149	.91309	.91466	.91621	.91774
1.4	.91924	.92073	.92220	.92364	.92507	.92647	.92785	.92922	.93056	.93189
1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-3.9	.00005	.00005	.00004	.00004	.00004	.00004	.00004	.00004	.00003	.00003
-3.8	.00007	.00007	.00007	.00006	.00006	.00006	.00006	.00005	.00005	.00005
-3.7	.00011	.00010	.00010	.00010	.00009	.00009	.00008	.00008	.00008	.00008
-3.6	.00016	.00015	.00015	.00014	.00014	.00013	.00013	.00012	.00012	.00011
-3.5	.00023	.00022	.00022	.00021	.00020	.00019	.00019	.00018	.00017	.00017
-3.4	.00034	.00032	.00031	.00030	.00029	.00028	.00027	.00026	.00025	.00024
-3.3	.00048	.00047	.00045	.00043	.00042	.00040	.00039	.00038	.00036	.00035
-3.2	.00069	.00066	.00064	.00062	.00060	.00058	.00056	.00054	.00052	.00050
-3.1	.00097	.00094	.00090	.00087	.00084	.00082	.00079	.00076	.00074	.00071
-3.0	.00135	.00131	.00126	.00122	.00118	.00114	.00111	.00107	.00104	.00100
-2.9	.00187	.00181	.00175	.00169	.00164	.00159	.00154	.00149	.00144	.00139
-2.8	.00256	.00248	.00240	.00233	.00226	.00219	.00212	.00205	.00199	.00193
-2.7	.00347	.00336	.00326	.00317	.00307	.00298	.00289	.00280	.00272	.00264
-2.6	.00466	.00453	.00440	.00427	.00415	.00402	.00391	.00379	.00368	.00357
-2.5	.00621	.00604	.00587	.00570	.00554	.00539	.00523	.00508	.00494	.00480
-2.4	.00820	.00798	.00776	.00755	.00734	.00714	.00695	.00676	.00657	.00639
-2.3	.01072	.01044	.01017	.00990	.00964	.00939	.00914	.00889	.00866	.00842
-2.2	.01390	.01355	.01321	.01287	.01255	.01222	.01191	.01160	.01130	.01101
-2.1	.01786	.01743	.01700	.01659	.01618	.01578	.01539	.01500	.01463	.01426
-2.0	.02275	.02222	.02169	.02118	.02068	.02018	.01970	.01923	.01876	.01831
-1.9	.02872	.02807	.02743	.02680	.02619	.02559	.02500	.02442	.02385	.02330
-1.8	.03593	.03515	.03438	.03362	.03288	.03216	.03144	.03074	.03005	.02938
-1.7	.04457	.04363	.04272	.04182	.04093	.04006	.03920	.03836	.03754	.03673
-1.6	.05480	.05370	.05262	.05155	.05050	.04947	.04846	.04746	.04648	.04551
-1.5	.06681	.06552	.06426	.06301	.06178	.06057	.05938	.05821	.05705	.05592
-1.4	.08076	.07927	.07780	.07636	.07493	.07353	.07215	.07078	.06944	.06811
-1.3	.09680	.09510	.09342	.09176	.09012	.08851	.08691	.08534	.08379	.08226
-1.2	.11507	.11314	.11123	.10935	.10749	.10565	.10383	.10204	.10027	.09853
-1.1	.13567	.13350	.13136	.12924	.12714	.12507	.12302	.12100	.11900	.11702
-1.0	.15866	.15625	.15386	.15151	.14917	.14686	.14457	.14231	.14007	.13786
-0.9	.18406	.18141	.17879	.17619	.17361	.17106	.16853	.16602	.16354	.16109
-0.8	.21186	.20897	.20611	.20327	.20045	.19766	.19489	.19215	.18943	.18673
-0.7	.24196	.23885	.23576	.23270	.22965	.22663	.22363	.22065	.21770	.21476
-0.6	.27425	.27093	.26763	.26435	.26109	.25785	.25463	.25143	.24825	.24510
-0.5	.30854	.30503	.30153	.29806	.29460	.29116	.28774	.28434	.28096	.27760
-0.4	.34458	.34090	.33724	.33360	.32997	.32636	.32276	.31918	.31561	.31207
-0.3	.38209	.37828	.37448	.37070	.36693	.36317	.35942	.35569	.35197	.34827
-0.2	.42074	.41683	.41294	.40905	.40517	.40129	.39743	.39358	.38974	.38591
-0.1	.46017	.45620	.45224	.44828	.44433	.44038	.43644	.43251	.42858	.42465
-0.0	.50000	.49601	.49202	.48803	.48405	.48006	.47608	.47210	.46812	.46414

L-4/T-1/MME **Date : 26/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **MME 411** (Principles of Materials Characterization)

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) Does an atom of atomic number z (atom contains z electrons) scatter a wave whose amplitude is z times the amplitude of the wave scattered by a single electron? Justify your answer. **(10)**

   (b) If diffraction peaks of a crystalline solid shift to high 2θ by the internal stress, is this a tensile or compressive stress? **(3)**

   (c) A 0.95% carbon steel was quenched in brine solution and microstructure revealed martensite (α) and austenite (γ). An XRD test was carried out to quantify the phases and following data were obtained from the pattern. **(22)**

   $2\theta_{\alpha(211)} = 35.5°$; $2\theta_{\gamma(311)} = 39.8°$

   $I_{\gamma(211)} = 51$ unit; $I_{\gamma(311)} = 79$ unit

   X-ray radiation used $\lambda_{MoK\alpha} = 0.710730$ Å

   Calculate the weight fraction of the martensite and austenite using comparison method (Required data are given in Table 1 to 3 and Fig. 1).

2. (a) What is Ewald sphere? Explain the formation of diffraction patterns from a single crystal by Ewald sphere. **(12)**

   (b) Compare transmission electron microscopy (TEM) and scanning electron microscopy (SEM) in terms of optical arrangement, illumination source, working environment and image formation mechanism. **(20)**

   (c) How will you prepare a ceramic sample for SEM investigation? **(3)**

3. (a) An SEM image with composition contrast shows bright and dark areas. Which one of these contains heavy metallic element? Defend your selection. **(5)**

   (b) Why is acceleration voltage increased to obtain better resolution in SEM? Is there any negative effect of increasing acceleration voltage on SEM image? **(10)**

   (c) You need to analyse and identify carbide precipitates in a low-alloy, high-strength steel in TEM. Explain how you will prepare the sample for TEM investigation. **(8)**

   (d) Explain the selected area method that is used to analyse the carbide precipitate crystal structure in TEM. **(12)**

Contd P/2

MME 411

4. (a) Briefly discuss the working principle of an atomic force microscope. **(10)**

   (b) How does X-ray spectroscopy method differs from X-ray diffraction method? **(5)**

   (c) Explain an X-ray spectroscopy method that is used to determine the bulk composition of a metallic/ceramic sample. **(10)**

   (d) Discuss how phases are identified by using compositional mapping in an electron microscope. **(10)**

SECTION – B

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

5. (a) Compare and contrast between Auger electron process and X-ray photoelectron process for surface elemental analysis. **(20)**

   (b) Describe the significance of chemical shift in elemental analysis. **(8)**

   (c) Mention the advantages of SIMS over electron spectroscopy. **(7)**

6. (a) Classify the basic types of molecular vibration with neat sketches. **(9)**

   (b) Describe the working principle of Infrared spectroscopy. **(9)**

   (c) Explain the differences between stokes and anti-stokes Raman spectra and where you find these transitions. **(9)**

   (d) State some common application of Raman spectroscopy. **(8)**

7. (a) Briefly describe the principles in Differential Scanning Calorimetry (DSC). **(12)**

   (b) Draw a schematic diagram of the setup of the temperature sensors and heaters in a DSC. **(10)**

   (c) Draw a typical Thermogravimetry (TG) curve and what information are obtainable from the TG curve. **(13)**

8. (a) Discuss the reflection and refraction of ultrasound at an interface. **(10)**

   (b) What are the advantages and disadvantages of eddy current testing over other NDT methods? **(13)**

   (c) How can you detect a surface crack using magnetic particle inspection (MPI)? **(12)**

Table 1: Some compounds and solid solutions (for Question 1c)

Substance	Type of structure	Lattice parameters (A)	Spacing of cleavage planes (A)
NaCl KCl AgBr	FCC, B1 FCC, B1 FCC, B1	a = 5.639 a = 6.290 a = 5.77	2.820
CaF_2 (fluorite)	FCC, C1	a = 5.46	
$CaCO_3$ (calcite)	Rhombohedral, G1	a = 6.37 α = 46.1°	3.036
SiO_2 (α-quartz)	Hexagonal, C8	a = 4.90 c = 5.39	
$H_2KAl_2(SiO_4)_3$ (mica, muscovite)	Monoclinic	a = 5.18 b = 8.96 c = 20.15 β = 98.6°	10.08
Fe_3C (cementite)	Orthorhombic	a = 4.525 b = 5.088 c = 6.740	
Austenite	FCC, A1	a = 3.555 + 0.044x (x = weight percent carbon)	
Martensite	BC Tetragonal	a = 2.867 − 0.013x c = 2.867 + 0.116x (x = weight percent carbon)	

Table 2: Multiplicity factors (for Question 1c).

Cubic:	hkl	hhl	$0kl$	$0kk$	hhh	$00l$	
	48*	24	24*	12	8	6	
Hexagonal and Rhombohedral:	$hk\cdot l$	$hh\cdot l$	$0k\cdot l$	$hk\cdot 0$	$hh\cdot 0$	$0k\cdot 0$	$00\cdot l$
	24*	12*	12*	12*	6	6	2
Tetragonal:	hkl	hhl	$0kl$	$hk0$	$hh0$	$0k0$	$00l$
	16*	8	8	8*	4	4	2
Orthorhombic:	hkl	$0kl$	$h0l$	$hk0$	$h00$	$0k0$	$00l$
	8	4	4	4	2	2	2
Monoclinic:	hkl	$h0l$	$0k0$				
	4	2	2				
Triclinic:	hkl						
	2						

Table 3: Atomic scattering factor (for Question 1c)

$\frac{\sin\theta}{\lambda}$ (Å^{-1})	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2
Fe	26	23.1	18.9	15.6	13.3	11.6	10.2	8 9	7.9	7.0	6.3	5.7	5.2
Co	27	24.1	19.8	16.4	14.0	12.1	10.7	9.3	8.3	7.3	6.7	6.0	5.5
Ni	28	25.0	20.7	17.2	14.6	12.7	11.2	9.8	8.7	7 7	7.0	6.3	5.8
Cu	29	25.9	21.6	17.9	15.2	13.3	11.7	10.2	9.1	8.1	7.3	6.6	6.0
Zn	30	26.8	22.4	18.6	15.8	13.9	12.2	10.7	9.6	8.5	7.6	6.9	6.3

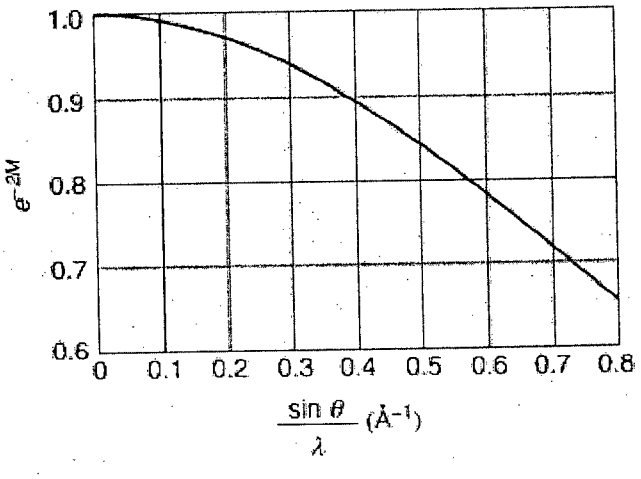

Figure 1: Temperature factor (e^{-2M}) is a function of diffraction angle and wavelength (for Question 1c)

L-4/T-1/MME **Date : 31/07/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **MME 475** (Polymers and Composites)

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) Outline the main features of injection molding process with an aid of injection molding cycle. **(13)**

   (b) Design and describe an injection molding manufacturing process suitable for PVC plastic production. **(22)**

2. (a) Differentiate between syndiotactic polymer and isotactic polymer. **(14)**

   (b) "Localized strengthening is important during tensile loading of a polymer" – explain. **(5)**

   (c) Discuss the factors that influence the mechanical properties of semicrystalline polymers. **(16)**

3. (a) Compare and contrast addition polymerization with condensation polymerization. **(18)**

   (b) Why impact and fatigue testing are beneficial to polymer. **(10)**

   (c) Write a short note on thermoplastic elastomer. **(7)**

4. (a) Select and outline a manufacturing process suitable for plastic film production. **(18)**

   (b) What is sandwich injection molding? Why is sandwich injection molding preferred for plastic production? **(10)**

   (c) Mention the importance of venting zone in an extruder. **(7)**

SECTION – B

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

The questions are of equal value.

5. What do you understand by the term "hybrid laminate"? Ceramic matrix composite development is not advancing as fast as polymer matrix composite" – discuss.

6. With necessary sketches compare and contrast the production processes of metal matrix composite by melt stirring and liquid melt infiltration (via gas pressure) techniques.

Contd P/2

MME 475

7. Composite produced by spray-up method should be rolled – why? Mention the basic differences between SMC and DMC of matched die moulding.

8. What is polymer pyrolysis in CMC production? Discuss the major advantages and disadvantages of reaction bonding process for the production of ceramic matrix composites.

9. What do you understand by the term "continuous fiber reinforced composites"? For continuous fiber composites in isostrain condition prove that $E_C = V_\alpha E_\alpha + V_\beta E_\beta$. All symbols have their usual meanings.

10. Discuss the stress distribution over the length of fiber in a composite when the fiber length is smaller than the critical length and also prove that

$$V_{cri} = \left[(T.S)_m - \sigma_m \varepsilon_f\right] / \left[(T.S)_f + (T.S)_m - \sigma_m \varepsilon_f\right]$$

11. Discuss the creep deformation behaviour of continuous and discontinuous fiber reinforced composite.

12. What is the usual mechanism of fatigue failure of thermoplastic polymer composites? Discuss the possible ways to enhance the fatigue properties of polymer composites.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2014-2015

Sub : **MME 323** (Physical Properties of Materials)

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) Demonstrate the splitting of outer shell electronic states of Si atom as a function of interatomic distance with a schematic diagram. State the possible number of occupied and empty states before and after splitting assuming that there is only one gram-mole of Si with periodic atomic arrangement. **(15)**

   (b) Determine the relative effective mass (M^*/M_0) of conduction band electron within a crystal lattice having a lattice parameter a = 10Å. Assume that the electronic state of the conduction band follow a parabolic E vs K relationship; where **(20)**

   $$E\ (K = \pm \pi/a) = E_c + 0.32\ (eV)$$

   and $$E\ (K = 0) = E_c\ (eV)$$

   Given that: $M_0 = 9.11 \times 10^{-31}$ kg; $\hbar = 1.054 \times 10^{-34}$ J-s; 1 eV = 1.6×10^{-19} J.

2. (a) Show that the equilibrium concentration of holes within the limit of Boltzman approximation can be give as, **(20)**

   $$P = N_V \cdot \exp\left[\frac{E_V - E_F}{K_B T}\right]$$

   where all the notations have their usual meanings.

   (b) If no more than 2% dispersion between the Fermi-Dirac distribution function and its Boltzman approximation is allowed, then what is the minimum energy difference in terms of K_BT between the Fermi Level (E_F) and the lower edge of the conduction band (E_C) for which the general equilibrium expression of conduction band electron concentration is valid. **(15)**

3. (a) State (with appropriate examples) the basic differences between, (i) Direct and Indirect bandgap semiconductors (ii) Intrinsic and Extrinsic semiconductors. **(10)**

   (b) Prove that (with appropriate expression), all extrinsic semiconductors either p-type or n-type transform into intrinsic semiconductors at high temperatures. **(10)**

   (c) Say 'Ge' is doped with 'As' with a bulk concentration of 10^{22} cm^{-3}. Now show that, nearly 100% of the donor atoms get ionized at 300 K. Given that 'As' forms donor states 0.0127 eV below the conduction band edge (E_C) and the effective density of states of the conduction band can be given by, $N_C = CT^{3/2}$ with $C = 4.83 \times 10^{21}$ in MKS unit. **(15)**

Contd P/2

MME 323

4. (a) Show that equilibrium hole concentration in an n-type compensated semiconductor is given by; **(15)**

$$P = n_i^2 \left\{ \frac{N_d - N_a}{2} + \sqrt{\left(\frac{N_d - N_a}{2} \right)^2 + n_i^2} \right\}^{-1}$$

where, P = equilibrium hole concentration

N_d = donor concentration

N_a = acceptor concentration

n_i = intrinsic carrier concentration

(b) A silicon semiconductor at 300 K is initially doped with donor at a concentration of $N_d = 5 \times 10^{15}$ cm^{-3}. Acceptors are to be added to form p-type material. This material is to have a resistance R = 10 kΩ and handle a current density j = 50 $A.cm^{-2}$ when 5 V is applied. Here 5 V generates an electric field of strength 100 $V.m^{-1}$ along the length of the material and the variation in hole mobility (μ_p) with total dopant or impurity concentration ($N_a + N_d$) is depicted in Figure 1. **(20)**

Find out the acceptor concentration (N_a) required to attain the given current-voltage response in case of the p-type material.

[Hint: First determine the conductivity of the p-type material and equal it with $\mu_p.e.(N_a - N_d)$. Then find out the appropriate combination of μ_p and N_a which satisfy the equation through trial and error. Please note that you can get the μ_p value from Figure 1 for a given value of impurity concentration ($N_a + N_d$), where N_a is needed to be set arbitrarily and N_d is already given.]

SECTION – B

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

5. (a) Define drift velocity, mobility and relaxation time for free electron. Derive the expression for conductivity of metals. **(25)**

(b) The mobility of electron in copper is 3×10^{-3} m^2/vs. Assume $e = 1.6 \times 10^{-19}$ C and $m_e = 9.1 \times 10^{-31}$ kg. Calculate the mean free time. **(10)**

6. (a) Outline the various drawbacks of classical free electron theory of metals. **(12)**

(b) Derive the three-dimensional Schrödinger's time dependent wave equation. **(23)**

Contd P/3

MME 323

7. (a) Illustrate the physical significance of wave function. **(10)**

   (b) State and prove Wiedmann-Franz Law. **(17)**

   (c) Why does Lorentz number determined experimentally does not agree with the value calculated from the classical theory? **(8)**

8. (a) Derive an expression for the density of states. **(20)**

   (b) Calculate Fermi energy and Fermi temperature in a metal. The Fermi velocity, V_F of electrons in the metal is 0.86×10^6 m/s. Given $K_B = 1.38 \times 10^{-23}$ J/K. Each term expresses their usual meaning. Assume any missing data. **(15)**

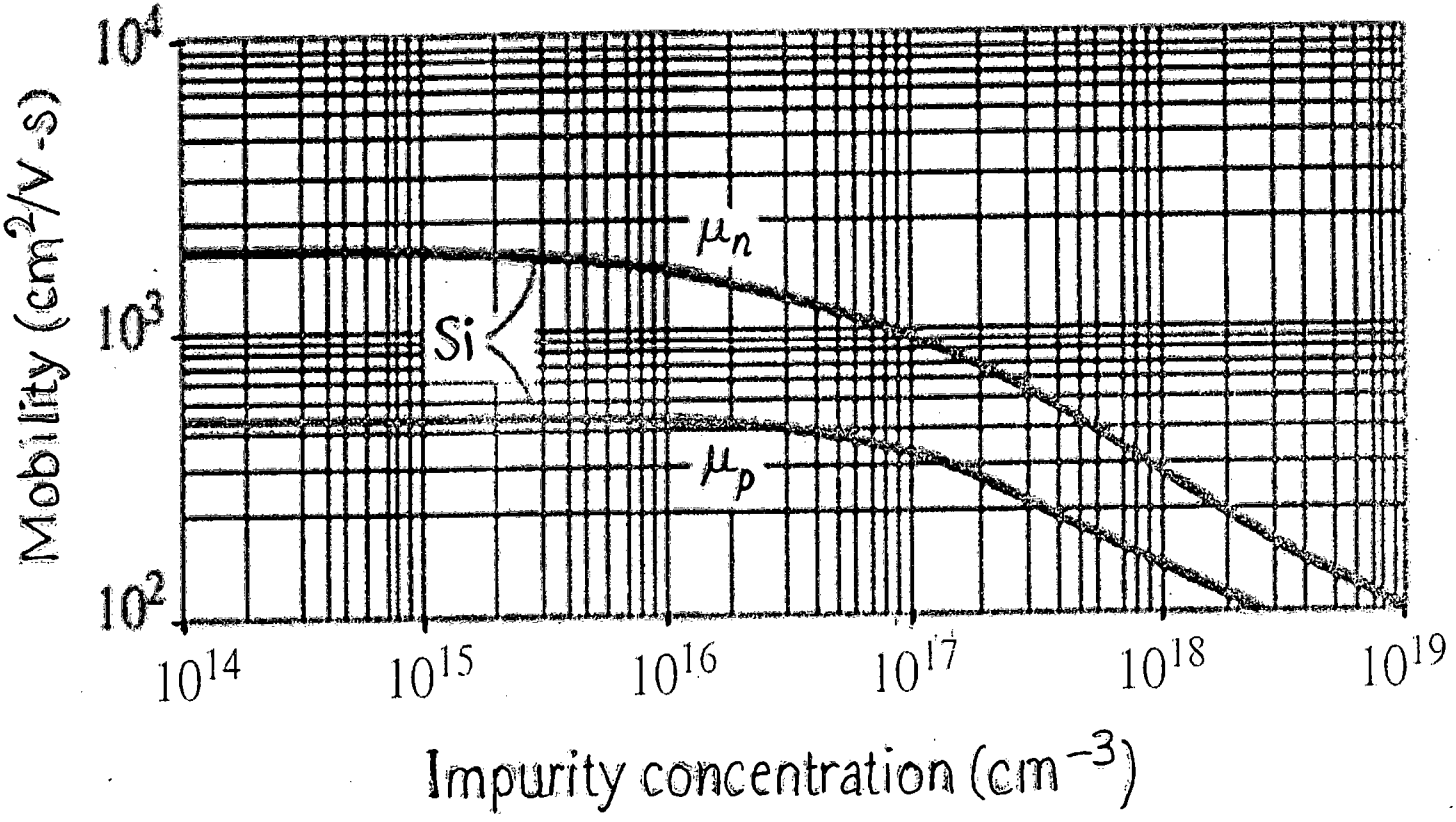

Figure - 1 for question 4(b)