Kafer El-Sheikh University
Faculty of Engineering
Mechanical Engineering Departmen
Examiner: Dr. Mahmoud Tash (Cairo University-Engineering-Metallurgy)

1st year Mechanical Engineering, 2017/2018
MDP 1104 : Metallurgy
Time allowed: 3 h

Model Answer

Final-Exam (75 points)

Answer the following Questions (*N.B. Please write the correct answer (A, B, C, D) in the answer box for Q1-Q4 and fill the space in Q5 and draw cooling curve and microstructure for part E in Q 5. All Answer must be re-written in Page No. 6*)

Q1: (10 pt) Crystal Structure and Phase Diagram

	Ans.
1. Number of atoms per unit cell in FCC is -------- a) 2 b) 4 c) 6 d) 8	B
2. Atomic packing factor in BCC a) 0.2 b) 0.74 c) 0.68 d) 0.8	C
3. Relationship between a and r in BCC is ---- a) $r=a*\sqrt{3}$ b) $4*r=a*\sqrt{2}$ c) $4*r=a*2$ d) $4*r=a*\sqrt{3}$	D
4. In Figure 1 below, Direction A is -----a) [100] b) [110] c) [1'2'2] d) [111]	B
5. In Figure 1 below, Direction B is ----- a) [100] b) [110] c) [1'2'2] d) [111]	D
6. In Figure 1 below, Direction C is ----- a) [100] b) [110] c) [1'2'2] d) [111]	C
7. In Figure 2 below, Plane A is -----a) (210) b) (110) c) (111) d) (01'0)	C
8. In Figure 2 below, Plane B is -----a) (210) b) (110) c) (111) d) (01'0)	A
9. In Figure 2 below, Plane C is -----a) (210) b) (110) c) (111) d) (01'0)	D
10. Iron has a density of 7.87 gm/cm3 [At. Wt. of Fe=55.85, A.N.= 0.6002x10 24]. The atomic radius is -------a) r=2.24 Å b) r=3.24 Å c) r=1.24 Å d) r=0.24 Å (1 pt.)	C
11. Iron has a lattice parameter of 0.2866 nm [At. Wt. of Fe=55.85, A.N.= 0.6002x1024] . The Density of iron is------ a) 7.882 gm/cm3 b) 7.1 gm/cm3 c) 9 gm/cm3 d) 6 gm/cm3 (1 pt.)	A
12. The atomic radius of BCC tungsten is 1.4 Å [At. wt = 183.8 g/g.mole, A.N.= 0.6002x1024]. The density of tungsten is ---a) 14 gm/cm3 b) 18.3 gm/cm3 c) 9 gm/cm3 d) 16 gm/cm3 (1 pt.)	B

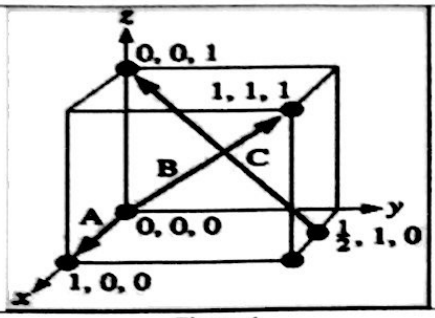


Figure 1

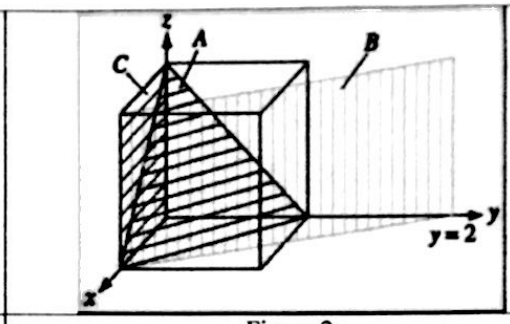


Figure 2

Q2: (20 pt) Phase Diagram & Fe-Fe_3C PHASE DIGRAM (Use Figure 3 & Figure 4)

	Ans.
1. The amount of liquid in comparison with solid (amount of L: amount of S) that forms if a 20%Cu-80%Ni alloy is heated to 1200 C is (a). 0:100 (b) 100:0 (c) 50: 50 (d) 75:25	A
2. The amount of liquid in comparison with solid (amount of L: amount of S) that forms if a 20%Cu-80%Ni alloy is heated to 1400 C is (a). 0:100 (b) 100:0 (c) 50: 50 (d) 75:25	C
3. The amount of liquid in comparison with solid (amount of L: amount of S) that forms if a 50%Cu-50%Ni alloy is heated to 1200 C is (a). 0:100 (b) 100:0 (c) 50: 50 (d) 75:25	A
4. The amount of liquid in comparison with solid (amount of L: amount of S) that forms if a 50%Cu-50%Ni alloy is heated to 1400 C is (a). 0:100 (b) 100:0 (c) 50: 50 (d) 75:25	B
5. The amount of liquid in comparison with solid (amount of L: amount of S) that forms if a 70%Cu-30%Ni alloy is heated to 1200 C is (a). 0:100 (b) 100:0 (c) 50: 50 (d) 75:25	C
6. The amount of liquid in comparison with solid (amount of L: amount of S) that forms if a 70%Cu-30%Ni alloy is heated to 1400 C is (a). 0:100 (b) 100:0 (c) 50: 50 (d) 75:25	B

7. The pearlite structure obtained in the eutectoid steel in Fe-C diagram contains 88% Fe3C & 12% ferrite at room Temperature. (a) True (b) False	B
8. The amount of phases of alloy contains 0.2% C after equilibrium cooling to room temperature is 90% ferrite+ 10% austenite : a) True (b) False	B
9. The amount of phases of alloy contains 0.4% C after equilibrium cooling to room temperature is 94%austenite + 6% ferrite: a) True (b) False	B
10. The amount of phases present in the alloy contains 0.8%C after equilibrium cooling to room temperature is :- (a) 60% martensite& 40% ferrite (b) 88% ferrite& 12% Fe_3C (c)80% austenite & 20% ferrite (d) 94% Fe_3C & 6% ferrite	B
11. The amount of phases present in the alloy contains 1.2%C after equilibrium cooling to room temperature is :- (a) 94% martensite & 6% ferrite (b) 82% ferrite& 18% Fe_3C (c) 80% austenite & 20% ferrite (d) 82 Fe_3C & 18% ferrite	B
12. The amount of phases present in the alloy contains 1.2%C after equilibrium cooling to room temperature is :- (a) 94% martensite & 6% ferrite (b) 82% ferrite& 18% Fe3C (c) 80% austenite & 20% ferrite (d) 82 Fe3C & 18% ferrite	B
13. The structure of 0.5%C steel consists of:- (a) 88% Fe3C & 12% ferrite (b) 22% Fe3C & 78% ferrite (c) 22% ferrite & 78% Fe3C (d) 92.5%ferrite &7.5% Fe_3C At room temperature after annealing.	D
14. The structure of the steel contains 0.5%C consists of (After water quenching to room temperature) (a) 88% Fe3C & 12% ferrite (b) 37.5% pearlite and 62.5% martensite (c) 100% martensite (d) None of the above.	C
15. The microstructure of hypo-eutectoid steel containing 0.2%C consists of :- (a) 90% pearlite and 10% ferrite (b) 75% Pearlite and 25% ferrite (c) 75% ferrite and 25% pearlite (d) 100% ferrite At room temperature	C
16. The structure of 0.5%C steel consists of:- (a) 88% Fe3C & 12% ferrite (b) 22% Fe3C & 78% ferrite (c) 22% ferrite & 78% Fe3C (d) 92.5%ferrite &7.5% Fe3C At room temperature after annealing.	D
17. The structure of the steel contains 0.5%C consists of (After water quenching to room temperature) (a) 88% Fe3C & 12% ferrite (b) 37.5% pearlite and 62.5% martensite (c) 100% martensite (d) None of the above.	C
18. The microstructure of hypo-eutectoid steel containing 0.2%C consists of :- (a) 90% pearlite and 10% ferrite (b) 75% Pearlite and 25% ferrite (c) 75% ferrite and 25% pearlite (d) 100% ferrite At room temperature	C
19. The structure of the alloy containing 0.8%C at 750 0 C consists of :- (a)100% Ferrite (b) 100% Austenite (c) 50% Ferrite + 50% Austenite (d) 100% Pearlite	B
20. The amount of phases present in the alloy contains 0.4%C after equilibrium cooling to room temperature is :- (a) 94% martensite & 6% ferrite (b) 94% ferrite& 6% Fe3C (c) 94% austenite & 6% ferrite (d) 94% Fe3C & 6% ferrite	B

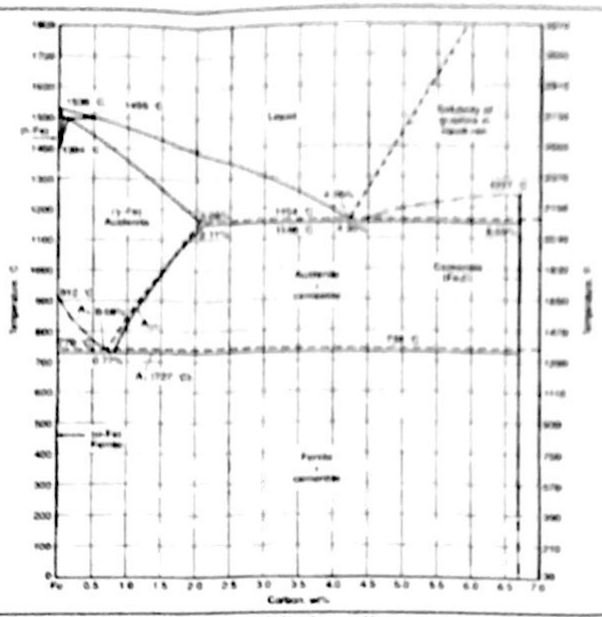


Figure. 4 Iron-carbon equilibrium diagram up to 6.67 wt% C. Solid lines indicate Fe-Fe3C diagram; dashed lines indicate iron-graphite diagram.

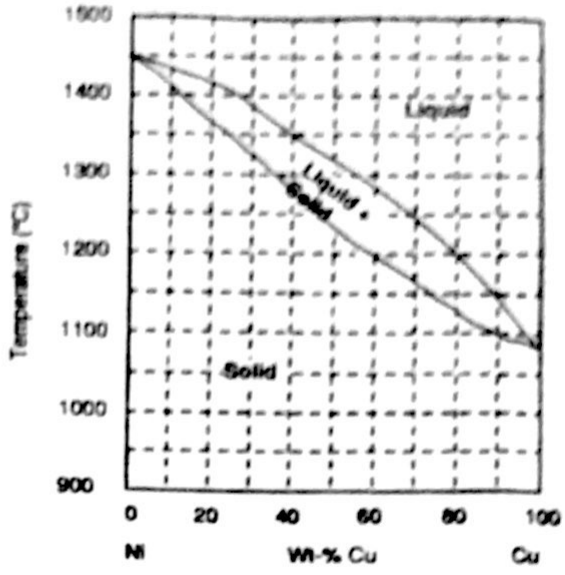


Figure 3. Cu-Ni Phase Diagram

Q 3 (15pt): Heat Treatment & MATERIAL SELECTION

	Answ
1. Annealing is usually performed to:- (a) Decrease hardness. (b) Increase ductility. (c) Relieve stresses. (d) All of the above.	D
2. Tempering optimizes mechanical properties as it:-(a) Increases tensile strength and hardness (b) Increases ductility and toughness. (c) Decreases tensile strength and hardness. (d) Both b & c.	D
3. Hardening and tempering produce optimum strength and toughness for:- (a) Steels of carbon content higher than 0.2%. (b) Al alloys. (c) Cu alloys. (d) All of the above.	A
4. Normalizing of steels is:- (a) Heating to ferrite followed by air cooling. (b) Heating to austenite followed by water cooling. (c) Heating to austenite followed by air cooling. (d) Heating to austenite followed by furnace cooling	C
5. Full annealing of steels is: (a) Heating to ferrite followed by air cooling. (b) Heating to austenite followed by water cooling. (c) Heating to austenite followed by air cooling. (d) Heating to austenite followed by furnace cooling.	D
6. Tempering optimizes mechanical properties and it usually follows:-(a) Annealing. (b) Quenching. (c) Normalizing. (d) Both (b) and (c).	B
7. Steels Quenching is : (a) Heating to ferrite followed by rapid cooling. (b) Heating to austenite followed by rapid cooling. (c) Heating to pearlite followed by rapid cooling. (d) All of the above	B
8. Martensite is an unstable phase that appears due to non-equilibrium cooling conditions in ferrous alloys and it is (a) Of BCT (b) Of BCC (c) Of FCC (d) Of HCP structure	A
9. Tempering of martensite makes it:-(a) More brittle (b) Tougher (c) Harder (d) Of higher UTS.	B
10. Quenching is usually carried out to:-(a) Harden the steel (b) Soften the steel (c) Homogenize the properties (d) Relief stresses	A
11. Parts subjected to acidic media are usually made of:- (a) Low carbon steels (b) Tool steels (c) Stainless steels (d) Heat resisting steels.	C
12. The main difference between gray cast iron and white cast iron is: - (a) The shape of graphite; flake or nodular. (b) The type of carbon; Combined or free. (c) The shape of cementite; lamellar or broken. (d) None of the above.	B

13. The main difference between gray cast iron and nodular cast iron is: -(a)The shape of graphite; flake or nodular. (b) The type of carbon; Combined or free. (c) The shape of cementite; lamellar or broken. (d) None of the above.	A
14. The main difference between malleable cast iron and white cast iron is:-(a) The shape of graphite; flake or nodular. (b) The type of carbon; combined or free. (c) The shape of cementite; lamellar or broken. (d) None of the above.	C
15. The greatest ductility is obtained in --- cast iron. (a) White (b) Gray (c) Nodular (d) Malleable	C
16. Cast iron containing graphite flakes is called:- (a) White cast iron (b) Gray cast iron (c) Nodular cast iron (d) Malleable cast iron	B
17. Cast iron containing spheroids of graphite is called:- (a) White cast iron (b) Gray cast iron (c) Nodular cast iron (d) Malleable cast iron	C
18. The main difference between the carbon steels and the stainless steels is: - a) Carbon content. b) Nickel content. c) Chromium content. d) All of the above.	D
19. Low- carbon steel, medium carbon steel and high carbon steel form a group of steel called:- (a) Stainless steel (b) Tool steel (c)Plain carbon steel (d)Heat resisting steel	C
20. Pistons and some car engine parts are made from:- (a) Al-Si alloy (b) Cu-alloys (C) low-carbon steel (d) stainless steel	A

Q4 (15 pt): Ceramics, Polymers and Composite Materials

	Ans.
1. Boron nitride is a ceramic material used in:- (a) Insulator (b) Lubricant (c) Electronic devices (d) Cutting tools	A
2. Ceramics are:- (a)Electrically conducting and exhibit low thermal conductivity (b)Heat resistant and exhibit low thermal conductivity (c)Totally elastic and have low melting points (d)Both (a) & (c)	B
3. Ceramics are inorganic materials that consist of metallic and non-metallic elements chemically bonded together and they are usually:- (a)Electrically non- conducting (b)Heat resistant (c)Hard (d)All of the above.	D
4. Tungsten carbide used for manufacturing:-(a) Insulator (b) Lubricant (c) Electronic device (d) Cutting tools	D
5. Tungsten carbide is a:-(a) Metallic material (b) Ceramic material (c) Polymer (d) Composite	B
6. Ceramics are fired at elevated temperatures to provide fusion and cause chemical reactions in the material that produce the desired properties, this fusion process is called:- (a) Annealing (b) Sintering (c) Hardening (d) Glazing.	B
7. Carbides are:- (a)Ceramics (b) Composites (c) Polymers (d) Metals	A
8. Carbides are a ceramic material used in applications required: - (a) Heat resistance (b) High strength (c) High ductility and toughness (d) Both a&b	D
9. Polymers are a group of materials characterized by chains of molecules made up of smaller units called:- (a) Crystals (b) Grains (c) Monomers. (d) None of the above	C
10. Thermosetting polymers have a strong primary bond and are often formed by:- (a) Polymerization (b) Condensation (c) Crystallization (d) Solidification	C
11. Thermoplastic polymers are often formed by:- (a) Polymerization (b) Condensation (c) Crystallization (d) Solidification	D
12. Polymeric materials:- (a) Consist of organic long molecular chains or networks. (b) Can be crystalline, non-crystalline, or mixture of both. (c) Are inorganic substances composed of one or more metallic elements. (d) Both A&b	D
13. Most polymers:- (a) Are organic materials that contain molecules composed of hydrogen, oxygen and carbon. (b) Are organic materials that contain molecules composed of hydrogen, oxygen and sulphur. (c) Are organic materials that contain molecules composed of titanium, hydrogen and sulphur (d) None of the above.	A
14. Thermoplastic polymers exhibit:- (a) Plastic and ductile properties (b) Can be formed at elevated temperature (c) Can be cooled remelted and reformed (d) All of the above.	D

15. Some polymers have strong primary bonds, often formed by condensation Polymerization and those are called:- (a)Thermosetting polymers (b)Thermoplastic Polymers (c) Both a&b (d) None of the above	A
16. One of the components of the composite material forms the matrix while the other present as particles or fibers provides:-(a) The strength or hardness required. (b) The bonding required. (c) The toughness required d) The ductility required .	A
17. Composites are generally formed by (a) Suspending reinforcing fibers in binding matrix (b) By melting fibers and matrix with each other (c) By chemical bonding of fibers and matrix (d) None of the above	A
18. In composites:- (a)The matrix holds the fibers together in a structural unit. (b)The matrix protects the fibers from external damage and transfers the applied loads to the fibers. (c) Both (a) & (b) (d)None of the above	C
19. Among the applications of ceramics: pottery, brick, tile, glass, ovenware, and refractories, due to their high resistance to :- (a)Heat (b)Deformation (c) Electricity (d) All of the above	D
20. Fiber glass reinforced plastic is among the materials known as:- (a) Metallic materials (b) Ceramic materials (c) Composite materials (d) Polymers.	C

Q5 (15 pt.): <u>Fe-Fe_3C PHASE DIGRAM</u>

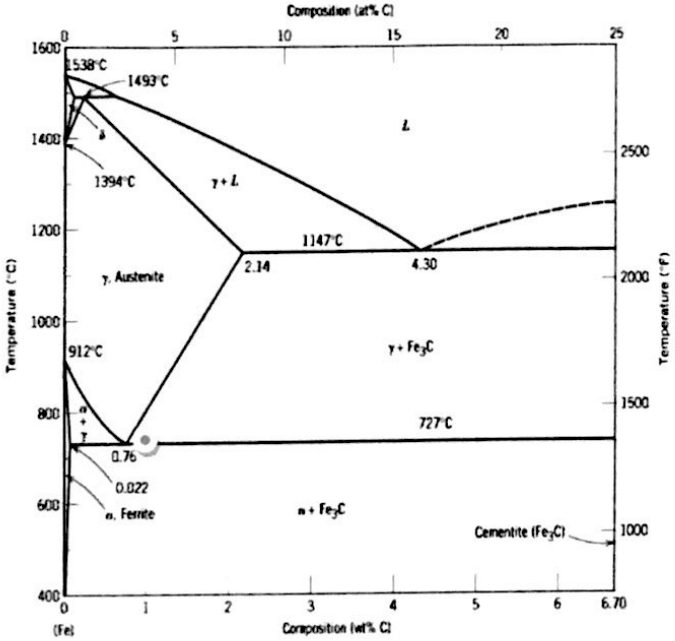
A) The main applications for carbon steels are (1)----------(2)----------, for low alloy steels are (1)----------(2)----------, for tool steels are (1)----------(2)----------and for stainless steels are (1)----------(2)---------- (4pt.)

B) Composite materials are classified into (1)----------(2)----------(3)---------- based on the type of matrix. (1.5 pt.)

C) The main types of engineering ceramics are (1)----------(2)----------(3)---------- . Also, the main applications of Ceramics Materials are (1)----------(2)----------(3)---------- (3 pt.)

D) Polymers or plastics are classified into (1)----------(2)----------(3)---------- (1.5 pt.)

E) Sketch the cooling curve and microstructure for eutectic alloy. (5pt.)



Model Answer — Final Exam — Total (75) Pts.

Your Answer for Q1 (10 pt.)		
1	B	
2	C	
3	D	
4	B	
5	D	
6	C	
7	C	
8	A	
9	D	
10	C	
11	A	
12	B	
Grade	/10	

Your Answer for Q2 (15pt.)		
1	A	
2	C	
3	A	
4	B	
5	C	
6	B	
7	B	
8	B	
9	B	
10	B	
11	B	
12	B	
13	D	
14	C	
15	C	
16	D	
17	C	
18	C	
19	B	
20	B	
Grade	/15	

Your Answer for Q3 (15pt.)		
1	D	
2	D	
3	A	
4	C	
5	D	
6	D	
7	B	
8	A	
9	B	
10	A	
11	C	
12	B	
13	A	
14	C	
15	C	
16	B	
17	C	
18	D	
19	C	
20	A	
Grade	/15	

Your Answer for Q4 (15pt.)		
1	A	
2	B	
3	D	
4	D	
5	B	
6	B	
7	A	
8	D	
9	C	
10	C	
11	D	
12	D	
13	A	
14	D	
15	A	
16	A	
17	A	
18	C	
19	D	
20	C	
Grade	/15	

~ Y. 2D

Your Answer For Q5 (15 pt.)

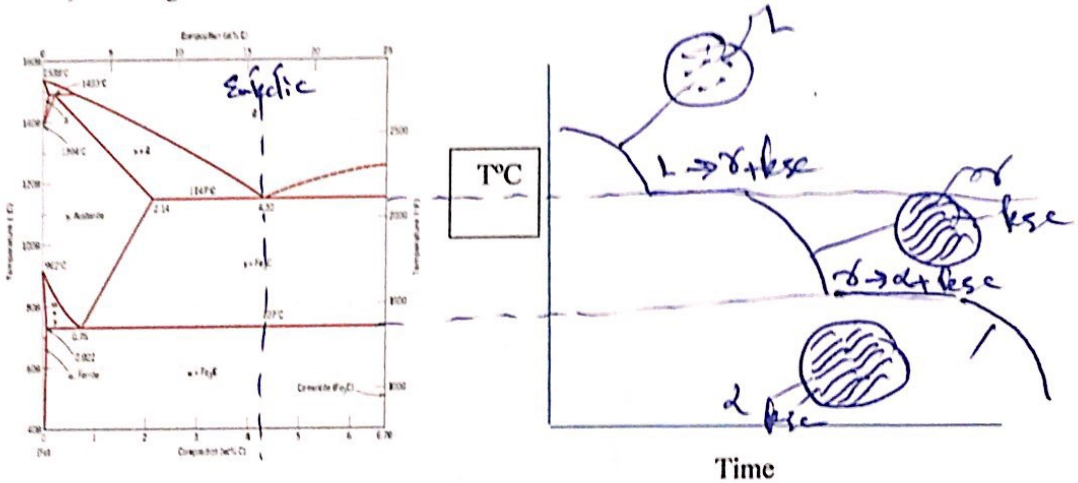
A) 1- Rebars 2- steal structural beams, 1- axe 2- boilers
1- Die, 2- tools, 1- knife 2- surgery tools

B) 1- Metal Matrix Composites 2- polymer matrix Composites
3- Ceramics matrix Composites

C) 1- oxide, 2- carbide, 3- nitride 3 chemical attacking resistance
1- insulators 2- refractories

D) 1- Thermoplastics 2- Thermosetting 3- Elastomers

E) Cooling curve and microstructure for eutectic alloy.



15. Some polymers have strong primary bonds, often formed by condensation Polymerization and those are called:- (a)Thermosetting polymers (b)Thermoplastic Polymers (c) Both a&b (d) None of the above	
16. One of the components of the composite material forms the matrix while the other present as particles or fibers provides:-(a) The strength or hardness required. (b) The bonding required. (c) The toughness required d) The ductility required .	
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19. Among the applications of ceramics: pottery, brick, tile, glass, ovenware, and refractories, due to their high resistance to :- (a)Heat (b)Deformation (c) Electricity (d) All of the above	
20. Fiber glass reinforced plastic is among the materials known as:- (a) Metallic materials (b) Ceramic materials (c) Composite materials (d) Polymers.	

Q5 (15 pt.): Fe-Fe_3C PHASE DIGRAM

A) The main applications for carbon steels are (1)Rebars springs (2)steel structural beams, for low alloy steels are (1)axle boilers (2)armor steel, o-steel, for tool steels are (1)die, Tools (2)Cutting Tools and for stainless steels are (1)Knifes (2)Surgical tool (4pt.)

B) Composite materials are classified into (1)MMC metal matrix (2)CMC Ceramic matrix (3)PMC Polymer matrix based on the type of matrix (1.5 pt.)

C) The main types of engineering ceramics are (1)oxides, (2)Carbides, (3)Nitride, Also, the main applications of Ceramics Materials are (1)insulators (2)Refractories (3)Chemical attack resistor (3 pt.)

D) Polymers or plastics are classified into (1)Thermoplastic (2)Thermosetting (3)elastomers (1.5 pt.)

E) Sketch the cooling curve and microstructure for eutectic alloy. (5pt.)