

**FINAL  
ALTERNATIVE ASSESSMENT**

(COVER PAGE)

Session : April 2021

Programme : Diploma in Mechanical Engineering (DMEN)  
Diploma in Electrical & Electronic Engineering (DEEI)

Course : **EGM1184: Structures and Properties of Materials**  
**EGM1185: Materials Science**

Date of Examination : 26 July 2021 (Monday)

Time : 8.00am – 10.15am Reading Time : Nil

Duration : 2 Hours 15 Minutes

**Special Instructions** :

This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

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Material permitted : Non-Programmable Scientific Calculator

Materials provided : Periodic Table

Examiner(s) : **Johnny Wong Kee Hui**

Chief Moderator : Iylia Elena Abdul Jamil

*This paper consists of 7 printed pages, including the cover page*

DIPLOMA IN ELECTRICAL & ELECTRONICS ENGINEERING PROGRAMME (DEEI)  
DIPLOMA IN MECHANICAL ENGINEERING PROGRAMME (DMEN)  
EGM1185: MATERIALS SCIENCE  
EGM1184: STRUCTURE AND PROPERTIES OF MATERIALS  
FINAL ALTERNATIVE ASSESSMENT: APRIL 2021 SESSION

**Instructions:** This paper consists of **FOUR (4)** questions. Answer all **FOUR (4)** questions.

**Question 1**

- a. Find the chemical formula of an intermetallic compound that consists of 37 wt % Ti and 63 wt % Al.  
(7 marks)
- b. Copper is added to silver to create sterling silver, which is stronger and more durable. The amount of copper added is 7.5 wt %. A sterling silver spoon has a mass of 100 grams. Find the number of copper and silver atoms in the spoon.  
(7 marks)
- c. Illustrate in a unit cube a crystal plane that has Miller index of  $[3 \bar{2} 1]$ , together with the intercepts at the  $x, y$  and  $z$  planes.  
(5 marks)
- d. Describe and illustrate the following types of defects that can be present in a metal.
  - a. Vacancy  
(3 marks)
  - b. Interstitially  
(3 marks)

### Question 2

- a. The temperature of 1 kg of the alloy shown in Figure Q2(a) is lowered slowly until the liquid-solution composition is 18 wt % B and the solid-solution composition is 66 wt % B. Find the amount of each phase in grams.

(6 marks)

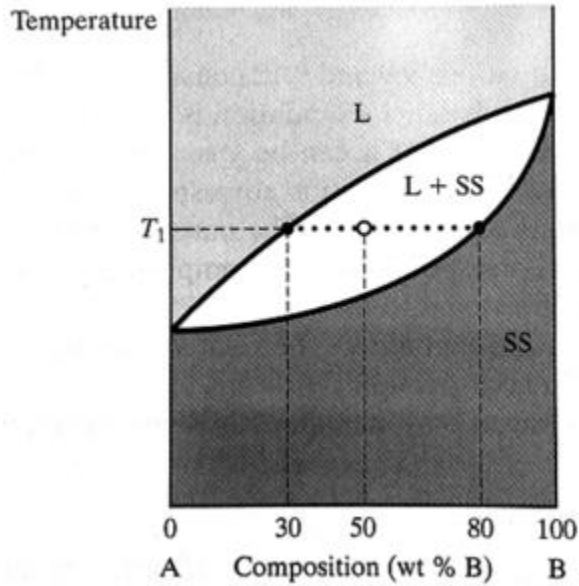


Figure Q2(a)

- b. For 1 kg of eutectoid steel at room temperature, find the amount of each phase ( $\alpha$  and  $\text{Fe}_3\text{C}$ ) present. Refer to the diagram shown in Figure Q2(b).

(6 marks)

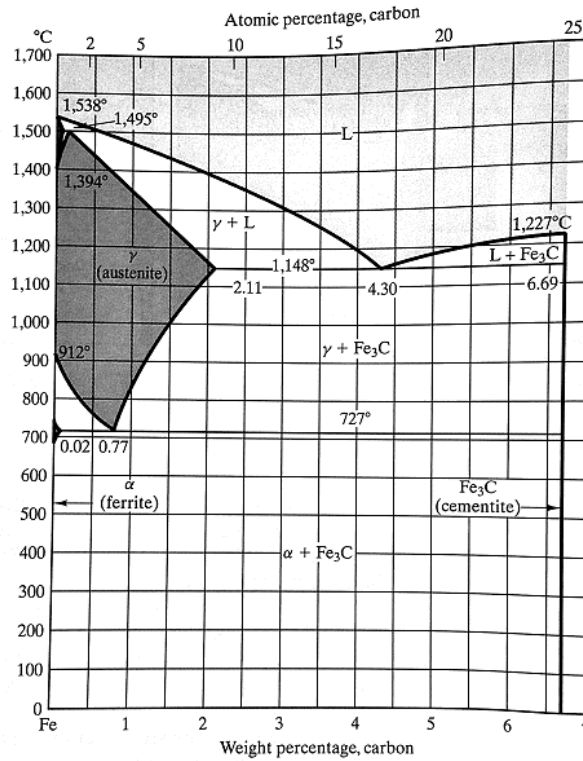


Figure Q2(b)

c. From Figure Q2(c), find:

- i. the solubility of tin in solid lead (Pb) at 100°C. (2 marks)
- ii. the maximum solubility of lead (Pb) in solid tin (Sn). (2 marks)
- iii. the amount of  $\beta$  that forms if a 90% Pb - 10% Sn alloy is cooled to 0°C. (3 marks)
- iv. the mass of tin contained in the  $\alpha$  and  $\beta$  phases. (3 marks)
- v. the mass of lead contained in the  $\alpha$  and  $\beta$  phases. (3 marks)

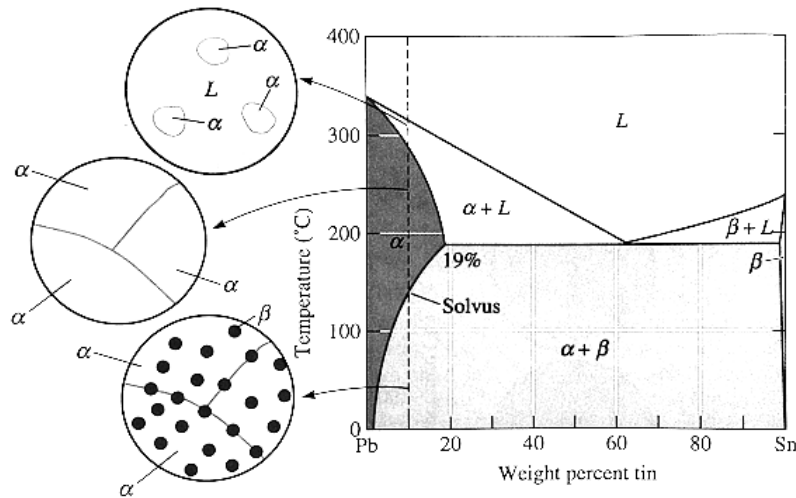


Figure Q2(c)

**Question 3**

- a. Distinguish between natural aging and artificial aging for a precipitation metal hardening. (4 marks)
- b. Define the following terms related to the mechanical behavior of materials
- i. Endurance limits, (2 marks)
  - ii. Fatigue strength, (2 marks)
  - iii. Engineering stress and its SI unit, (2 marks)
  - iv. Engineering strain and its SI unit. (2 marks)
- c. A 20-cm-long rod with a diameter of 0.250 cm is loaded with a 5000 N weight. If the diameter decreases to 0.210 cm, find the following:
- i. The engineering stress at this load. (3 marks)
  - ii. The engineering strain at this load. (3 marks)
  - iii. The true stress at this load. (2 marks)
  - iv. The true strain at this load. (3 marks)
- d. Define the hardness of a metal. (2 marks)

**Question 4**

- a. The electrical conductivity of several materials is shown in Table Q4(a). Justify which material will be more suitable if an electrical transmission line 1500 m long that will carry a current of 50 A with no more than  $5 \times 10^5$  W loss in power is needed.

(8 marks)

Table Q4(a)

	$\sigma$ ( $\text{ohm}^{-1} \cdot \text{cm}^{-1}$ )	$A$ ( $\text{cm}^2$ )	Diameter (cm)
Aluminum	$3.77 \times 10^5$	0.00199	0.050
Copper	$5.98 \times 10^5$	0.00125	0.040
Silver	$6.80 \times 10^5$	0.00110	0.037

- b. Write down the equation for the following laws, and define the symbols in each of the equation and indicate their SI units.

i. Macroscopic forms of Ohm's Law

(3 marks)

ii. microscopic forms of Ohm's law.

(3 marks)

- c. If there are 400 grains per square inch on a photomicrograph of a ceramic material at 200x magnification, find its ASTM grain-size number.

(5 marks)

- d. Find the radius of the largest interstitial void in the FCC  $\gamma$  iron lattice. The atomic radius of the iron atom in this lattice is 0.129 nm, and the largest interstitial voids occur at the position of (0, 1/2, 0).

(6 marks)

**~THE END~**

EGM1184/EGM1185 (F)/ April 2021 Session/formatted

# PERIODIC TABLE OF ELEMENTS

1		4		10		18																																																																																															
Atomic Number	Symbol	Atomic Number	Symbol	Atomic Number	Symbol	Atomic Number	Symbol																																																																																														
Name	Atomic Mass, u	Name	Atomic Mass, u	Name	Atomic Mass, u	Name	Atomic Mass, u																																																																																														
<b>1</b> <b>H</b> Hydrogen 1.0080	<b>4</b> <b>Be</b> Beryllium 9.012183	<b>2</b> <b>He</b> Helium 4.00260	<b>11</b> <b>Na</b> Sodium 22.9897693	<b>12</b> <b>Mg</b> Magnesium 24.305	<b>3</b> <b>Li</b> Lithium 7.0	<b>6</b> <b>C</b> Carbon 12.011	<b>7</b> <b>N</b> Nitrogen 14.007	<b>8</b> <b>O</b> Oxygen 15.999	<b>9</b> <b>F</b> Fluorine 18.99840316	<b>10</b> <b>Ne</b> Neon 20.180	<b>13</b> <b>Al</b> Aluminum 26.981538	<b>14</b> <b>Si</b> Silicon 28.085	<b>15</b> <b>P</b> Phosphorus 30.97376200	<b>16</b> <b>S</b> Sulfur 32.07	<b>17</b> <b>Cl</b> Chlorine 35.45	<b>18</b> <b>Ar</b> Argon 39.9	<b>19</b> <b>K</b> Potassium 39.098	<b>20</b> <b>Ca</b> Calcium 40.08	<b>21</b> <b>Sc</b> Scandium 44.95591	<b>22</b> <b>Ti</b> Titanium 47.87	<b>23</b> <b>V</b> Vanadium 50.941	<b>24</b> <b>Cr</b> Chromium 51.996	<b>25</b> <b>Mn</b> Manganese 54.93804	<b>26</b> <b>Fe</b> Iron 55.84	<b>27</b> <b>Co</b> Cobalt 58.93319	<b>28</b> <b>Ni</b> Nickel 58.693	<b>29</b> <b>Cu</b> Copper 63.55	<b>30</b> <b>Zn</b> Zinc 65.4	<b>31</b> <b>Ga</b> Gallium 69.72	<b>32</b> <b>Ge</b> Germanium 72.63	<b>33</b> <b>As</b> Arsenic 74.92159	<b>34</b> <b>Se</b> Selenium 78.97	<b>35</b> <b>Br</b> Bromine 79.90	<b>36</b> <b>Kr</b> Krypton 83.80	<b>37</b> <b>Rb</b> Rubidium 85.468	<b>38</b> <b>Sr</b> Strontium 87.6	<b>39</b> <b>Y</b> Yttrium 88.9058	<b>40</b> <b>Zr</b> Zirconium 91.22	<b>41</b> <b>Nb</b> Niobium 92.9064	<b>42</b> <b>Mo</b> Molybdenum 96.0	<b>43</b> <b>Tc</b> Technetium 97.90721	<b>44</b> <b>Ru</b> Ruthenium 101.1	<b>45</b> <b>Rh</b> Rhodium 102.9055	<b>46</b> <b>Pd</b> Palladium 106.4	<b>47</b> <b>Ag</b> Silver 107.868	<b>48</b> <b>Cd</b> Cadmium 112.41	<b>49</b> <b>In</b> Indium 114.82	<b>50</b> <b>Sn</b> Tin 118.71	<b>51</b> <b>Sb</b> Antimony 121.76	<b>52</b> <b>Te</b> Tellurium 127.6	<b>53</b> <b>I</b> Iodine 126.9045	<b>54</b> <b>Xe</b> Xenon 131.29	<b>55</b> <b>Cs</b> Cesium 132.9054520	<b>56</b> <b>Ba</b> Barium 137.33	<b>57</b> <b>La</b> Lanthanum 138.9055	<b>58</b> <b>Ce</b> Cerium 140.12	<b>59</b> <b>Pr</b> Praseodymium 140.9077	<b>60</b> <b>Nd</b> Neodymium 144.24	<b>61</b> <b>Pm</b> Promethium 144.91276	<b>62</b> <b>Sm</b> Samarium 150.4	<b>63</b> <b>Eu</b> Europium 151.96	<b>64</b> <b>Gd</b> Gadolinium 157.2	<b>65</b> <b>Tb</b> Terbium 158.92535	<b>66</b> <b>Dy</b> Dysprosium 162.50	<b>67</b> <b>Ho</b> Holmium 164.93033	<b>68</b> <b>Er</b> Erbium 167.26	<b>69</b> <b>Tm</b> Thulium 168.93422	<b>70</b> <b>Yb</b> Ytterbium 173.04	<b>71</b> <b>Lu</b> Lutetium 174.967	<b>72</b> <b>Hf</b> Hafnium 178.5	<b>73</b> <b>Ta</b> Tantalum 180.9479	<b>74</b> <b>W</b> Tungsten 183.8	<b>75</b> <b>Re</b> Rhenium 186.21	<b>76</b> <b>Os</b> Osmium 190.2	<b>77</b> <b>Ir</b> Iridium 192.22	<b>78</b> <b>Pt</b> Platinum 195.08	<b>79</b> <b>Au</b> Gold 196.96657	<b>80</b> <b>Hg</b> Mercury 200.59	<b>81</b> <b>Tl</b> Thallium 204.383	<b>82</b> <b>Pb</b> Lead 207	<b>83</b> <b>Bi</b> Bismuth 208.9804	<b>84</b> <b>Po</b> Polonium 209	<b>85</b> <b>At</b> Astatine 209	<b>86</b> <b>Rn</b> Radon 222.01758	<b>87</b> <b>Fr</b> Francium 223.01973	<b>88</b> <b>Ra</b> Radium 226.02541	<b>89</b> <b>Ac</b> Actinium 227.02775	<b>90</b> <b>Th</b> Thorium 232.038	<b>91</b> <b>Pa</b> Protactinium 231.036	<b>92</b> <b>U</b> Uranium 238.0289	<b>93</b> <b>Np</b> Neptunium 237.04817	<b>94</b> <b>Pu</b> Plutonium 244.06420	<b>95</b> <b>Am</b> Americium 243.06138	<b>96</b> <b>Cm</b> Curium 247.07035	<b>97</b> <b>Bk</b> Berkelium 247.07031	<b>98</b> <b>Cf</b> Californium 251.07959	<b>99</b> <b>Es</b> Einsteinium 252.0830	<b>100</b> <b>Fm</b> Fermium 257.09511	<b>101</b> <b>Md</b> Mendelevium 258.09843	<b>102</b> <b>No</b> Nobelium 259.10100	<b>103</b> <b>Lr</b> Lawrencium 262.110

