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Student ID no.: \_\_\_\_\_

國立高雄應用科技大學 機械與精密工程研究所博士班  
101 學年度第 2 學期 博士班資格考(Qualifying Exam)

考試科目：Precision Manufacturing (Part-A)

本考科試題共有兩部分(Part-A and Part-B)，考生於每部份試題中至多選三題作答，兩部分總合只能選答五題，每題 20 分，共 100 分（考試時間為 100 分鐘）

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Click if you choose this question to answer

1. (a) There are four engineers related to manufacturing, namely: design engineers, manufacturing engineers, industrial engineers, and material engineers. Please describe their roles respectively. (b) There are five different layouts in manufacturing system, namely: Job shop, Flow shop, Linked-cell, Project shop, and Continuous processes. Please take an example for each layout.

Click if you choose this question to answer

2. (a) Please describe two types of hardness testing as shown in Fig. 1 in detail. (b) Discuss the major difference between these two types of hardness testing.

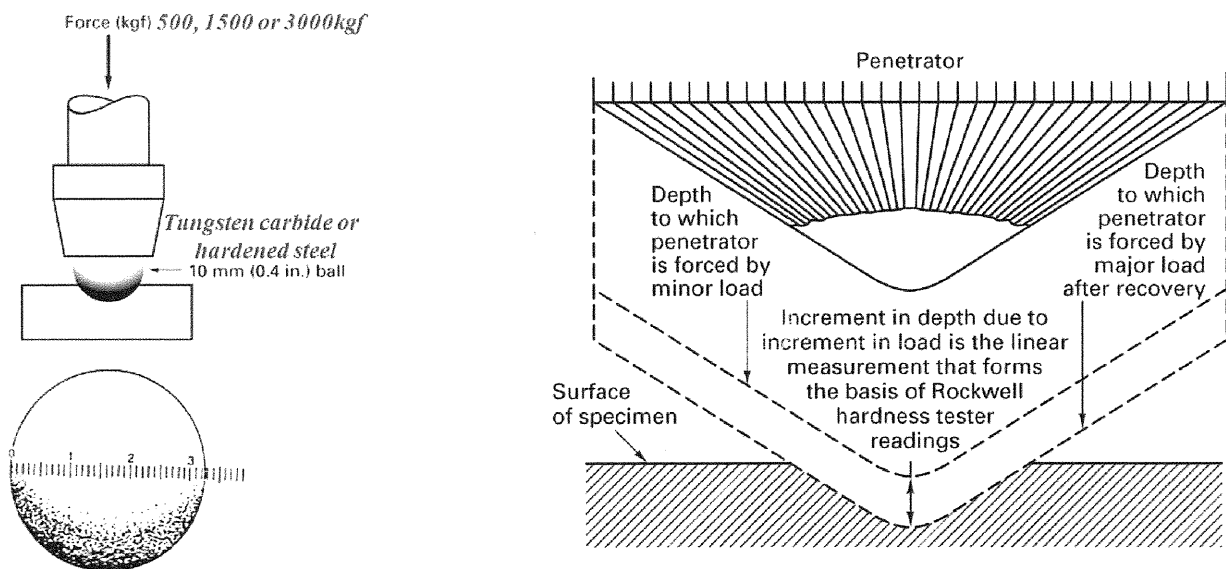
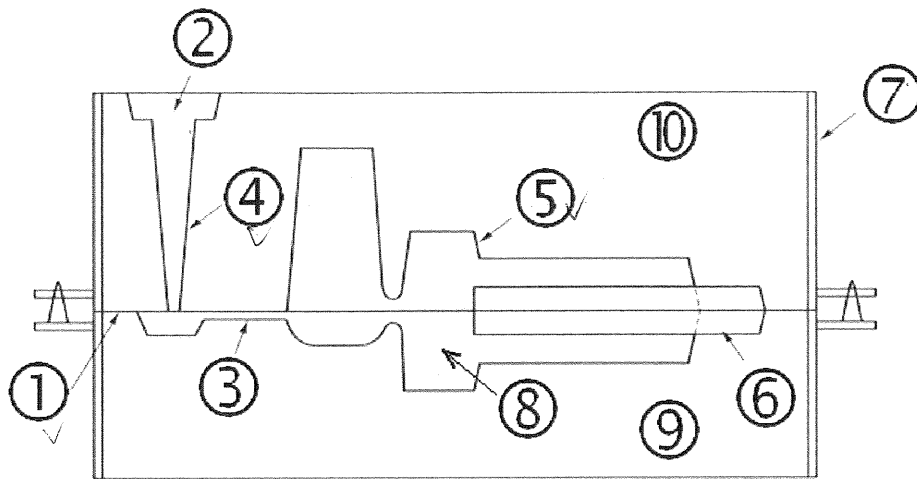


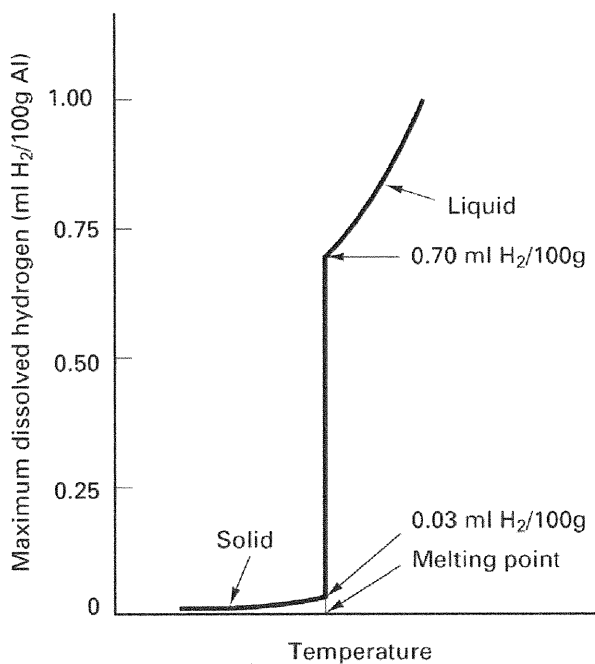
Fig. 1 Two types of hardness testing.

Click if you choose this question to answer

3. (a) Based on Fig.2, write down the according number for each casting terminology. (b) Based on the maximum solubility of hydrogen in aluminum as a function of temperature, which is shown in Fig. 3, describe the reason why it tends to form *bubbles* or *gas porosity* within the casting during aluminum solidify process.



**Fig. 2 Casting terminology: COPE, DRAG, Riser, Pouring cup, Gating system, Flask, Core printing, Draft, Sprue, Parting line.**



**Fig. 3 maximum solubility of hydrogen in aluminum as a function of temperature**

Click if you choose this question to answer

4. Chvorinov's rule tells  $t_s = B(V/A)^{2.0}$  where  $t_s$  is total solidification time,  $V$  is volume of casting,  $A$  is surface area through which heat is extracted, and  $B$  is the mold constant. Assume that the solidification time of riser is 1.25 times of casting, please use the above rule to calculate the dimensions of an effective riser for a casting which is a rectangular plate 2 inch by 4 inch by 6 inch with the dimensions. Assume that the casting and riser are not connected, except through a gate and runner, and that the riser is a cylinder of height/diameter ratio  $H/D = 1.5$ . The finished casting is what fraction of the combined weight of the riser and casting?

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考試科目： Precision Manufacturing (Part-B)

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**Click if you choose this question to answer**

1. (a) What is the distinction between the drawing and the ironing operations?  
(b) Two cylinder-cup products, one is made by drawing, another is an ironing-cup. How can you classify them just according the appearance only of the product?  
(c) What is the different for hold-down considerations between the pressure-ring and the draw-beads?

**Click if you choose this question to answer**

2. 2. If the orthogonal machining system has the rake angle  $\alpha$ , the friction angle on tool-chip interface area is  $\lambda$  and the shear angle is  $\phi$ .  
(a) Draw the Merchant's circular force diagram to show the relative vectors for  $F_s$ ,  $F_n$ , and  $F_t$ .  
(b) Express those desired forces ( $F_s$ ,  $F_n$ ,  $F_t$ ) in terms of the measured dynamometer components,  $F_c$  and  $F_t$  and appropriate angles.

**Click if you choose this question to answer**

3. (a) Draw the schematic diagram and show the differences between ECM and EDM of the nontraditional machining.  
(b) Imitate (a) for ECG and EDG.

**Click if you choose this question to answer**

4. In the field of microelectronic manufacturing and electronic assembly;  
(a) What is epitaxy, and why is it important for microelectronic manufacturing?  
(b) In metallization, what is the difference between a contact and a via?  
(c) What are the advantages of surface mount technology and through-hole technology for attachment of IC packages and discrete electrical components to boards?

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考試科目：Engineering Materials (Part-A)

本考科試題共有兩部分(Part-A and Part-B)，考生於每部份試題(四題)中至多選三題作答，兩部分總合只能選答五題，每題 20 分，共 100 分(考試時間為 100 分鐘)

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Click if you choose this question to answer

1. Determine the atomic factor and estimate the density of (a) molybdenum (bcc,  $a = 0.31408$  nm) (b) gold (fcc,  $a = 0.40729$  nm) (c) cobalt (hcp,  $a = 0.25$  nm,  $c = 0.40825$  nm).

Click if you choose this question to answer

2. (1) Describe and illustrate the following imperfections that can exist in crystal lattices: (a) Frenkel imperfection and (b) Schottky imperfection.  
(2) why are grain boundaries favorable sites for the nucleation and growth of precipitates?

Click if you choose this question to answer

3. What are X-rays, and how are they produced?

Click if you choose this question to answer

4. What factors affect the diffusion rate in solid metal crystals?

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考試科目：Engineering Materials (Part-B)

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Click if you choose this question to answer

1. A stress of 85 MPa is applied in the [001] direction of a unit cell of a BCC iron single crystal. Calculate the resolved shear stress for the following slip systems: (a) (011)  $[\bar{1}\bar{1}1]$ , (b) (110)  $[\bar{1}11]$ , and (c) (0 $\bar{1}1$ )[111]

Click if you choose this question to answer

2. Determine the critical crack length for a through crack contained within a thick plate of 7075-T751 aluminum alloy that is under uniaxial tension. For this alloy,  $K_{IC} = 24 \text{ MPa} \sqrt{m}$  and  $\sigma_f = 560 \text{ MPa}$ . Assume  $Y = \sqrt{\pi}$ .

Click if you choose this question to answer

3. Consider an alloy containing 70 wt % Ni and 30 wt % Cu (see Fig. 1).

(a) At 1350°C, make a phase analysis assuming equilibrium conditions. In the phase analysis, include the following:

- What phases are present?
- What is the chemical composition of each phase?
- What amount of each phase is present?

(b) Make a similar phase analysis at 1500°C.

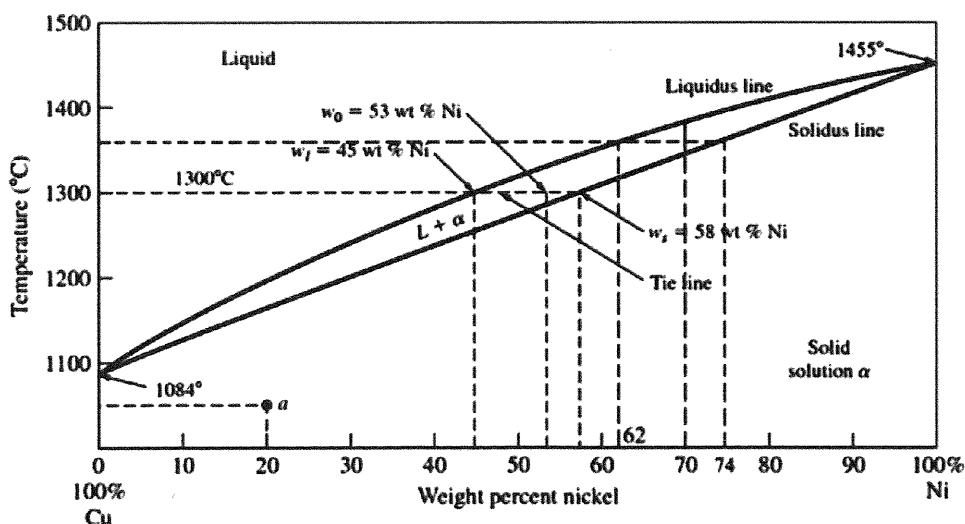


Fig. 1

Click if you choose this question to answer

4. A plain-carbon steel contains 93 wt % ferrite–7 wt % Fe<sub>3</sub>C. What is its average carbon content in weight percent? (The carbon content of ferrite is 0.02 wt%, atomic mass of iron is 55.85 g/mole, C is 12.01 g/mol)

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考試科目：Engineering Mathematics (Part-A)

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Click if you choose this question to answer

1. Find the general solution of the following ordinary differential equation.

$$y'' - y' - 2y = 4 \sin x$$

Click if you choose this question to answer

2. Solve the following ordinary differential equation by Power Series Method.

$$y'' + y = 0$$

Click if you choose this question to answer

3.  $\begin{cases} x' + 2y' = 1 \\ x'' - y = e^{-t} \end{cases}$   $x(0) = 0, y(0) = 0, x'(0) = -2$ , find  $x(t)$ ?

Click if you choose this question to answer

4. Using Laplace Transform, solve the following problem

$$y'' + 9y = \delta(t - 2), y(0) = 1, y'(0) = 0$$

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考試科目： Engineering Mathematics (Part-B)

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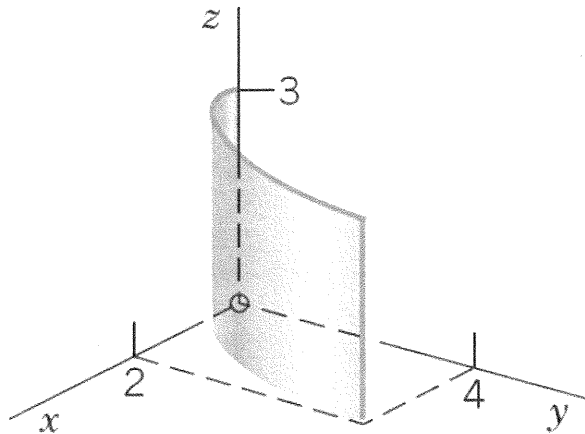
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1. Compute the flux of water through the parabolic cylinder  $S$ :

$$y = x^2, 0 \leq x \leq 2, 0 \leq z \leq 3$$

The velocity vector is  $\mathbf{v} = \mathbf{F} = [3z^2, 6, 6xz]$ , speed being measured in meters/sec.



Click if you choose this question to answer

2. Find the two half-range expansions of the function:

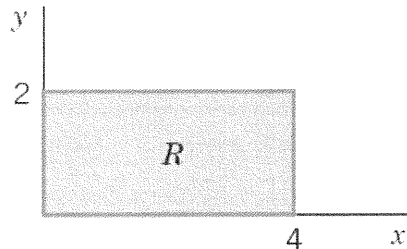
$$f(x) = \begin{cases} \frac{2k}{L}x, & 0 < x < \frac{L}{2} \\ \frac{2k}{L}(L-x), & \frac{L}{2} < x < L \end{cases}$$



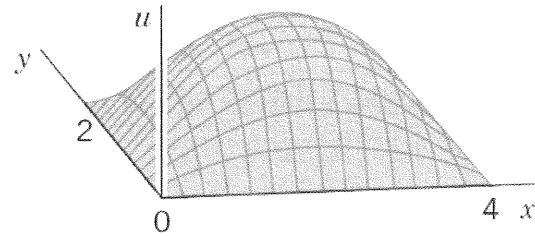
Click if you choose this question to answer

3. Find the vibrations of a rectangular membrane of sides  $a = 4$  ft and  $b = 2$  ft, if the tension is 12.5 lb/ft, the density is 2.5 slugs/ft<sup>2</sup> (as for light rubber), the initial velocity is 0, and the initial displacement is

$$f(x, y) = 0.1(4x - x^2)(2y - y^2) \text{ ft.}$$



Membrane



Initial displacement

Click if you choose this question to answer

4. A tetrahedron is determined by three edge vectors  $\mathbf{a}$ ,  $\mathbf{b}$ ,  $\mathbf{c}$ . Find its volume when  $\mathbf{a} = [2, 0, 3]$ ,  $\mathbf{b} = [0, 4, 1]$ ,  $\mathbf{c} = [5, 6, 0]$ .

