國立高雄應用科技大學 機械與精密工程研究所博士班
104 學年度第二學期 博士班資格考(Qualifying Exam)

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）

This Qualifying exam includes two parts (Part-A and Part-B). Student should choose two to three questions in each part (four questions), and the total question to answer for the sum of two parts should not excess five questions. Each question 20 points, a total of 100 points (exam time 100 minutes)

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

1.

An X-ray diffractometer recorder chart for an element that has either the BCC or the FCC crystal structure showed diffraction peaks at the following 2θ angles: 41.069°, 47.782°, 69.879°, and 84.396°. The wavelength of the incoming radiation was 0.15405 nm. (X-ray diffraction data courtesy of the International Centre for Diffraction Data.)

(*a*) Determine the crystal structure of the element.

(*b*) Determine the lattice constant of the element.

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

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

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

3. (1) Describe and illustrate the following imperfections that can exist in crystal lattices: (*a*) Frenkel imperfection, (*b*) Schottky imperfection.

(2) Describe and illustrate the following planar defects: (*a*) twins, (*b*) stacking faults.

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

4. A gear made of 1020 steel (0.20 wt % C) is to be gas-carburized at 927℃. Calculate the carbon content at 1 mm below the surface of the gear after a 7.0-h carburizing time. Assume the carbon content at the surface of the gear is 1.15 wt %. D (C in γ iron) at 927℃ = 1.28 x 10^{-11} m^2/s.

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考試科目：Engineering Materials **(Part-B)**

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

This Qualifying exam includes two parts (Part-A and Part-B). Student should choose two to three questions in each part (four questions), and the total question to answer for the sum of two parts should not excess five questions. Each question 20 points, a total of 100 points (exam time 100 minutes)

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

1.(a)Describe what occurs microscopically when a cold-worked sheet of such as aluminum undergo a recovery heat treatment.
  (b)What are five important factors that affect the recrystallization process metals.

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

2. Describe the four basic structural changes that take place when a homogeneous ductile metal is caused to fail by fatigue under cyclic stresses.

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

3. write equations for the following invariant reactions :eutectic, eutectoid, peritectic, and peritectoid. How many degrees of freedom exist at invariant reaction points in binary phase diagrams?

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

4. If a hypereutectoid plain-carbon steel contains 4.7 wt% proeutectoid cementite, what is its average carbon content?

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考試科目： Engineering Mathematics (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）

This Qualifying exam includes two parts (Part-A and Part-B). Student should choose two to three questions in each part (four questions), and the total question to answer for the sum of two parts should not excess five questions. Each question 20 points, a total of 100 points (exam time 100 minutes)

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

1.. Please solve the given system of differential equations by systematic elimination:

$$\frac{d^2x}{dt^2} + \frac{dy}{dt} = -5x$$

$$\frac{dx}{dt} + \frac{dy}{dt} = -x + 4y$$

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

2. Use Laplace transform to solve the given initial-value problem:

$$y'' + 4y = f(t), \quad y(0) = 0, \quad y'(0) = -1, \quad where$$

$$f(t) = \begin{cases} 1, & 0 \le t < 1 \\ 0, & t \ge 1 \end{cases}$$

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

3. Find the general solution of the given differential equation on the interval $(0, \infty)$,

$$16x^2y'' + 16xy' + (16x^2 - 1)y = 0;$$

Using Bessel's equation of order v:
$$x^2y'' + xy' + (x^2 - v^2)y = 0$$

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

4. Solve the given differential equation:

$$x^2y'' + xy' - y = \ln x;$$

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考試科目： Engineering Mathematics (Part-B)

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）

This Qualifying exam includes two parts (Part-A and Part-B). Student should   choose two to three questions in each part (four questions), and the total question to answer for the sum of two parts should not excess five questions. Each question 20 points, a total of 100 points (exam time 100 minutes)

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

1.

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

2.

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

3.

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

4.

(1) Find the inverse of the matrix $\begin{pmatrix} -1 & 3 & 0 \\ 3 & -2 & 1 \\ 0 & 1 & 2 \end{pmatrix}$

(2) Determine whether the line integral

$\int_C (y + yz)\, dx + (x + 3z^3 + xz)\, dy + (9yz^2 + xy - 1)\, dz$ is independent or dependent of path between (1, 1, 1) and (2, 10, 4) ?

(3) Show that the set $\{1,\ \cos x,\ \cos 2x,\ \cos 3x,\ \ldots\}$ is orthogonal on $[-\pi,\ \pi]$.

(4) Use separation of variables to find product solution for the following partial differential equation $\dfrac{\partial u(x, y)}{\partial x} = \dfrac{\partial u(x, y)}{\partial y}$

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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(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）

This Qualifying exam includes two parts (Part-A and Part-B). Student should choose two to three questions in each part (four questions), and the total question to answer for the sum of two parts should not excess five questions. Each question 20 points, a total of 100 points (exam time 100 minutes)

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

1. (a) Describe the basic steps involved in making powder metallurgy parts. (5%)

   (b) A fine iron powder is compacted in a mechanical press at a pressure 400 MPa. During sintering, the shrinkage of the green part is approximately 5%. Based on the following chart (density of green part as a function of compacting pressure), what will be the final density of the part? (15%)
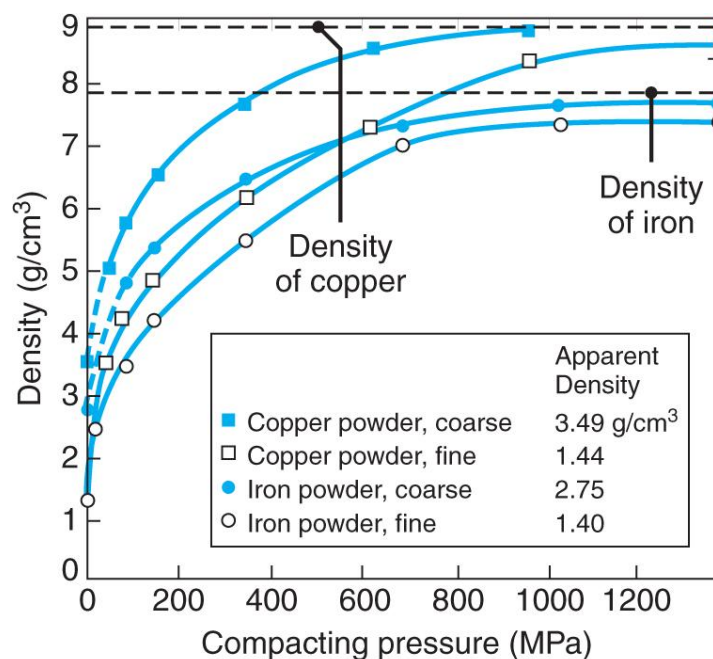
☐ **Click if you choose this question to answer**

2. What are the advantages and limitations of isothermal forming process? (20%)

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

3. (a) What is the significance of hot spots in metal casting? (10%)
   (b) What is Chvorinov's rule? (10%)

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

4. (a) What is the significance of the exponent n in the equation $\sigma = K\varepsilon^n$, that represents the true stress-true strain relationship? (10%)
   (b) Describe the squeeze casting process and its advantages. (10%)

Student name:_____ Student ID no.:_____

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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 forging die and forging parts are shown in Fig. 1. (1) Do these processes belong to cold forging or hot forging? Please explain the reasons. (2) Please indicate which one belong to blocker forging (粗鍛) and which one belong to finish forging (完成鍛). (3) How to conduct the manufacturing process from 4 to 5? Note that the numbers are indicated in Fig. 1.
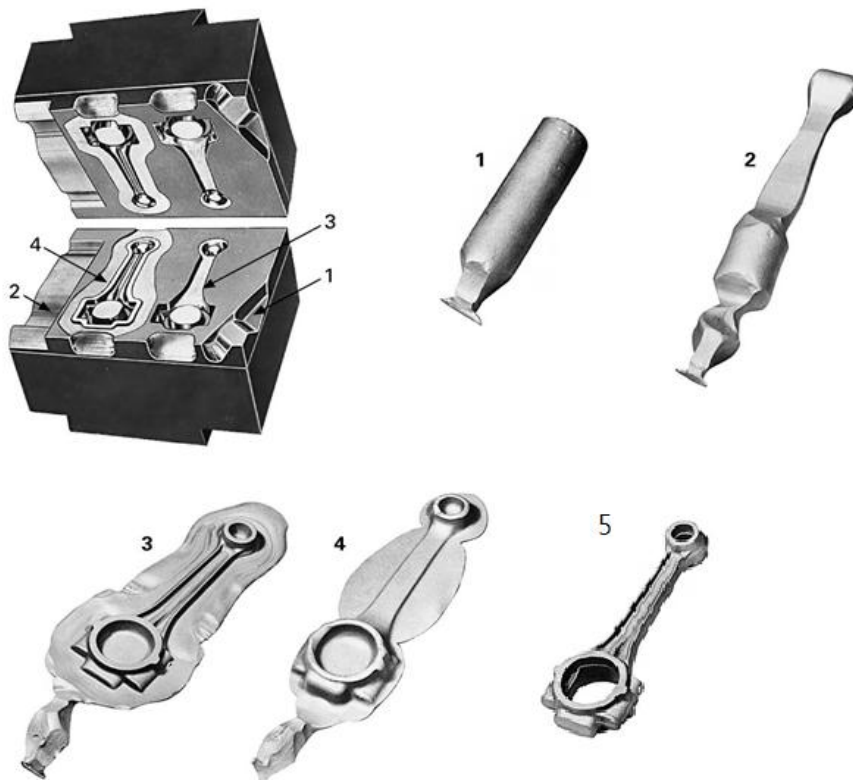

Fig. 1. A forging die and forging parts

2. Please use Merchant's force circle (refer to Fig. 2) to derive the shear plane angle ϕ (Eq. 1), and the cutting force F_C (Eq. 2). Where λ is the friction angle on the tool's rake face, α is the rake angle on the tool's rake face, t is the cutting depth, w is the chip width, k is the shear yield strength of the metal being machined.

$$\phi = \frac{\pi}{4} - \frac{1}{2}(\lambda - \alpha) \qquad \text{(Eq. 1)}$$
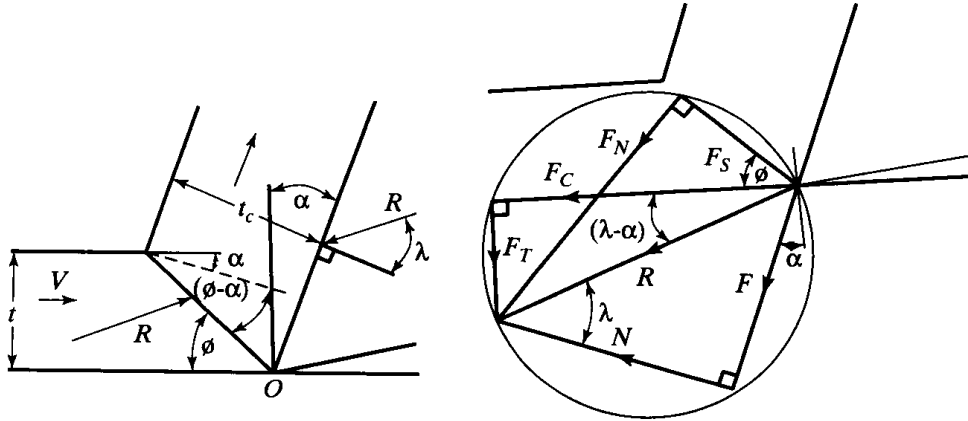
$$F_C = 2wtk \cot \phi \qquad \text{(Eq. 2)}$$

Fig. 2.   Merchant's force circle.

3. Nontraditional Machining processes are listed as follow: EDM, WEDM, CMP, ECM, USM, WJM, AJM, and AFM. Please choose **one** of the above processes to explain nontraditional machining process including drawing a figure, describing the process characteristics, advantages and disadvantages.

4. Figure 3 depicts a typical microstructure produced by a fusion weld. Please use **all the numbers** indicated in Fig. 3 to point out which zone belongs to **Base metal**, **Weld metal**, or **Heat affected zone**. Please describe the **shortages** of Heat affected zone.
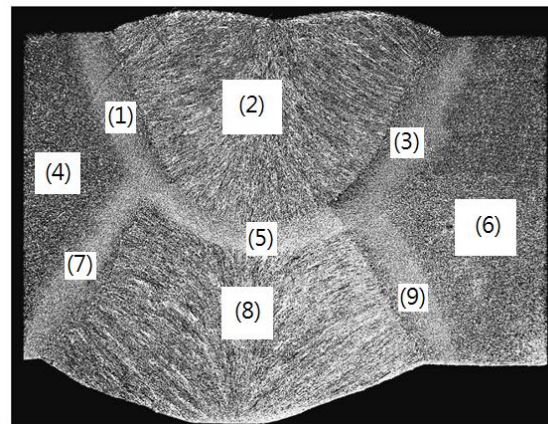

Fig. 3. A typical microstructure produced by a fusion weld

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