Student name:_____ 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 學年度第一學期 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 FCC crystal structure showed diffraction peaks at the following 2θ angels 41.069°, 47.782°, 69.879°, and 84.396°. The wavelength of the incoming radiation was 0.15405 nm.

(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. Calculate the radius of the largest interstitial void in the FCC γ iron lattice. The atomic radius of the iron atom is 0.129 nm in the FCC lattice. And the largest interstitial void occur at the (1/2,0,0), (0,1/2,0), (0,0,1/2), etc,-type positions.

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

3. What special techniques must be used to produced single crystals?

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

4. Write the equations for Fick's first law and second law of diffusion, and define each of the terms in SI units.

Student name:_____ 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 學年度第一學期 博士班資格考(Qualifying Exam)

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. Compare the engineering stress and strain with the true test and strain for the tensile test of low-carbon steel that has the following test values.

Load applied to specimen=69,000N Initial specimen diameter=1.27 cm

Diameter of specimen under 69,000N load=1.2 cm

☐ **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 $K_{IC} = 22.0$ ksi$\sqrt{\text{in.}}$ and $\sigma_f = 82.0$ ksi. Assume $Y = \sqrt{\pi}$.

☐ **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. A 1.10 percent C hypereutectoid plain-carbon steel is slowly cooled from 900°C to a temperature just slightly below 723°C.

(*a*) Calculate the weight percent proeutectoid cementite present in the steel.

(*b*) Calculate the weight percent eutectoid cementite and the weight percent eutectoid ferrite present in the steel

Student name:_____ 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 1 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）

This Qualifying exam includes two parts (Part-A and Part-B). Student should choose two to three questions in each part, 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) Please describe that how to obtain the true stress-true strain curve from tensile test in detail. (b) Please explain the difference from true stress-true strain to engineering stress-engineering strain (see Fig. 1) in detail.

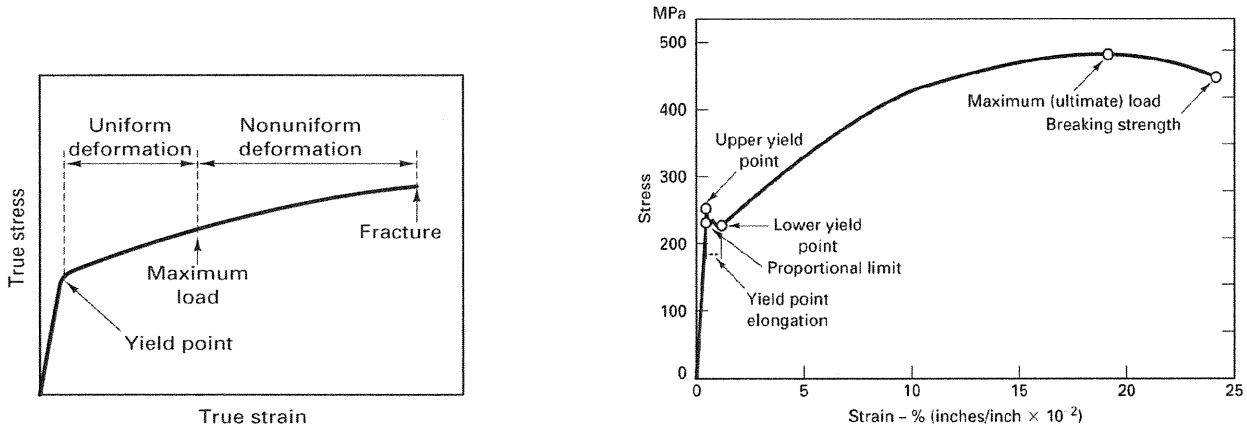


Fig.1 Stress – strain relation.

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

2. (a) Please describe two types of die casting process as shown in Fig. 2 in detail. (b) Discuss the characteristics and application areas of these two processes in detail.

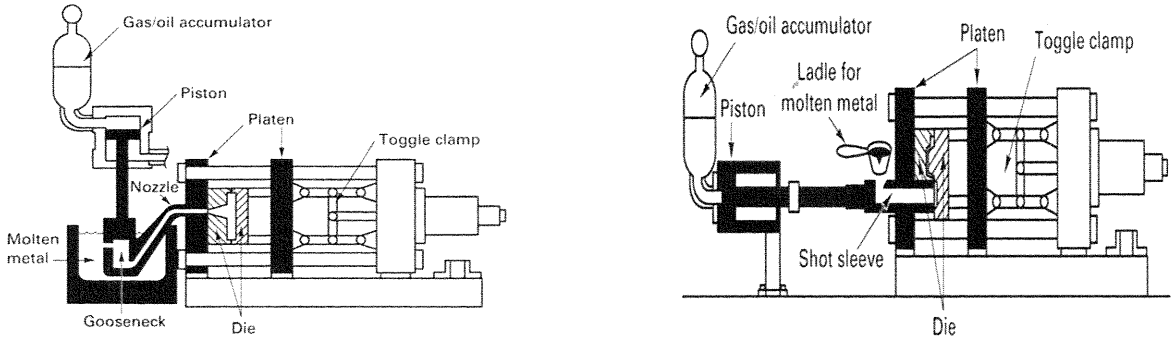


Fig. 2 Die-casting machine/process.

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

3. (a) Based on Fig.3, describe the four main processes for powder metallurgy in detail. (b) Based on Fig. 4, describe the characteristic of powder manufacturing in detail.

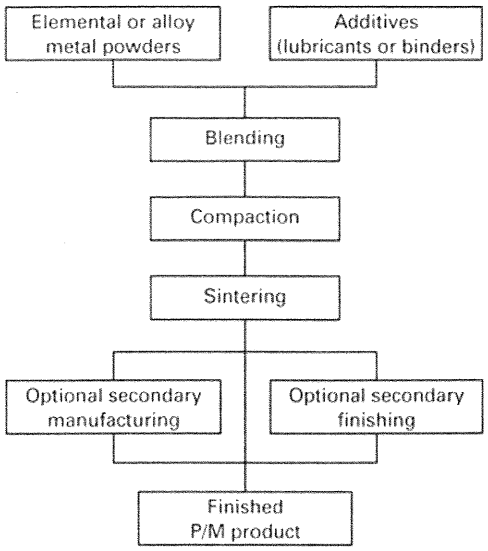


Fig. 3

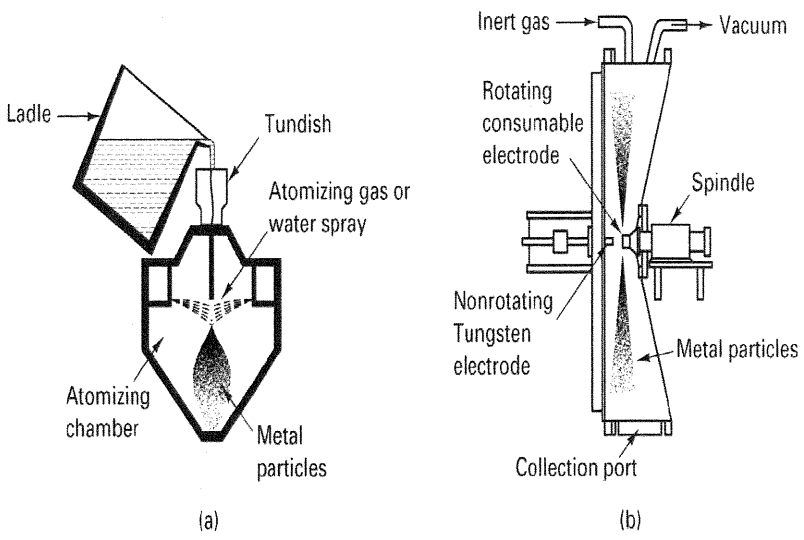


Fig.4

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

4. (a) What is metal forming? (b) Which product can be made by metal forming process? (c) How to distinguish hot working to cold working? (d) Based on Fig. 5, please explain the relationship between yield strength and temperature for four materials. Please answer the above questions in detail.

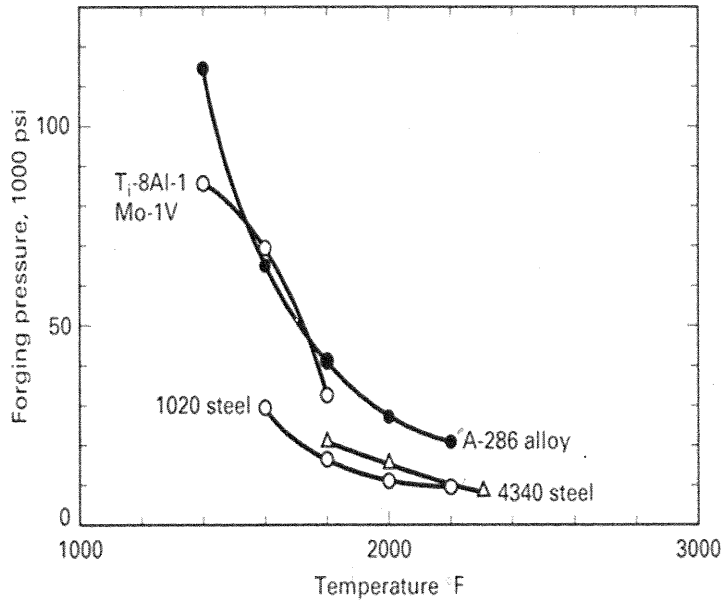


Fig. 5 The relationship between yield strength and temperature.

Student name: _____ 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 1 學期 博士班資格考(Qualifying Exam)

考試科目： Precision Manufacturing (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, 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**

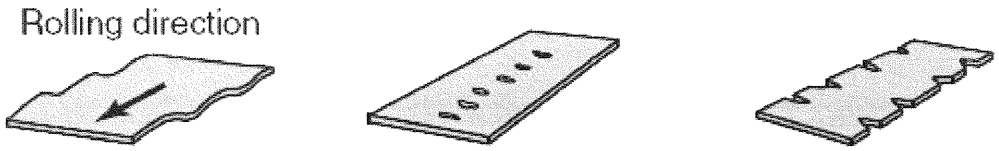
1. What are the major classifications of basic manufacturing processes?

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

2. Chvorinov's rule can be used to calculate the solidification time. If a cylinder with a diameter of 25 mm and height 75 mm solidifies in 3 minutes in a sand casting operation, what is the solidification time when the cylinder height is doubled? Using n = 2.0 in Chvorinov's rule.

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

3. Some typical defects in the flat rolling are shown in the figure below: (a) wavy edges (b) center cracking (c) edge cracking. Try to explain the cause of the phenomena.



(a) (b) (c)

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

4. What are the four basic types of nontraditional machining?

Student name:_____ 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 學年度第一學期 博士班資格考(Qualifying Exam)

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. Find the general solution of $2xyy'=y^2-x^2$

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

2. Solve the Euler- Cauchy differential equation $x^2y''-2xy'+2y=x^3$

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

3. Laplace transform, Given F(s)= £(f), find f(t)=?

$$F(s)=\frac{s^2+2s+3}{(s^2+2S+2)(S^2+2S+5)}$$

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

4. Solve the ordinary differential equation by power series solution:

$y''+(\sin x)y=e^{x^2}$ with y(0)=y'(0)=0

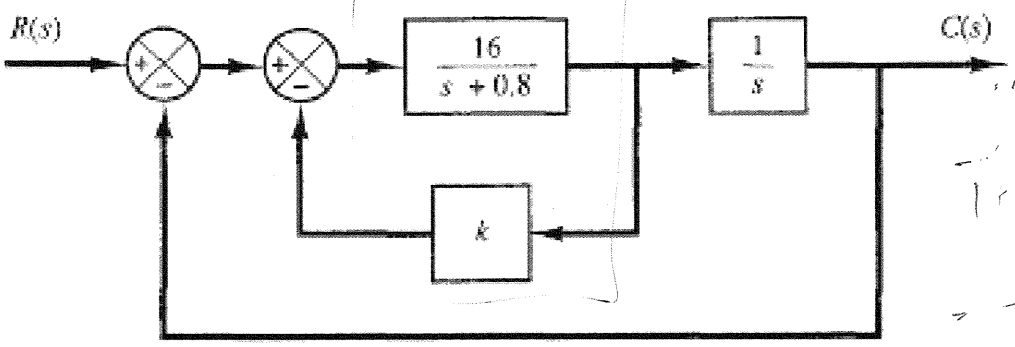


Figure 5–85
Block diagram of a system.

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

3. Determine the range of K for stability of a unityfeedback control system whose open-loop transfer function is

$$G(s) = \frac{K}{s(s+1)(s+2)}$$

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

4. Determine the values of K, T_1 , and T_2 of the system shown in Figure 7-60 so that the dominant closed-loop poles have the damping ratio § = 0.5 and the undamped natural frequency w_n, = 3 rad/sec

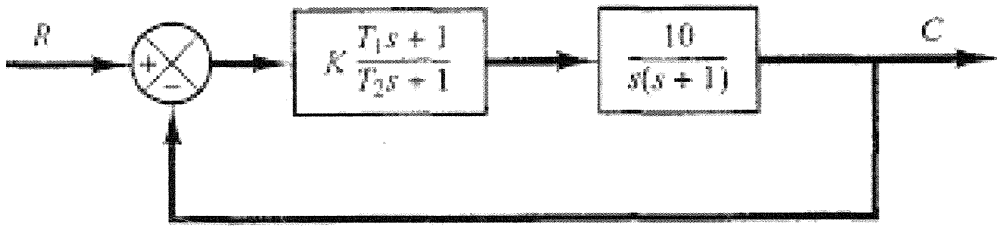


Figure 7–60
Control system.

Student name:_____ 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 學年度第一學期 博士班資格考(Qualifying Exam)

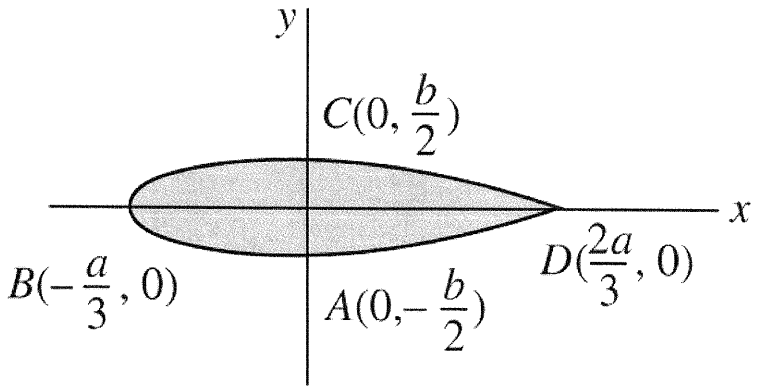
考試科目： Engineering Mathematics (Part-B)

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.A cross-section of an experimental airfoil is the lamina shown in the figure below. The arc ABC is elliptical, whereas the two arcs AD and CD are parabolic. Find the moment of inertia about the x-axis of the lamina under the assumption that the density is $\rho(x,y) = 1$.



The polar moment of inertia of a lamina with respect to the origin is defined to be:

$$I_0 = \iint_R (x^2 + y^2)\rho(x,y)dA = I_x + I_y$$

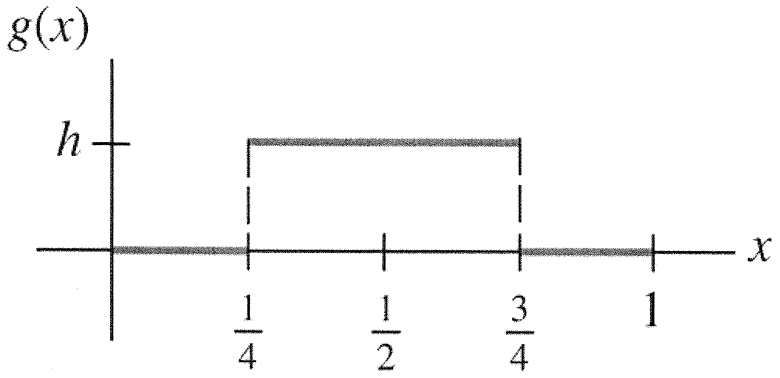
☐ **Click if you choose this question to answer**

2. Find the complex Fourier series of *f(x)* on the given interval:

$$f(x) = e^{-|x|}, \quad -1 < x < 1$$

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

3. At $t = 0$ a string of unit length is stretched on the positive x-axis. The ends of the string $x = 0$ and $x = 1$ are secured on the x-axis for $t > 0$. Find the displacement $u(x,t)$ if the initial velocity $g(x)$ is as given in the figure below.



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

4. The displacement $u(x,t)$ of a string that is driven by an external force is determined from:

$$\frac{\partial^2 u}{\partial x^2} + \sin \pi x \sin \omega t = \frac{\partial^2 u}{\partial t^2}, \quad 0 < x < 1, \quad t > 0$$

$$u(0,t) = 0, \quad u(1,t) = 0, \quad t > 0$$

$$u(x,0) = 0, \quad \left.\frac{\partial u}{\partial t}\right|_{t=0} = 0, \quad 0 < x < 1.$$

Solve for $u(x,t)$.

Student name: _____ 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 學年度第一學期 博士班資格考(Qualifying Exam)

考試科目： Automatic Control (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. Consider the liquid-level system shown in Figure 4-49. At steady state the inflow rate is $\bar{Q}$ and the outflow rate is also $\bar{Q}$. Assume that at $t = 0$ the inflow rate is changed from $\bar{Q}$ to $\bar{Q}+q_i$, where q_i is a small quantity. The disturbance input is q_d, which is also a small quantity. Draw a block diagram of the system and simplify it to obtain $H_2(s)$ as a function of $Q_i(s)$ and $Q_d(s)$, where $H_2(s) = \mathcal{L}[h_2(t)]$, $Q_i(s) = \mathcal{L}[q_i(t)]$, and $Q_d(s) = \mathcal{L}[q_d(t)]$. The, capacitances of tanks 1 and 2 are C_1, and C_2, respectively.

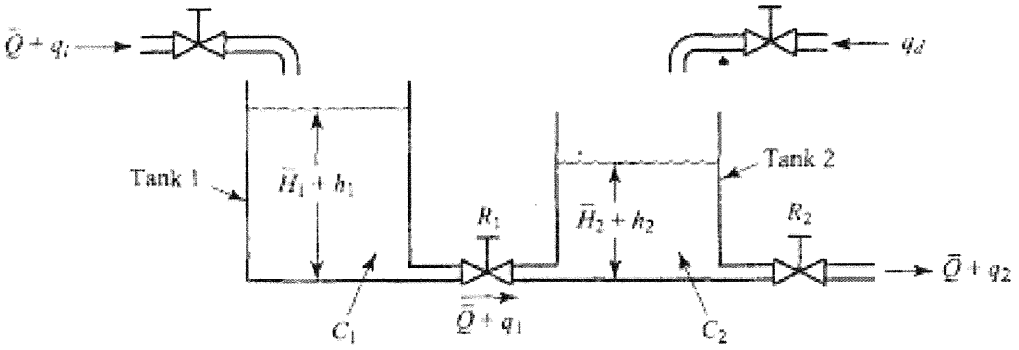


Figure 4–49
Liquid-level system.

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

2. Consider the system shown in Figure 5-85. Determinethe value of k such that the damping ratio § is 0.5.Then obtain the rise time t_r , peak time t_p , maximum overshoot M_p , and settling time t_s in the unit-step response.

缺 2 題！

$\zeta = 0.8 + 16K$

$16K =$

Student name:_____ 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 學年度第一學期 博士班資格考(Qualifying Exam)

考試科目： Automatic Control (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）

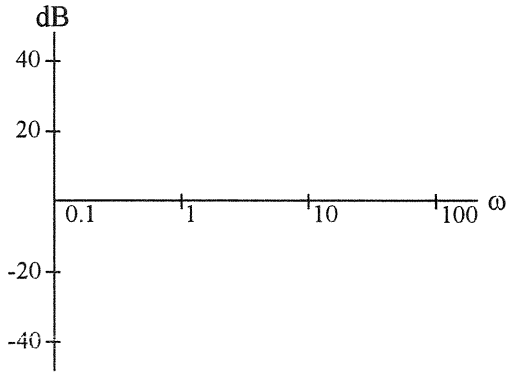
This Qualifying exam includes two parts (Part-A and Part-B). Student should choose two to three questions in each part (four questions), and the total question to answer for the sum of two parts should not excess five questions. Each question 20 points, a total of 100 points (exam time 100 minutes)

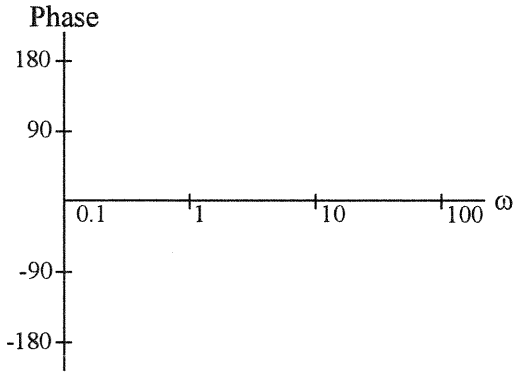
] Click if you choose this question to answer

1. Consider the system whose overall transfer function is $G(s) = \dfrac{10s}{(s+2)(s+5)}$.

(1) Derive the equations of gain and phase for the frequency response.

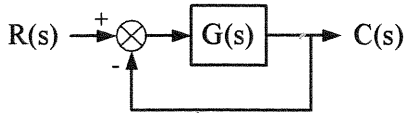
(2) Plot the Bode diagram for the system.





Click if you choose this question to answer

2. Consider a unit feedback control system with a forward loop gain $G(s) = \dfrac{10}{s(s+1)(s+10)}$.



(1) Find the value of phase crossover frequency and gain margin.

(2) Find the value of gain crossover frequency and phase margin.

(3) Draw the Nyquist or polar plot and determine if the system is stable.

Click if you choose this question to answer

3. Consider the system whose overall transfer function is $\frac{Y(s)}{U(s)} = \frac{s+3}{s^2+2s+5}$.

(1) Obtain the state space representation of the system, $\dot{X} = AX + BU$ and $Y = CX$.

(2) Find $(sI - A)^{-1}$.

(3) Compute e^{At}.

(4) Calculate $x(t)$.

(5) Calculate $y(t)$.

Click if you choose this question to answer

4. Consider the system whose state space equation is

$$\dot{X} = AX + BU = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -6 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u, \quad Y = CX = \begin{bmatrix} 2 & 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

(1) Is the system completely state controllable?

(2) Is the system completely state observable?

(3) Find $(sI - A)^{-1}$.

(4) Obtain the transfer function of the system $\frac{Y(s)}{U(s)}$.