國立雲林科技大學 105 學年度 系所：機械系
碩士班招生考試試題 科目：工程數學(1)

1. **(25%)** Consider the 2nd order ordinary differential equation (O.D.E.),

$$y'' + 6y' + 9y = \cos(3x),$$

and y is a function of x. Please find the general solution of the O.D. E.

2. **(25%)** Please solve the initial value problem for all $t \geq 0$,

$$y'' - 2y' - 3y = f(t), \qquad y(0) = 0, y'(0) = 1$$

where y is a function of t and

$$f(t) = \begin{cases} 0 & for\ 0 \leq t < 4 \\ 1 & for\ t \geq 4 \end{cases}.$$

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Prob. 3 (35%)

(1) Please find the projection of vector $\vec{A} = 3\vec{i} + \vec{j} + 5\vec{k}$ on the direction of vector $\vec{B} = \vec{i} + \vec{j} + \vec{k}$

(2) Please find the projection of vector $\vec{A} = 3\vec{i} + \vec{j} + 5\vec{k}$ on the plane of $x + y + z = 0$.

(3) Please find the angle between vector $\vec{A} = 3\vec{i} + \vec{j} + 5\vec{k}$ and the plane of $x + y + z = 0$.

(4) 10 points

Please find the equation of the plane which contains (2,4,8), and is perpendicular to the line $x = 10 - 3t$, $y = 5 + t$, $z = 6 - 0.5t$.

(5) 10 points

Please find the parametric equation of the line which contains (1,1,1), and is perpendicular to the plane $-7x + 2y + 3z = 1$.

Prob. 4 (15%)

Please find the following line integral along curve $C: y = 2x^2$ from (0,0) to (4,32)

$$\int_C (xy^2 dx + x^2 y dy)$$

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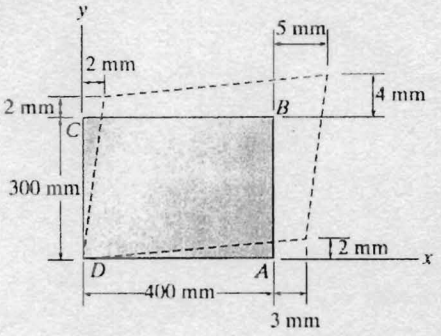
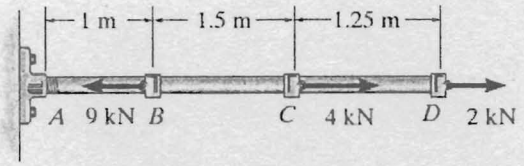
科目：材料力學

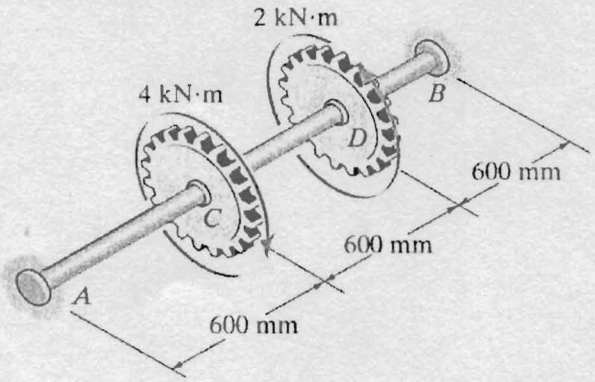
1. The piece of plastic is originally rectangular, and it distorts as shown by the dashed lines. (a) Determine the shear strain at corners A and B. (b) Determine the average normal strain that occurs along the diagonals AC and DB. [20%]



2. The A-36 steel rod is subjected to the loading shown. If the cross-sectional area of the rod is 50 mm^2, determine the displacement of its end D. Neglect the size of the couplings at B, C, and D. The Young's modulus of A-36 steel is $E_{st} = 200$ GPa. [10%]



3. The shaft is made of A-36 steel, has a diameter of 80 mm, and is fixed at B while A is loose and can rotate 0.005 rad before becoming fixed. When the torques are applied to C and D, determine the maximum shear stress in regions AC and CD of the shaft. The shear modulus of A-36 steel is $G_{st} = 75$ GPa. [20%]



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4. If the steel wide-flange beam is subjected to a shear of V = 40 kN,
   (a) determine the shear stress on the web at A. (10%)
   (b) determine the maximum shear stress in the beam. (15%)

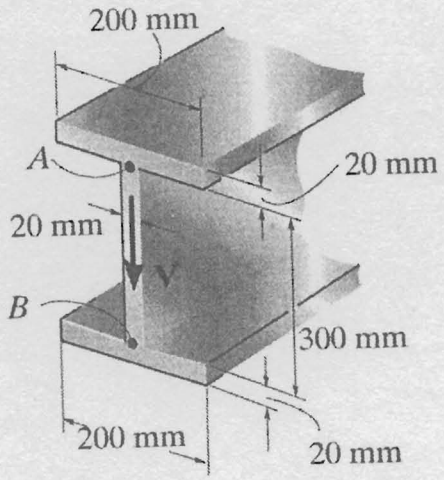

Fig. 4

5. The steel band is 50 mm wide and is secured around the smooth rigid cylinder. If the bolts are tightened so that the tension in them is 3600 N,
   (a) determine the normal stress in the band. (10%)
   (b) determine the pressure exerted on the cylinder. (15%)

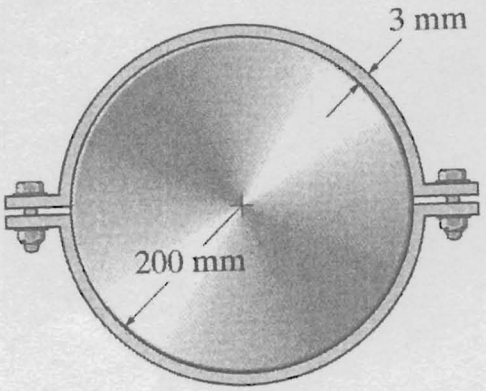

Fig. 5

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系所：機械系

科目：自動控制

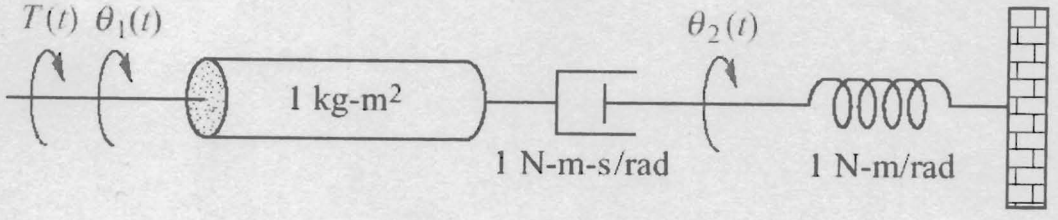
1. For the following transfer function,

$$T(s) = \frac{20}{s^2 + 6s + 144}$$

(a) Find the locations of poles and zeros. (5%)
(b) Plot them on the s-plane. (5%)
(c) Write the expression for the general form of time-domain step response. (10%)
(Hint: No need to solve for the coefficients!)
(d) State the nature of response (overdamped, underdamped, etc). (5%)

2. For the system shown below, a step torque is applied at $\theta_1(t)$. Find

(a) The transfer function, $G(s) = \theta_2(s) / T(s)$. (10%)
(b) The percent overshoot, settling time, and peak time for $\theta_2(t)$. (15%)



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3. Consider the system shown in Fig. 3a.

(A) If K is set to be 4, the step response is as shown in Fig. 3b. Determine (approximately) the *percent overshoot* and the 2% *settling time*. (15%)

(B) Discuss how to reduce the percent overshoot by adjusting K. (10%)

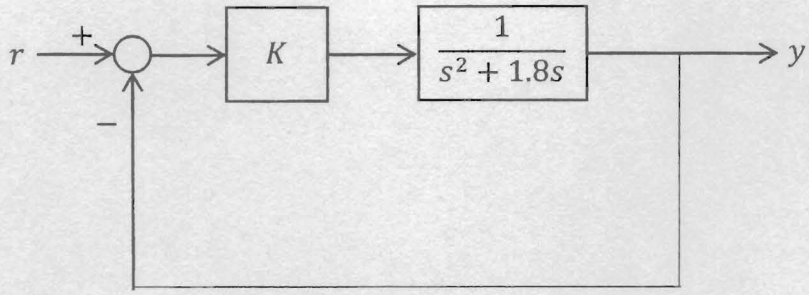

Fig. 3a

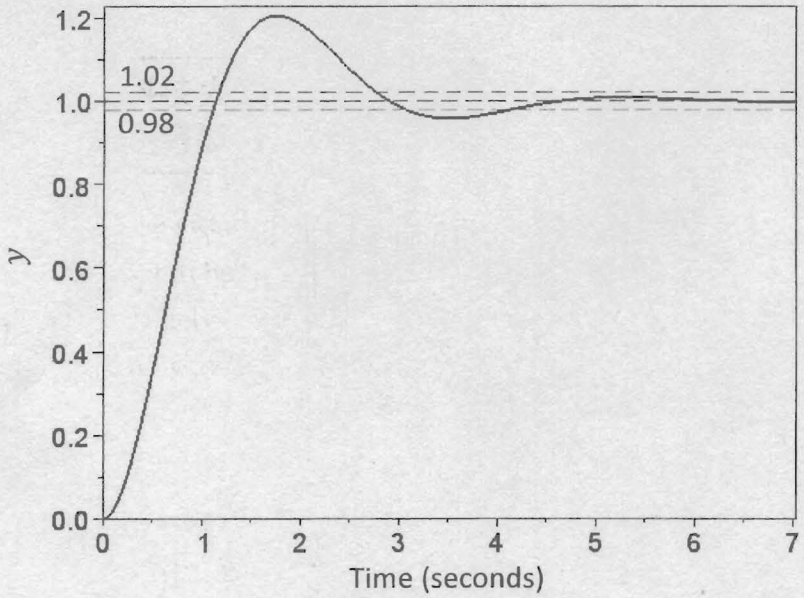

Fig. 3b

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4. For the system shown in Fig. 4a, the unit step responses of the closed-loop system for different values of K are plotted in Fig. 4b. Which of the following combinations is correct? Please *explain* your answer. (25%)

(A) $K = 5.8 \rightarrow y_1$, $K = 6 \rightarrow y_2$, $K = 7 \rightarrow y_3$

(B) $K = 5.8 \rightarrow y_2$, $K = 6 \rightarrow y_3$, $K = 7 \rightarrow y_1$

(C) $K = 5.8 \rightarrow y_3$, $K = 6 \rightarrow y_2$, $K = 7 \rightarrow y_1$

(D) $K = 5.8 \rightarrow y_1$, $K = 6 \rightarrow y_3$, $K = 7 \rightarrow y_2$

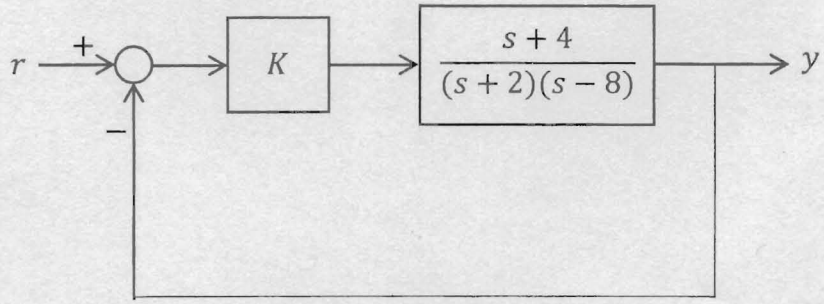

Fig. 4a

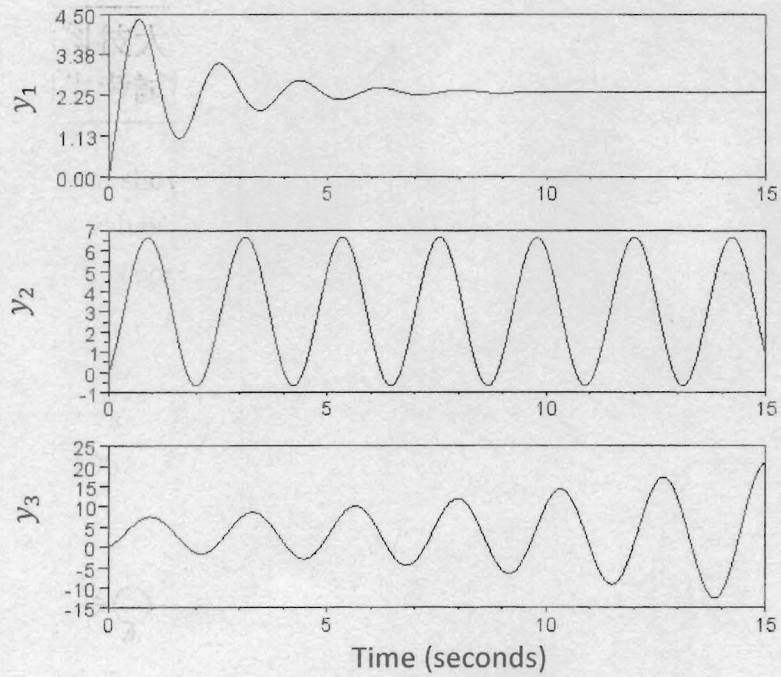

Fig. 4b