

本試題共分六大科目：(一)工程數學 (二)熱工學 (三)機械設計 (四)材料力學 (五)機械製造 (六)自動控制。每一科目含2題，共計12題。考生可任選四題作答，總分為100分。

(一) 工程數學

1. 試求解下列微分方程 (25%)

$$x^2 y'' - 5xy' + 8y = 2 \ln x$$

2. 試求解下列熱傳導方程 (25%)

$$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$$

$$u(x, 0) = f(x) \quad (-\infty < x < \infty)$$

(二) 熱工學

3. Consider a simple ideal Rankine cycle with fixed turbine inlet temperature and condenser pressure. What is the effect of increasing the boiler pressure on (i) pump work input, (ii) turbine work output, (iii) heat supplied, (iv) heat rejected, (v) cycle efficiency, (vi) moisture content at turbine exit? (25%)
4. A heat engine receives heat from a source at 1200 K at a rate of 500 kJ/s and rejects the waste heat to a medium at 300 K. The power output of the heat engine is 180 kW. Determine the reversible power and the irreversibility rate for this process. (25%)

(三) 機械設計

5. 試說明影響疲勞強度之因素有那些? (25%)
6. 試說明 Velocity ratio, gear ratio 與 Train value 的定義與各計算方法。(25%)

(背面仍有題目,請繼續作答)

(四) 材料力學

7. (1) 一般較基本之材料力學，所談論的是較細長的結構件，請你針對以下有關結構件名詞做個解釋(10%)：(a) 弦 (String) (b) 樑 (Beam) (c) 柱 (Column) (d) 構架 (Truss) (e) 軸 (Shaft)。
- (2) 若剛體(Rigid body)承受外力時，請繪出其應力—應變圖(5%)，其楊氏係數為何(5%)？為何在計算結構件內之應力問題時，往往需要考慮材料的變形以及材料性質？請說明(5%)。
8. 一個薄壁圓柱形壓力容器(Cylindrical pressure vessel)，半徑為 R ，厚度為 h ，其內部承受均勻壓力 P 。假設此壓力容器兩端封閉，請問該壓力容器內外表面之最大剪應力分別是多少(10%)？若壓力容器是由脆性材料製成，請問可以承受之最大壓力是多少(5%)？若壓力容器是由韌性材料製成，依照最大剪應力理論(Maximum shear stress theory)及最大畸變形能理論(Maximum distortion energy theory)計算可以承受之最大壓力分別是多少(10%)？假設材料之降服強度及最高強度分別為 σ_Y 及 σ_U 。

(五) 機械製造

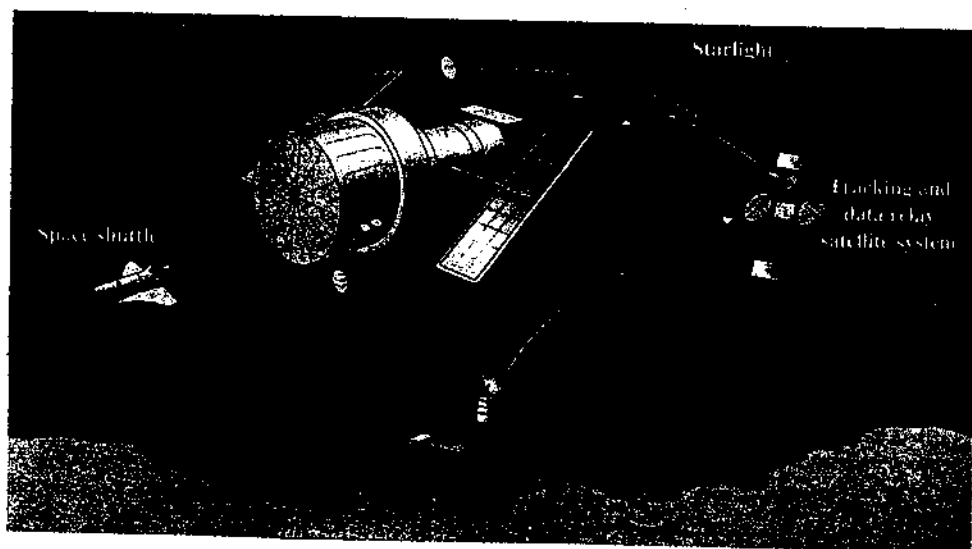
9. Three pieces of castings have the same volume, V , but different shapes. One is a sphere, one a cube, and the other a cylinder with height that is equal to the diameter. (1) Determine the surface area of the sphere in terms of V (6%). (2) Determine the surface area of the cube in terms of V (6%). (3) Determine the surface area of the cylinder in terms of V (6%). (4) Which piece will solidify the fastest and which one the slowest? (7%)
10. A 1.5 m-diameter disc with a 600-mm-diameter hole in the center is to be faced, starting at the outside, on a vertical boring machine. The rotating frequency of the table is 0.5 sec^{-1} the feed is 0.25 mm, and the back engagement (depth of cut) is 6 mm. The specific cutting energy for the work material and the particular cutting conditions is 3.5 GJ/m^3 , Calculate (1) The machining time(9%). (2) The power consumption at the beginning of the operation (8%). (3) the power consumption just before the end of operation (8%).

(六) 自動控制

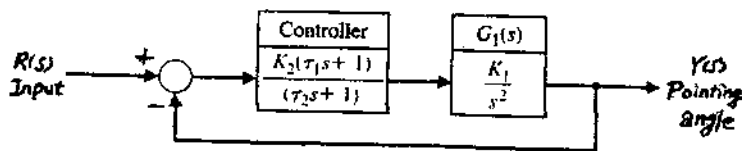
11. A space telescope is to be launched to carry out astronomical experiments. The pointing control system is desired to achieve 0.01 minute of arc and track solar objects with apparent motion up to 0.21 minute per second. The system is illustrated in Fig.(a). The control system is shown in the Fig.(b). (25%)

Assume that $\tau_1 = 1$ second and $\tau_2 = 0$ (an approximation).

- (a) Determine the gain $K = K_1 K_2$ required so that the response to a step command is as rapid as reasonable with an overshoot of less than 5%
- (b) Determine the steady state error of the system for a step and a ramp input.
- (c) Determine the value of K_1, K_2 for an ITAE optimal system for
 - (1) a step input and (2) a ramp input.



(a)

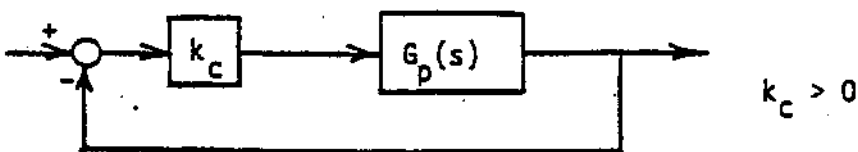


(b)

Fig.

(25%) Consider the feedback system sketched below.

12.



The frequency response of the open loop transfer function with $k_c = 1$ is shown below. Find the condition for k_c so that the feedback system is asymptotically stable.

