(1) What is the difference between the "strength" and "stiffness" of a structure? What will happen if the strength of a structure is not enough? What will happen if the stiffness of a structure is not enough? (5%) What material property represents the strength of the material? What material property represents the stiffness of the material? (5%)

(2) 請指出下列敘述錯誤之處並加以更正。(每題 3 分)

a. 應力單位 1N/mm^2=1MPa，鋼的楊氏係數大約是 207MPa。

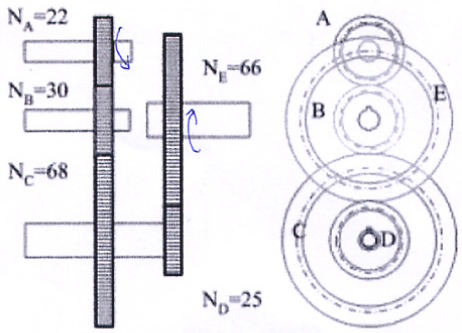
b. 應力與應變關係可以表示為 $\sigma = E\varepsilon$，其中 E 為材料的抗拉強度。

c. 扭轉一枝粉筆導致斷裂時，其斷裂方向一定和粉筆的軸成 45 度，是因為在這個方向上有最大剪應力的緣故。

d. 結構幾何形狀上突然有變化時，受力時便會造成疲勞破壞的現象。

e. 結構受力時材料並沒有立即產生破壞，而是在反覆受力超過一定的次數後，才會發生破壞，此種破壞模式稱作側潰(buckling)。

(3) 下圖齒輪減速機構中，齒輪 A 是動力輸入軸、齒輪 E 是動力輸出軸，馬達功率為 750W，齒輪 A 工作轉速 1750rpm，試計算齒輪 E 在此工作狀態下扭轉剪應力為何？齒輪 E 軸直徑 5mm，請詳細列出所有算式及單位，但不需實際計算出數值。(15%)



(4) When a spring is in compression or tension, the wire itself is twisted. Strain energy stored in the wire when the spring wire is twisted can be expressed as

$$U = \frac{1}{2}K_\theta\theta^2 = \frac{1}{2}\left(\frac{GJ}{L}\right)\theta^2 = \frac{1}{2}\left(\frac{GJ}{L}\right)\left(\frac{TL}{GJ}\right)^2 = \frac{T^2L}{2GJ}, \text{ where } T = \frac{FD_m}{2},\ J = \frac{\pi D_w^{\ 4}}{32}, \text{ and } L = \pi D_m N_a.$$

From $F = k\delta$, strain energy is equal to $U = \frac{1}{2}k\delta^2 = \frac{F^2}{2k}$. Derive spring constant k and discuss how the parameters of a spring (G, D_w, D_m, N_a) influence k. (10%)

2006/04 Doctoral Qualify Exam: Manufacturing Processes

1. Describe the working principles of the following manufacturing process and their advantages and disadvantages. 30%
   (i) Casting (ii) Bulking deformation (iii) Powder metallurgy
   (iv) Material removal (v) grinding (vi) Spinning
2. Describe the working principles of the following non-traditional manufacturing process and their advantages and disadvantages. 20%
   (i) Electrochemical Machining (ii) Plasma Arc Cutting
   (iii) Ultrasonic Machining (iv) Electrohydraulic forming