

國立臺灣科技大學

九十二學年度碩士班招生考試試題

系所組別：機械工程系碩士班甲組

科目：機械元件設計

總分 100 分

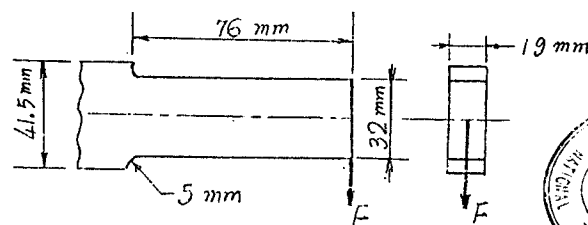
Four problems, each of which has 25 points.

1. Measurements were conducted on a machine component to determine the service conditions. A purely alternative stress was measured at a frequency of 40 cycles per minute. The distribution of stress amplitude and the relative frequency for 60 operations recorded was

$\sigma_a$ (MPa)	150	250	350
n (cycle)	20	30	10

The material has an endurance limit  $S_e'$  of 90 MPa reached at  $10^6$  cycles, while the fatigue strength  $S_f$  is 440 MPa for  $10^3$  cycles. It is recommended that a line on the  $\log S_f - \log N$  chart joining  $S_e'$  at  $10^6$  cycles and 440 MPa at  $10^3$  cycles be used to define the mean fatigue strength  $S_f$  corresponding to any life  $N$  between  $10^3$  and  $10^6$  cycles. If the material obeys the miner's rule ( $\sum \frac{n}{N} = 1$ ), determine the fatigue life (in hours) of the component. (25%)

2. A machine part is subjected to a fluctuating load. The maximum load  $F_{\max}$  is 3700 N, and the minimum load  $F_{\min}$  is 500 N. The material of the part is alloy steel, with ultimate tensile strength  $S_u$  of 400 MPa and yield strength  $S_y$  of 320 MPa. If the fully corrected endurance limit of the part  $S_e$  is 85 MPa, what's the factor of safety against fatigue failure? (25%)



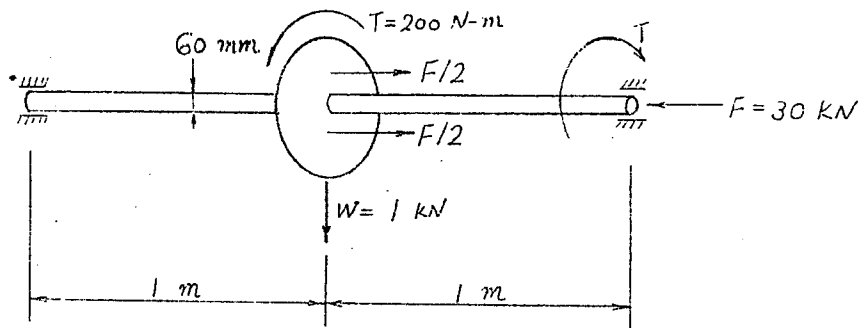
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3. A turbine wheel is load as shown below. Find the state of stresses near the wheel, at the most dangerous point, and the principal stresses. If the yield strength  $S_y$  is  $50 \text{ MPa}$ , find the factor of safety by using the von-Mises' criterion ( the maximum distortional strain energy theory). Consider the static strength and treat the structure as a simply supported beam. Stress concentration factor and fatigue failure are not under consideration. (25%)



4. Specify the diameter of a round column 1.5 m long, which is to carry a maximum load estimated to be  $22 \text{ kN}$ . Use a design factor  $n_d = 4$  and consider the ends as pinned. The column material selected has yield strength  $S_y$  of  $500 \text{ MPa}$  and a modulus of elasticity  $E$  of  $207 \text{ GPa}$ .

Note:

$$\text{Euler's column: } P_{cr}/A = \frac{C\pi^2 E}{(l/k)^2}$$

$$\text{Johnson's column: } P_{cr}/A = S_y - \frac{1}{CE} \left( \frac{S_y}{2\pi} \right)^2 \left( \frac{l}{k} \right)^2$$

$l/k$ : slenderness ratio, C: end-condition constant, A: cross-sectional area. (25%)

