# An Overview of Machine Design

1-4

Solution:

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|  | Manufacturing process | Design problems | Design revisions |
| (a) | Casting | Ununiform wall thickness may cause casting defects. |  |
| (b) | Forging | A rib in the element makes forging difficult. |  |
| (c) | Heat treatment | A sharp corner may cause stress concentration and cracks. |  |
| (d) | Assembly | A chamfer facilitates assembly. | better best |

# Strength of Machine Elements

Objective questions

2-1 c

2-2 c

2-3 d

2-4 b

2-5 d

Calculation questions

2-1

Solution:

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| Steps | Computation | Results | Units | |
| 1.Decide the maximum, minimum and stress amplitude of the fluctuating stress | From , and  We have  MPa, and  Finally,  MPa | σmax=400  σmin=100  σa=150 | MPa  MPa  MPa | |
| 2.Draw a σ-t curve | 073020170726-Fig5  Figure S2-1 Solution for Calculation question 2-1 |  |  |

2-2

Solution:

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| Steps | Computation | Results | Units |
| 1. When N=60000 | Since ,  Therefore,  MPa | σrN=326.93 | MPa |
| 2.When N=600000 | MPa | σrN=253.13 | MPa |
| 3.When N=6000000 | Since N=6000000>5×106, σrN =200 MPa. | σrN=200 | MPa |

2-3

Solution

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| Steps | Computation | Results | Units |
| 1.Find out the safety factor from the diagram | Since    so  .  Working stress: | σ0=692.3  σm=100  σa=180 | MPa  MPa  MPa |
| The coordinates of important points are:  A (0, σ-1), E (σs,0), C(σ0/2, σ0/2), A1(0, σ-1/Kσ), C1(σ0/2, σ0/2Kσ), M(σm, σa)  Substitute the data in the question, we have  A (0, 450), E (800,0), C(346.15, 346.15), A1(0, 450/1.62), C1(346.15, 213.7), M (100,180)  The simplified σm- σa diagram of the material is the lines ACGE.  The simplified σm- σa diagram of the element is the lines A1C1G1E.  073020170726-Fig6a  Figure S2-2 Solution for Calculation question 2-3 |  |  |
| The safety factor measured from the diagram is    Therefore, the shaft is safe. | S= 1.38 |  |
| 2. Calculate the safety factor of the shaft | The safety factor for fatigue strength:    The safety factor for static strength:    Therefore, the shaft is safe. | Sca = 1.4 |  |
| 3. Revise the design of the fillet radius | Increase the fillet radius to reduce stress concentration, and the fatigue strength of the shaft will be improved. |  |  |

2-4

Solution:

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| Steps | Computation | Results | Units |
| 1.Draw a simplified σm -σa diagram of the shaft material | The coordinates of important points are:  A (0, σ-1), E (σs,0), C(σ0/2, σ0/2), A1(0, σ-1/Kσ), C1(σ0/2, σ0/2Kσ), M(σm, σa)  Substitute the data in the question, we have  A (0, 450), E (800,0), C(350, 350), A1(0, 300), C1(350, 233.3), M (100, 200),  The simplified σm- σa diagram of the material is the lines ACGE.  The simplified σm- σa diagram of the element is the lines A1C1G1E.  073020170726-Fig6b  Figure S2-3 Solution for Calculation question 2-4 | σm=100  σa=200 | MPa  MPa |
| 2.The safety factor measured from the diagram | From the diagram | S= 1.34 |  |
| 3. Fatigue strength by calculation | Static strength by calculation:    The shaft is safe. | Sca= 1.37 |  |
| 4. Possible failure mode of the shaft | Fatigue |  |  |
| 5. Methods to improve the fatigue strength of the shaft | To reduce stress concentration;  To improve surface quality;  To use high strength material. |  |  |

2-5

Solution:

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| Steps | Computation | Results | Units |
| 1. Calculate the safety factor | From Eq.2-41, | Sca=1.16 |  |