Alasala University MEC432 Mechanical Design 1 Assignment 1: Shaft Design and Loading Analysis

Learning Outcomes of Assignment:

The primary aim of this assignment is to gain familiarity with the following concepts:

(a) Analysis of complex loading systems;

(b) Design of the shafts and analysis of the operating conditions.

ASSESSMENT.

This assignment will be assessed according to the following criteria (100 marks total) and it will contribute 20% towards the final mark of the course:

Plagiarism will not be tolerated and will result in 0 mark for both participating parties. You should not only present results but analyse them in accordance with the theoretical fundamentals and calculations, done by yourself.

System Overview.

As a mechanical design, the following set up is used:



You are required to design a intermediate shaft – the one shown as "Shaft" on the diagram above. Note, that the shaft is supported by two ball bearings on each end. The driver shaft and the driven shaft are placed in the horizontal and vertical place respectively, as shown on the second sketch. The torque is transmitted by two spur gears with an angle of teeth equal to 7^0 and arrangement of the teeth is shown above with points B and C (opposite angle on the gears). Transmitted power, rotational speed and outer diameters of the gears are added to the table below. Also, table includes required factor of safety and material, used to make the shaft. In addition, as the ball bearings are fixed on the shaft using the step, with the change in diameter of 10% (D_{small}=0.8 D_{shaft}) and with

smoothing radius of 0.15 of D_{small} Gears are connected to the shaft using the keys with subsequent cuts being added to the shaft. Distances are: $L_1=L_3=50$ mm.; $L_2=150$ mm. Not, that the bearings are placed at the end of the shaft, grooves to minimise axial dislocation are placed straight after the gears (points B and C).

| | | Transmitted | Rotational | Factor | Material | Diameter | Diameter |
|--------------|-----------|-------------|------------|--------|----------|----------|----------|
| | | Power, kW | Speed, | of | | of Small | of Large |
| | | | rpm | Safety | | gear, mm | Gear, |
| First name | Surname | | - | | | - | mm |
| Al Alhareth | Salem | 6.16 | 725 | 1.25 | ANSI1020 | 15 | 26 |
| Al Ali | Ahmed | 11.24 | 925 | 1.43 | ANSI1030 | 26 | 44 |
| | | | | | UNSG | | |
| Al Otaibi | Mohammad | 11.04 | 1425 | 4.61 | 10350 | 50 | 80 |
| Al Qadhib | Sulaiman | 13.81 | 1600 | 5.56 | ANSI1020 | 46 | 100 |
| Alabdulqadir | Mashal | 7.89 | 3000 | 4.24 | ANSI1030 | 20 | 48 |
| | | | | | UNSG | | |
| Alahmadi | Mohammed | 14.65 | 2500 | 1.94 | 10350 | 28 | 56 |
| Albathr | Ali | 11.33 | 550 | 3.36 | ANSI1020 | 56 | 94 |
| Alburaik | Saud | 2.72 | 800 | 4.83 | ANSI1030 | 32 | 64 |
| | | | | | UNSG | | |
| Aldossary | Khalifa | 2.89 | 750 | 4.01 | 10350 | 50 | 96 |
| Aldossary | Nawaf | 12.78 | 1150 | 2.03 | ANSI1020 | 34 | 86 |
| Aleid | Waleed | 5.38 | 2025 | 5.7 | ANSI1030 | 40 | 66 |
| | | | | | UNSG | | |
| Alfayez | Saleh | 12.04 | 1100 | 2.3 | 10350 | 18 | 58 |
| ALGAHURI | MOHANAD | 5.46 | 1450 | 2.15 | ANSI1020 | 28 | 58 |
| AlGhamdi | Ahmed | 10.03 | 975 | 2.54 | ANSI1030 | 40 | 86 |
| | | | | | UNSG | | |
| Alhabas | Mohammed | 12.86 | 625 | 2.42 | 10350 | 36 | 78 |
| Alhajri | Abdulaziz | 2.95 | 2225 | 3.84 | ANSI1020 | 58 | 88 |
| Alhalafi | Omar | 14.35 | 425 | 1.46 | ANSI1030 | 58 | 104 |
| | | | | | UNSG | | |
| Alhazim | Mohammed | 2.75 | 2750 | 4.71 | 10350 | 38 | 68 |
| Aljuraifani | Abdulaziz | 12.92 | 2250 | 2.1 | ANSI1020 | 54 | 96 |
| Alkhaldi | Mohammed | 8.80 | 2375 | 1.36 | ANSI1030 | 14 | 30 |
| | | | | | UNSG | | |
| Alkhannani | Sakhr | 11.77 | 925 | 1.87 | 10350 | 42 | 88 |
| Alkorbi | Hamad | 10.58 | 400 | 2.12 | ANSI1020 | 22 | 52 |
| Alkraidees | Bandar | 2.97 | 850 | 1.34 | ANSI1030 | 34 | 86 |
| | | | | | UNSG | | |
| ALMALEHI | RAJA | 7.72 | 1425 | 5.36 | 10350 | 70 | 144 |
| Almalihi | Fahad | 0.38 | 1800 | 5.23 | ANSI1020 | 28 | 60 |
| Almomen | Ahmad | 6.41 | 750 | 1.89 | ANSI1030 | 36 | 80 |
| | | | | | UNSG | | |
| Almotairi | Mohammed | 14.07 | 925 | 5.75 | 10350 | 20 | 60 |
| ALOTAIBI | Mohammed | 4.37 | 1850 | 4.8 | ANSI1020 | 48 | 90 |

| Alotaibi | Abdulrahman | 8.89 | 1475 | 4.21 | ANSI1030 | 30 | 88 |
|-----------|-------------|-------|------|------|----------|----|-----|
| | | | | | UNSG | | |
| Alqahtani | Faisal | 14.84 | 1500 | 4.53 | 10350 | 22 | 60 |
| AlQahtani | Nasser | 4.59 | 1600 | 1.72 | ANSI1020 | 22 | 44 |
| Alsaloly | Rashed | 12.00 | 1425 | 3.74 | ANSI1030 | 80 | 100 |
| | | | | | UNSG | | |
| Alsaqer | Mohammed | 12.20 | 1900 | 4.18 | 10350 | 22 | 60 |
| Alsenan | Hassan | 12.48 | 2750 | 4.12 | ANSI1020 | 30 | 66 |
| Alshabaan | Fares | 1.74 | 1450 | 4.14 | ANSI1030 | 25 | 68 |
| | | | | | UNSG | | |
| AlShamsy | Abdullah | 8.94 | 2250 | 4.39 | 10350 | 93 | 144 |
| Alzahrani | Saleh | 2.28 | 1100 | 2.6 | ANSI1020 | 34 | 58 |
| Bamasoud | Omar | 10.33 | 2125 | 2.23 | ANSI1030 | 52 | 98 |
| | | | | | UNSG | | |
| Haidan | Mohammed | 2.23 | 1675 | 2.06 | 10350 | 28 | 52 |
| HUSSEIN | HAMAD | 1.96 | 2275 | 1.21 | ANSI1020 | 30 | 80 |
| Lsluom | Saleh | 4.07 | 825 | 1.16 | ANSI1030 | 44 | 66 |
| | | | | | UNSG | | |
| MURRAH | FAISAL | 4.30 | 1250 | 3.39 | 10350 | 30 | 45 |
| Sharaf | Mousa | 4.34 | 950 | 4.88 | ANSI1020 | 44 | 88 |
| YAHYA | NAWAF | 14.75 | 875 | 3.15 | ANSI1030 | 36 | 70 |

Provided analysis should include the following steps:

- a) Calculate applied torque to the shaft and forces, applied to the gears (5 Points);
- b) Find reaction forces and draw required loading diagrams (20 Points);
- c) Calculate the location of the highest load and associated stresses (20 Points);
- d) Plot the Mohr's circle and find equivalent stresses (20 Points);
- e) Using FOS calculate diameter of the shaft (note, that until this moment the shaft diameter should be added as unknown) (20 Points);
- f) Using mechanical catalogues, choose preferred diameter (5 Points);
- g) Calculate and select required keys to the system using mechanical standards (10 Points).

What to submit:

You should clearly write all solutions to the questions and separate the calculations.

You should scan the solutions if they are hand-written.

Submit the file via LMS Dropbox.

You must attach a title page with information: course title, assignment name and your student ID and name.