College of Engineering
King Saud University
Muzahimiyah Branch

Student Name:	.....
Student ID:	.....

Academic Year	Semester	Exam period	Exam date
1441/1442 (2020/2021)	**2nd**	**Final Exam**	**29/04/2021 (17-9-1442H)**
Course Code	Course Title	Course level	Exam duration
AME 3010	**Mechanical Engineering Design**	**8**	**3 hrs.**
Instructor Name: **Prof. Mahir Es-Saheb**			

General Instructions:

1. **Answer ALL questions.**
2. **Assume any missing data, if any.**
3. **Use neat-labelled sketches.**

Question	**1**	**2**	**3**	**4**			**Total**
CLO No. (and %)	1-3 (100%)	3-6 (100%)	5-7 (100%)	6-8 (100%)			
Full mark	**20**	**20**	**20**	**20**			**80**
Student Marks							

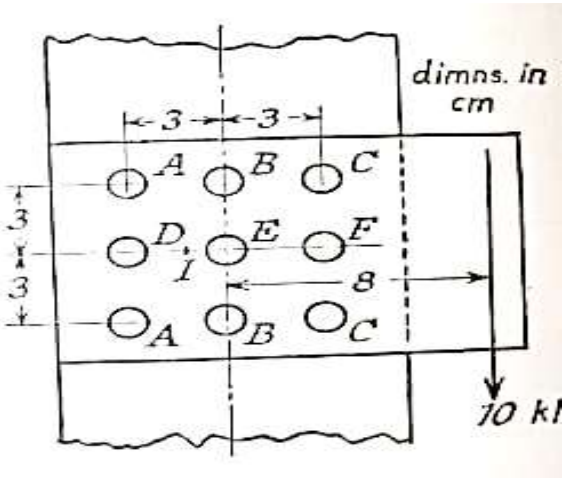
QUESTION 1 **[20 Marks]**

The shown structure is bolted to the wall by means of **9** AISI1020 steel bolts A, B, C etc. and supports a load F = 10kN.

(a) Calculate the maximum force acting on the bolts. **[8 Marks]**

(b) Determine the appropriate bolt size using Von- Mises theory with a safety factor of 4. **[4Marks]**

(c) If the load instead is varied from F = 3kN to F= 9kN and **the four bottom bolts (E, F,B and C) are removed**; determine the fatigue safety factor in this case if the bolt size and material are the same as found in (b). **[8Marks]**



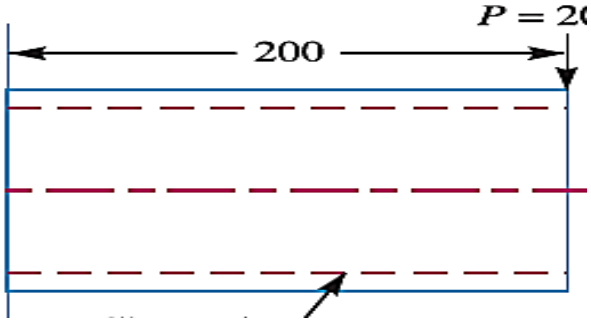
QUESTION 2 **[20 Marks]**

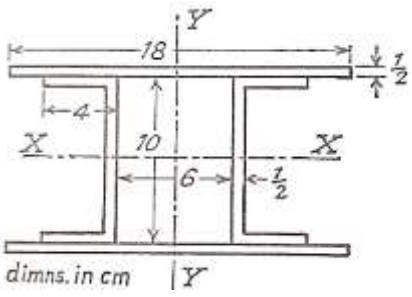
The welded structure shown, is fabricated by welding steel plates of 0.5 cm thickness to the two C-channels along the top and bottom flanges (4 cm side). This structure supports a vertical load P which varies from **2 kN** to **10 kN**; and an axial tensile force F varies from **1.5kN** to **3kN** acting at the centroid of the section. **Determine the weld size** required for a fatigue safety factor of 1.75 for the weld if an electrode of AWS 90 number is used. The solution should include:

i- Force analysis complete with proper and clear **FBD**. **[4 Marks]**

ii- Complete and systematic stress analysis of the welds showing the critical points. **[12 Marks]**

iii- The calculation steps and formulas of the fatigue. **[4 Marks]**



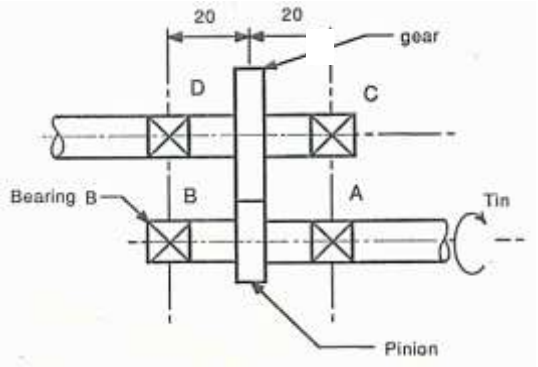


QUESTION 3 **[20 Marks]**

The figure shows a pair of shaft-mounted spur gears having a 16-tooth 20° pinion driving a 64-tooth gear. The power input is 24kW maximum at 3600rpm. The pinion is hobbed from AISI1040 Q&T steel and the gear is made from AISI1015 CD steel. The gears are intended for mild service and average mounting conditions.

a. Find the suitable values for the module and face width, based on bending stress of the gears using a factor of safety of 1.5**. [14 Marks]**

b. For the calculated face width, determine the safety factor for surface endurance (contact stresses). **[6 Marks]**

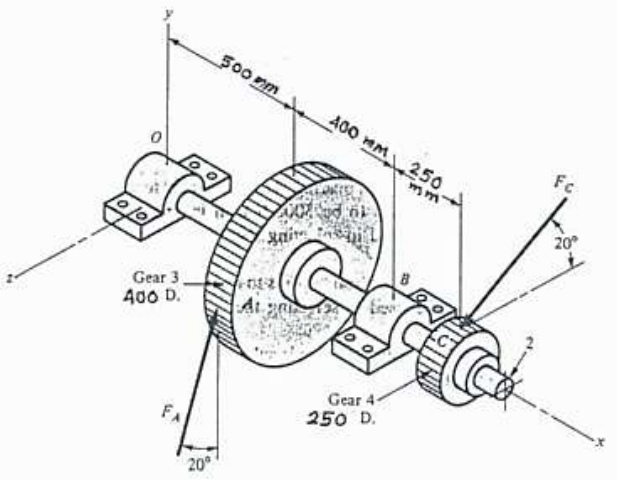


QUESTION 4 **[20 Marks]**

The figure shows a countershaft that running at 360rpm and supports two gears A and C. The force on gear A is F_A = 2670N. The reaction forces at O are F_{Oy} = 1727N and F_{Oz} = 2096N; meanwhile, at B are F_{By}= 1411N and F_{Bz}=-7209N. Use an application factor of 1.2, a life of 40 kh and a reliability of 98%.

(a) Select an angular contact ball bearing at O if it is subjected to an extra thrust load of 200N. **[10 Marks]**

(b) Select a straight roller bearing at B if it is subjected to an extra thrust load of 320N. **[10 Marks]**



Dimensions in millimetres