

* **Open Notebook Examination** (It is allowed to use lecture notebook).

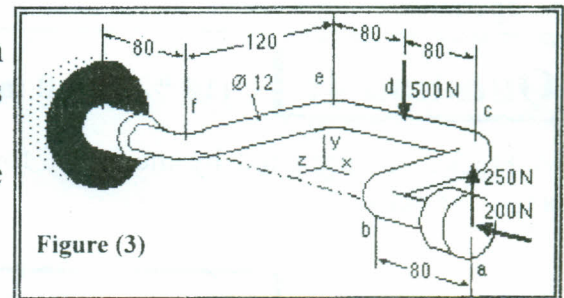
** Attempt to answer all questions and assume any missing data.

Question 1: (15 % of full mark)

The drill brace *abcdefg* ($d = 12$ mm) is made from a bent rod of 450 MPa yield steel, and is loaded as shown in Fig. (1) by the operator.

The simple support at *g* also provides the torque reaction necessary for equilibrium.

* What is the factor of safety?



Question 2: (60 % of full mark)

The four gears shown in Figure (1), have a module of 4 mm and a pressure angle of 20° . The motor shaft rotates 600 rpm and transmits 20 kW. Other data are on the drawing.

- What is the speed ratio between the motor (input) and output shafts?
- Determine all force components that the 20-tooth pinion applies to the 50 tooth gear, also the force components that the 50-tooth gear exerts on the 25-tooth pinion. Make a sketch showing the magnitude and direction of these forces applied to the gears.
- The total radial and axial reactions acting on ball bearings "A and B".
- Design **the upper shaft** which supported by the ball bearings "A and B".
- Make a constructional drawing (one sectional view), showing all details of the assembly.

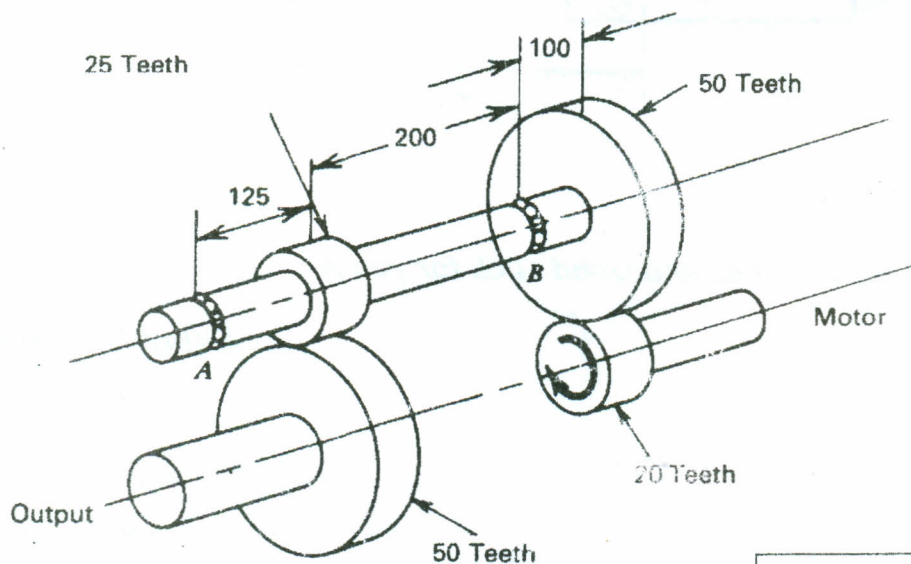


Figure (1)

Question 3: (20 % of full mark)

A screw of 50 mm. outside diameter (of square cross-section) is used in a screw-jack. Assuming that the height of nut is 1.5 times the outside diameter of the screw, and coefficient of friction is to be 0.15. If the screw-jack is used for lifting a 20 kN load at the rate of 0.02 m/s,

- (a) What is the corresponding rotating speed of the screw in rpm?
- (b) Determine the pitch, lead, mean diameter, number of engaged threads, and helix angle of the screw.
- (c) Estimate the required torque for raising and for lowering the load.
- (d) Calculate the maximum working values of torsional, axial, shear, and bearing stresses under operating conditions.

Question 4: (15 % of full mark)

A bracket is supported by means of four bolts as shown in Fig. (2). Determine the safe diameter of bolts.

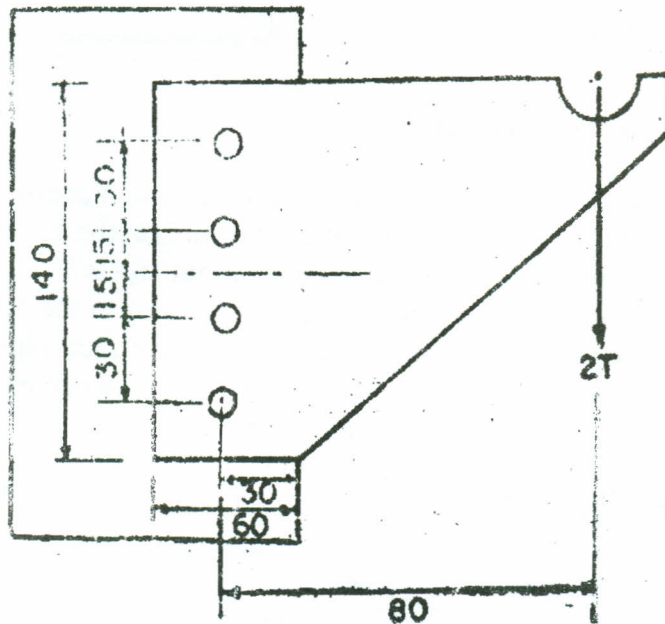


Figure (2)

With my Best Wishes and Good Luck for you &

Dr. Samy El-Gayyar