higher education & training

Department:
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AUGUST 2014

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N6

(8090086)

23 July (Y-Paper)
13:00–17:00

Candidates may use personal notes.

This question paper consists of 6 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N6

TIME: 4 HOURS

MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Show ALL the steps to achieve as many marks as possible. (An incorrect answer which must be carried forward will receive fair consideration.)
5. ALL work you do not want to be marked must be clearly crossed out.
6. Write neatly and legibly.

QUESTION 1

FIGURE 1 below, shows a kick start mechanism of a motor cycle. The maximum force on the pedal is 1 600 N.

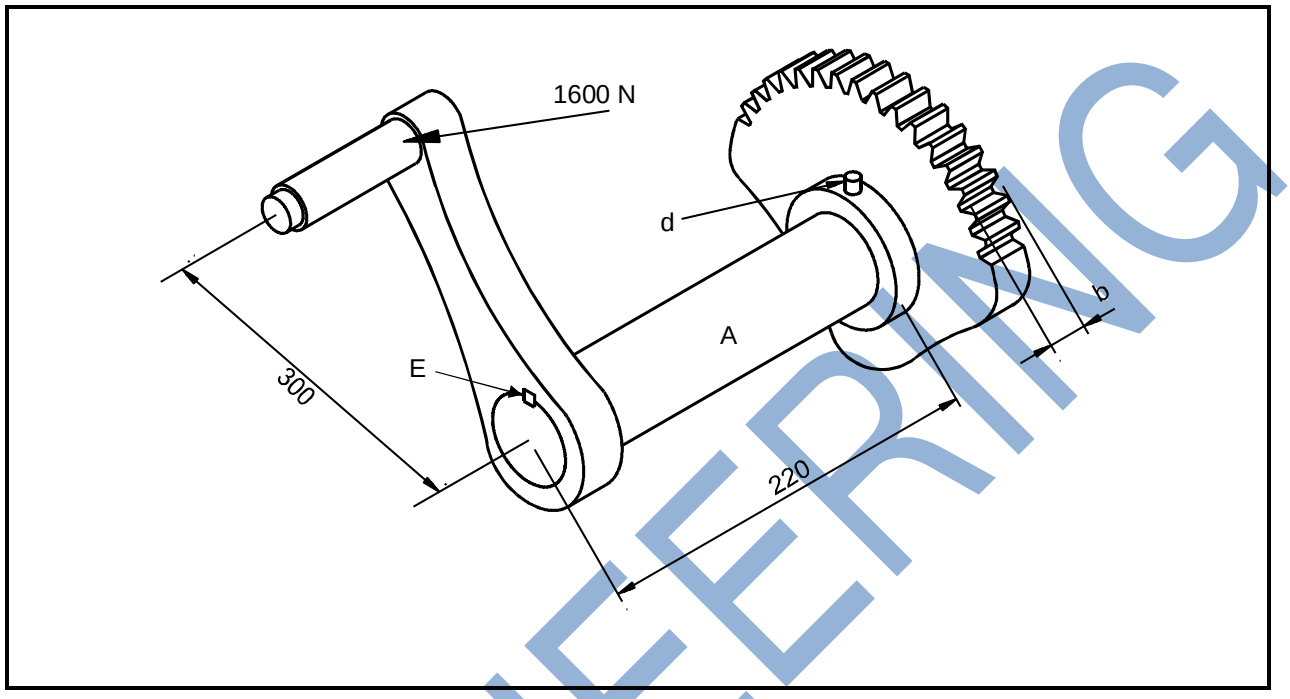

FIGURE 1

Determine the following:

1.1 The shaft diameter for both (Me) and (Te). The allowable tensile stress for the shaft is 80 MPa and the allowable shear stress is 50 MPa. The shaft is subjected to high shock and fatigue factors of = K_b = 2,5 and K_t = 2,5. (13)

1.2 The width of the gear (b), module of 10 mm, treating it as a cantilever (assume total tangential force acts on the tooth tip) where the following ratios apply and the stress is 100 MPa. Tooth height = 2,25 × module. PCD = 200 mm. (9)

1.3 The dimensions of the key (E) if the key material has a maximum shear stress of 45 MPa. (2)

1.4 The diameter (d) of the shear pin in double shear. The shear stress is 50 MPa. (2)

[26]

QUESTION 2

Two journals of a shaft 80 mm diameter carry a flywheel with a weight 4 kN which is positioned 400 mm from the centre line of the left hand bearing. The centre distance between the two bearing (journals) is 1 metre. If the friction coefficient is 0,3 when the shaft rotates at 1 200 r/min.

Calculate the following:

2.1 The power loss due to friction. (2)

2.2 The bending stress induced in the shaft (4)

2.3 The quantity of cooling oil in litres per minute that flows through the bearing to absorb the heat generated.
- Specific heat capacity of oil is 3,14 kJ/kg °C.
- Specific weight is 0,8 kg/litre
- The oil enters at 20 °C and leaves the bearing at 60 °C. (4)

2.4 Determine each journal length. Bearing pressure is 200 kPa. (6)

[16]

QUESTION 3

An hydraulic lifting apparatus is shown in FIGURE 2 below. Determine a suitable ram rod diameter (one end free, one fixed). The rod is made of mild steel with an ultimate stress of 300 MPa. Use a safety factor of 4 and a Rankine constant of $\frac{1}{7500}$ for hinged ends.

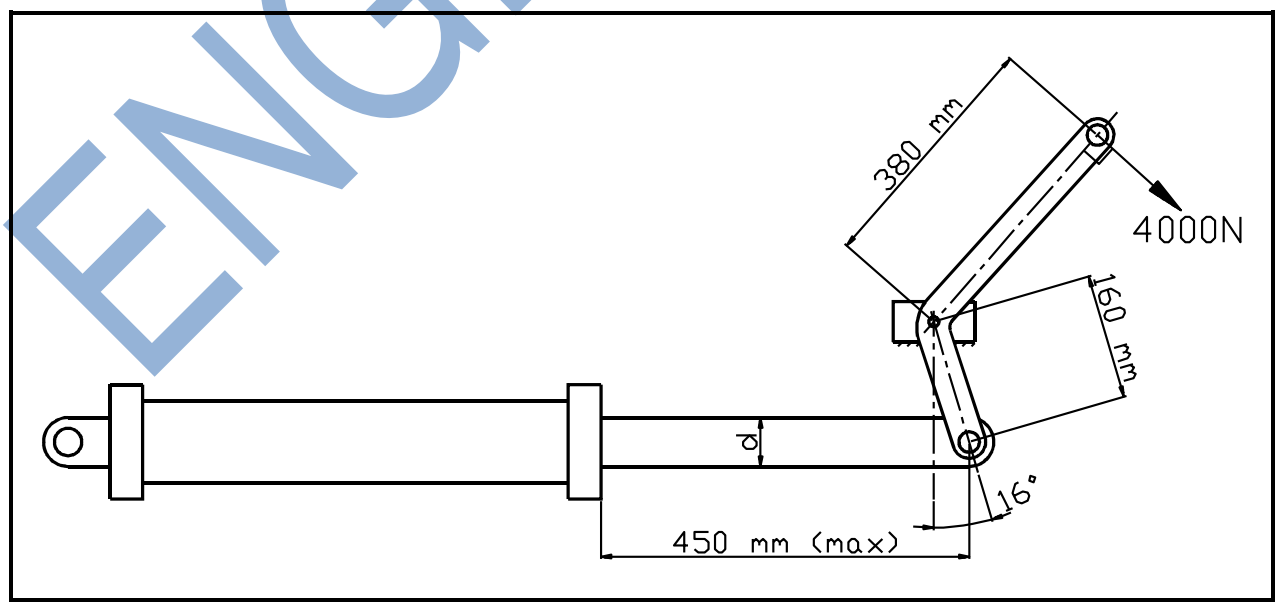

FIGURE 2 **[20]**

QUESTION 4

A disc clutch fitted between an electric motor and a machine has a single-driving plate with contact surfaces on both sides. The clutch is required to transmit 240 kW at a speed of 4 000 r/min. The outside diameter of the contact surfaces are 320 mm and the coefficient of friction is 0,4.

4.1 Calculate the inside diameter of the driving plate. Assume a constant uniform surface pressure of 220 kPa. (Use uniform pressure theory for clutch dimensions) (8)

4.2 Use the calculated plate dimensions in QUESTION 4.1 and calculate the power transmitted by the clutch if the uniform wear theory is used. (4)

4.3 In order to compensate for the difference in power between QUESTION 4.1 and QUESTION 4.2 the speed of the assembly needs to be altered.

Determine the new speed. (4)

4.4 The clutch in QUESTION 4.1 must be replaced with a multi-plate clutch having discs with outside and inside diameters of 180 mm and 130 mm respectively.

Calculate the number of plates required to transmit 240 kW at 4 000 rpm if the pressure is 220 kPa. (Use uniform wear theory) (4)

[20]

QUESTION 5

A gearbox is shown schematically in FIGURE 3 (below). The parallel shaft centres are 300 mm apart. Assume ALL teeth to be 20° full depth involute.
The input power drive shaft rotates at 1 200 r/min and carries TWO gears (A) and (C).

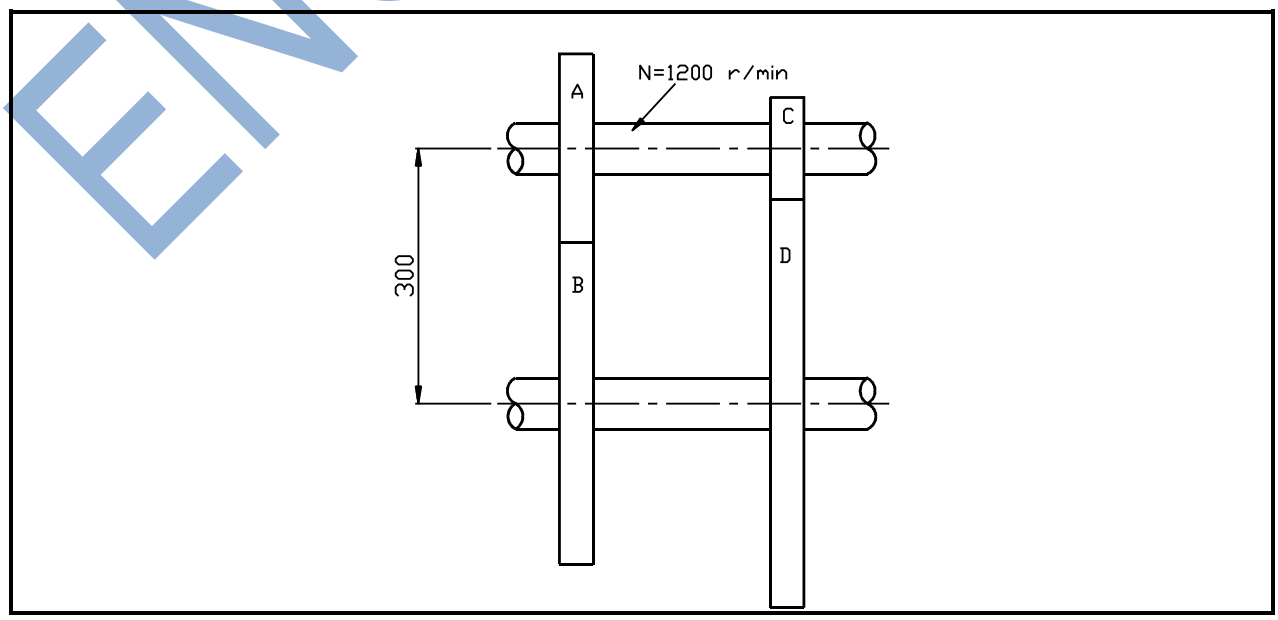

FIGURE 3

The output power driven shaft carries two sliding gears (B) and (D). (B) engages with (A) to give the driven shaft a speed of approximately 700 r/min. (D) engages with (C) to give the driven shaft a speed of approximately 300 r/min.

All the gear teeth are module 6 and widths of teeth are 3 times the circular pitch. Use a basic stress of 100 MPa for all teeth and assume one pair of teeth to make contact.

5.1 Calculate the number of teeth on each gear. (8)

5.2 The speed at each step. (1)

5.3 Use the Lewis formula to determine the power that the gearbox can transmit. (9)
[18]

TOTAL: 100