

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Agricultural & Plantation Engineering



Study Programme	:	Bachelor of Science Honours in Engineering (Agricultural Engineering) Programme
Name of the Examination	:	Final Examination
Course Code and Title	:	AGX4302 Design of Agricultural Machine Elements
Academic Year	:	2024/25
Date	:	27 th January 2026
Time	:	13.30-16.30hrs.
Duration	:	3 hours

Index number

General instructions

1. Read all instructions carefully before answering the questions.
2. Answers should be in clear handwriting.
3. Do not use red colour pen.
4. This question paper consists of two (02) sections.

Section 1

- Consists of 10 questions in **four (04)** pages.
- Answer all questions.
- The marks assigned for each question and parts thereof are indicated in brackets.
- Write answers only in the space provided.
- Please do not remove the question paper from the examination hall.
- You may spend **one (01)** hour to answer this section.

Section 11

- Contain **six (06)** questions in **three (03)** pages.
- Answer any **four (04)** questions.
- You may spend **two (02)** hours to answer this section.
- All questions carry equal marks.
- Answer for each question should commence from a new page.

SECTION 1

1. What is meant by "Adaptive Design?"

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(4 marks)

2. List **five (5)** factors to be considered in Machine design.

- i.
- ii.
- iii.
- iv.
- v.

(5 marks)

3. What is meant by following terms.

Clearance fit:

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.....

Stress Concentration:

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Ergonomics:

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(6 marks)

4. List **four (04)** types of threaded joints and give one application for each

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(4 marks)

5. Illustrate main parts of friction clutches.

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(5 marks)

6. A solid cylindrical shaft has a mass of 50 kg and a radius of 0.2 m. The cylinder rotates about its central axis.
- Calculate the mass moment of inertia of the cylinder about its central axis.
 - If the cylinder is required to accelerate from rest to 100 rad/s in 5 seconds, calculate the torque required.

.....

(5 marks)

7. A hollow circular shaft with an outer diameter of 60 mm and an inner diameter of 30 mm is subjected to a torque of 1200 Nm. Calculate the maximum torsional shear stress in the shaft. Moment of Inertia for hollow circular cross section is given by,
- $$I = \frac{\pi}{64} (D^4 - d^4)$$

.....

(4 marks)

8. List three (03) causes of wire rope failure.

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(3 marks)

9. A wire rope carries a tensile load of 25 kN and has a metallic cross-sectional area of 350 mm². Calculate the tensile stress.

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.....(2 marks)

10. List two (02) differentiate between sliding bearings and rolling element bearings

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.....(2 marks)

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SECTION 2: Answer any four (04) questions.

1. Imagine you are an agricultural engineer tasked with designing a key component for an agricultural machinery application. To ensure the component functions effectively and safely, a structured design approach must be followed. Describe the step-by-step procedure you would undertake to design this component.

(15 marks)

2. a) Explain stress and strain with suitable diagrams.

b) A steel rod of length 2 m and diameter 20 mm is subjected to an axial tensile load of 40 kN. (Young's modulus, $E = 200 \text{ GPa}$)

Calculate:

- i. Tensile stress
- ii. Tensile strain
- iii. Elongation of the rod

c) A steel rod is rigidly fixed at both ends and subjected to a temperature rise of 40°C . (Young's modulus, $E = 200 \text{ GPa}$, Coefficient of thermal expansion, $\alpha = 12 \times 10^{-6} / ^\circ\text{C}$). Calculate the thermal stress induced in the rod.

(15 marks)

3. A power screw with a mean diameter (d_m) of 25 mm and a lead (L) of 5 mm is used to lift a load (W) of 2000 N. The coefficient of friction (μ) between the screw and the nut is 0.15. Thus, P is required axial force, N is Normal reaction and μN is the friction force.

- i. Calculate the lead angle (α)
- ii. Determine the require axial force (p)
- iii. Determine the torque required (T) to raise the load using the formula

$$T = \frac{Wd_m}{2} \times \left[\frac{L + \pi\mu d_m}{\pi d_m - \mu L} \right]$$

- iv. find the efficiency of power screw

(15 marks)

4. a.) A single-plate clutch has: Inner radius: $r_i=80$ mm, Outer radius: $r_o=160$ mm. Calculate the mean effective radius R_m of the clutch for:

- i. Uniform pressure (constant pressure)
- ii. Uniform wear (constant wear of friction material)
- iii. A caliper brake is required for the front wheels of a sport's car with a braking capacity of 820 N m for each brake. Preliminary design estimates have set the brake geometry as $r_i = 100$ mm, $r_o = 160$ mm, and $\theta = 450$. A pad with a coefficient of friction of 0.35 has been selected. Determine the required actuating force and the average and maximum contact pressures.

(15 marks)

- 5.) a.) List five (05) factors considered in the selection of a suitable bearing
- b.) Define life of the bearing
- c.) A machine shaft is supported by a cylindrical roller bearing and is subjected to a radial load of 7.5 kN. The shaft rotates at a speed of 1000 rpm. The required service life of the bearing is 8760 hours. For a cylindrical roller bearing, the life exponent is $k=3.33$. Assume that the load acting on the bearing is purely radial.
- i.) Calculate the bearing life in million revolutions.
 - ii.) Determine the required basic dynamic load rating (C) of the bearing.
 - iii.) List the three (03) main factors to be considered during the installation of roller bearings.
 - iv.) A steel shaft of length 1.2 m operates with a temperature rise of 40 °C. If the coefficient of linear thermal expansion of steel is,

$$\alpha = 12 \times 10^{-6} / ^\circ\text{C}$$

calculate the axial growth of the shaft.

(15 marks)

6. Write short notes on following three (03) topics.

- i) Classifications of Machine Design
- ii) Factors consider in shaft designing
- iii) Fits
- iv) Stress Concentration
- v) Clutches

(15 marks)