UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: May 2023

Module Number: ME 5303 **Module Name: Mechanical Engineering Design**

[Three Hours]

[Answer **all questions**, each question carries ten marks]

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

Q1 a) Briefly describe the term "parts interchangeability" in machine design, using the terms "limits, fits and tolerances"

[2.0 Marks]

b) With the aid of labled sketches, describe one practical application for each of the following.
   i) Clearance fit,
   ii) Transition fit
   iii) Interference fit

[3.0 Marks]

c) Explain with graphical interpretations, the comparison of the following two fits. Use the alphabetical representation of fundamental deviations for basic shaft and basic hole system shown in Figure Q1.
   i) 100 H7/h7
   ii) 100 H5/h5

[2.0 Marks]

d) It is suggested at a design change of shaft/ hole dimensioning, to replace the fit (ii) above with (i). Discuss the consequences of this proposed change.

[3.0 Marks]

Q2 a) Ergonomics plays a major role in machine design. Briefly explain with an example for each of the following items, how they affect the wellbeing of the workers and worker efficiency.
   i) Ventilation
   ii) Noise level
   iii) Human muscle effort

[3.0 Marks]

b) Give three remedial actions for each of the above conditions (altogether 9 actions).

[4.0 Marks]

c) Three different work table heights (a, b and c) and reference "Elbow height" for a standing worker are shown in Figure Q2. Identify the most suitable working height for heavy work, light work and precision work. Briefly explain your selection.

[3.0 Marks]

Q3) a) The load carrying ability of a wedge-film journal bearing results when the journal and/or the bearing rotates relative to the load. With the aid of labeled sketches, explain the following two situations when a rotating shaft supports a weight of W.

i) Shaft starts to rotate

ii) Shatt rotates at design speed

[2 Marks]

b) With the aid of a sketch describe the pressure distribution on a shaft held in a journal bearing, when it is running at the design speed.

[2 Marks]

c) A 50 mm diameter shaft carrying a load of 2800N is supported by an 80 mm long journal bearing. The bearing has a radial clearance of 0.05 mm and the viscosity of the oil is 0.021 $kg\ m^{-1}s^{-1}$at the operating temperature. The bearing is capable of dissipating 80W of heat.

i) Sketch the bearing and shaft arrangement indicating all dimensions.

ii) Determine the maximum safe speed of the shaft.

Note: With the usual notation, the coefficient of friction is given by $\mu = \frac{33}{10^8}\frac{ZN}{p}\frac{d}{c} + 0.002$ and Heat generation is given by $Q_g = \mu WV$

[4 Marks]

d) If the above shaft must operate at slightly increased load but at the same speed, what precautions would you recommend?

[2 Marks]

Q4 a) Describe 2 advantages and 2 disadvantages of gear drives when compared with belt drives.

[2 Marks]

c) A pair of spur gears is to transmit 20 kW when the pinion rotates at 300 r.p.m.

b) The velocity ratio is 1:3. The allowable static stress for the pinion and gear materials is 120 MPa.

The pinion has 15 teeth and its face width is 14 times the module. Taking into consideration the effect of the dynamic loading and from the standpoint of strength only, determine the following.

i) Gear module

ii) Pitch Circle Diameters of the pinion and gear.

You may use the following relationships.

Tooth form Factor $y=0.154-0.912/T$, where T is the number of teeth

Velocity Factor $C_v=3/(3+V)$, where V is the surface speed of gears in m/s

Working static stress $\sigma_w = C_v \cdot \sigma_o$

Tangential tooth load $W_T = \sigma_w.b.\pi\ m.y$, where b is the width of the gear wheel

[6 Marks]

d) Explain what other design checks are required for the gear drive to be durable.

[2 Marks]

Q5 You are required to design a screw press to squeeze excess water out of raw garbage in a daily collected garbage processing facility. The garbage is loaded into a 450mm diameter and 3 m long cylindrical compression chamber. A screw feeder inside the compression chamber slowly feeds the garbage from one end of the compression chamber and squeezes excess water to drain through holes on the cylindrical wall of

the compression chamber. The squeezed garbage leaves the other end of the cylinder and is sent to a compost yard.

With the aid of clear sketches, answer the following questions.

a) Draw a block diagram (not a 3D sketch) for the electromechanical system of the press with necessary feedback and actuator mechanism.

[2 Marks]

b) As the designer of the system, what are the operational parameters that you would want to know from the client?

[2 Marks]

c) Draw a detailed sketch of the assembly of compression chamber, feeding screw, bearing arrangements and drive mechanism.

[2 Marks]

d) Identify 2 durability issues of the system and propose remedial actions.

[2 Marks]

e) Explain design features required during a possible blocking of the screw with garbage.

[2 Marks]

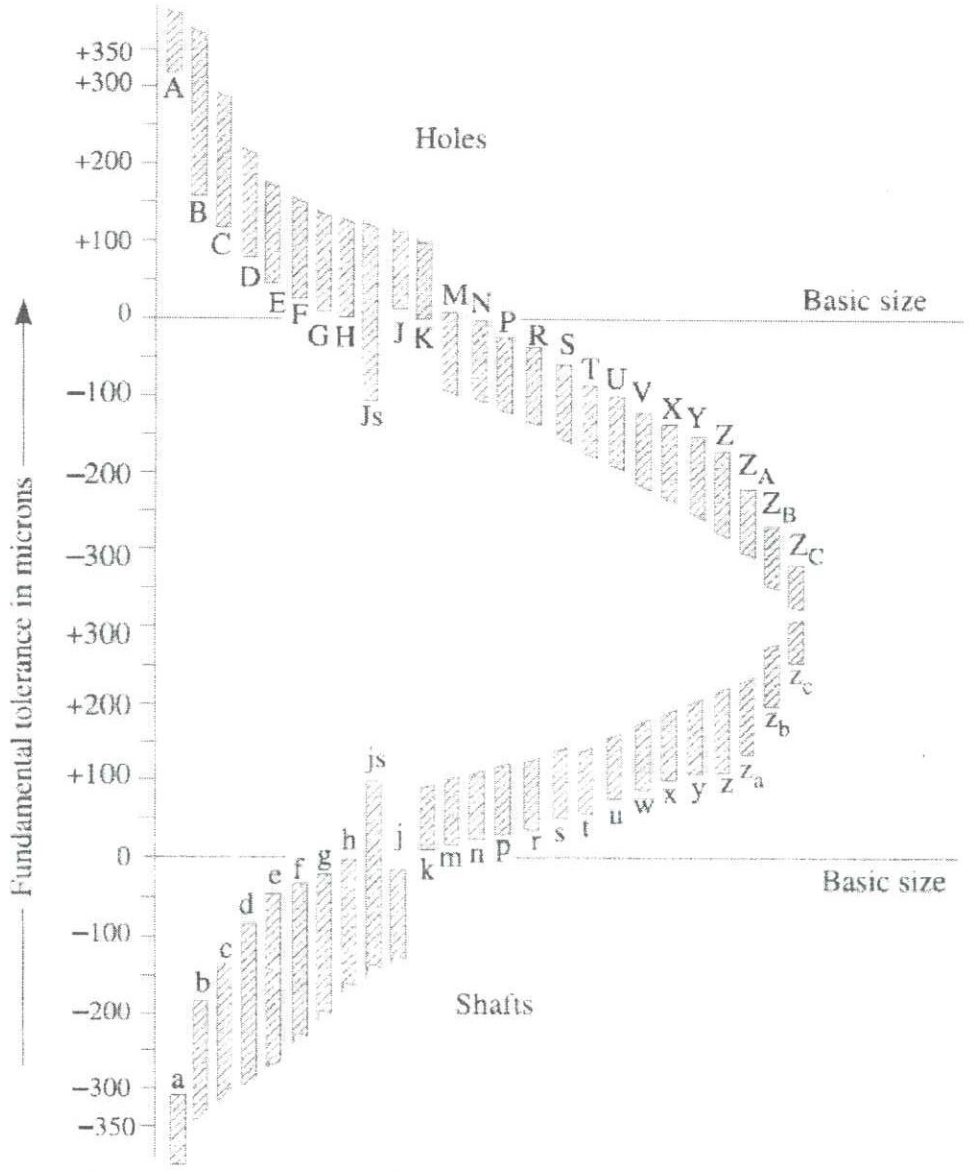

Figure Q1 The alphabetical representation of fundamental deviations for basic shaft and basic hole system

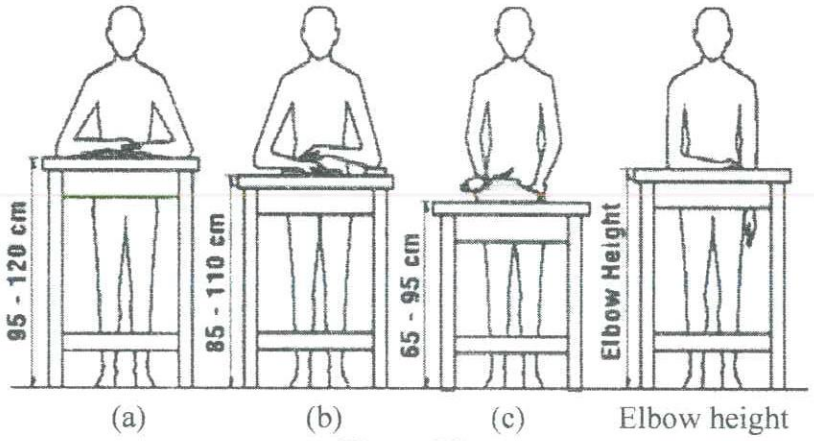

Figure Q2