UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: March 2026

Module Number: ME 5303 Module Name: Mechanical Engineering Design – C23

[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 and abbreviations stated herein denote standard parameters.

Q1 a) With reference to parts interchangeability, limits, fits and tolerances explain the terms "Basic Size", "Fundamental Deviation "and "Upper Deviation". Use a labeled sketch.

[3.0 Marks]

b) Compare the following three mating shaft-hole pairs. Use the alphabetical representation of fundamental deviations for the basic shaft and basic hole system shown in Figure Q1. A comparison of tolerance zone heights is expected in your answer. Use a **common zero line** in your sketch.

i) 200 G7/h7
ii) 300 G5/h5
iii) 300 G7/k7

[4.0 Marks]

c) Give one possible advantage and a disadvantage of replacing 300 G5/h5 with 300 H7/h7.

[3.0 Marks]

Q2 a) Briefly explain how the flowing factors affect the wellbeing of the workers and worker efficiency. State **one example for each** of them.

i) Illumination intensity and direction
ii) Noice and vibration level
iii) Metabolic rate

[3.0 Marks]

b) What are the corrective actions you may suggest for each of the above conditions?

[4.0 Marks]

c) Ergonomically designed workspaces reduce worker fatigue. With the aid of a sketch, explain how a car driver's space has been designed to satisfy "reach envelope" conditions.

[3.0 Marks]

Q3) a) Explain with a sketch, the hydrodynamic pressure distribution around a shaft carrying a radial load *W*, supported by a journal bearing. Assume counterclockwise rotation of the shaft at its design speed.

[3.0 Marks]

b) An 80 mm long, 50 mm diameter journal bearing supports 3500 N load. The bearing has a radial clearance of 0.05 mm and the viscosity of the oil is 0.021 kg/ms at the steady operating temperature. The bearing can dissipate 100 W of heat. Determine the safe speed of the shaft. State the assumptions.
Note: With the usual notation, the coefficient of friction of sliding contact bearing is given by $\mu = \frac{33}{10^8}\frac{ZN}{p}\frac{d}{c} + 0.002$ and heat generation is given by $Q_g = \mu WV$

[4.0 Marks]

c) Explain the possible risks and precautions if the above shaft is rotated at a faster speed but under the same load

[3.0 Marks]

Q4 a) Center distance between two meshing gears is crucial for its satisfactory operation. Explain how this requirement is achieved in design of gear drives.

[3.0 Marks]

b) A pair of spur gears has the following operational requirements. The distance between the shafts is restricted to 500 mm. The speed of the driving gear is 900 r.p.m. and the speed of the driven gear is 200 r.p.m. The torque requirement of the driven shaft is 5000 Nm. The allowable static stress of the gear material is 140MPa. Determine:
i) Pitch Circle Diameters of the pinion and gear.
ii) Module of the gears
State the assumptions. You may use the following relationships.
Tooth form Factor $y=0.154-0.841/T$, 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 $\sigma_w = C_v . \sigma_o$
The face width of the gear $b=10m$
Tangential tooth load $W_T = \sigma_w.b.\pi\, m.y$, where b is the width of the gear wheel

[4.0 Marks]

c) Describe two additional durability checks required for satisfactory performance of the above gear drive.

[3.0 Marks]

Q5 Assume that you are required to design a floor mounted crane to pick up 500 kg, 1 m^3 palates from a railway wagon and load them to a flatbed truck. The crane is electrically powered and manually operated.

a) Sketch the plan view and a side view of the set up **(not a 3D sketch)** for the unloading operation that you propose. Label all the main components and surrounding sub-systems required.

[4.0 Marks]

b) Describe two safety issues that you anticipate and propose respective safety precautions.

[3.0 Marks]

c) Describe three design features proposed in your design to protect the hoist from overloading.

[3.0 Marks]

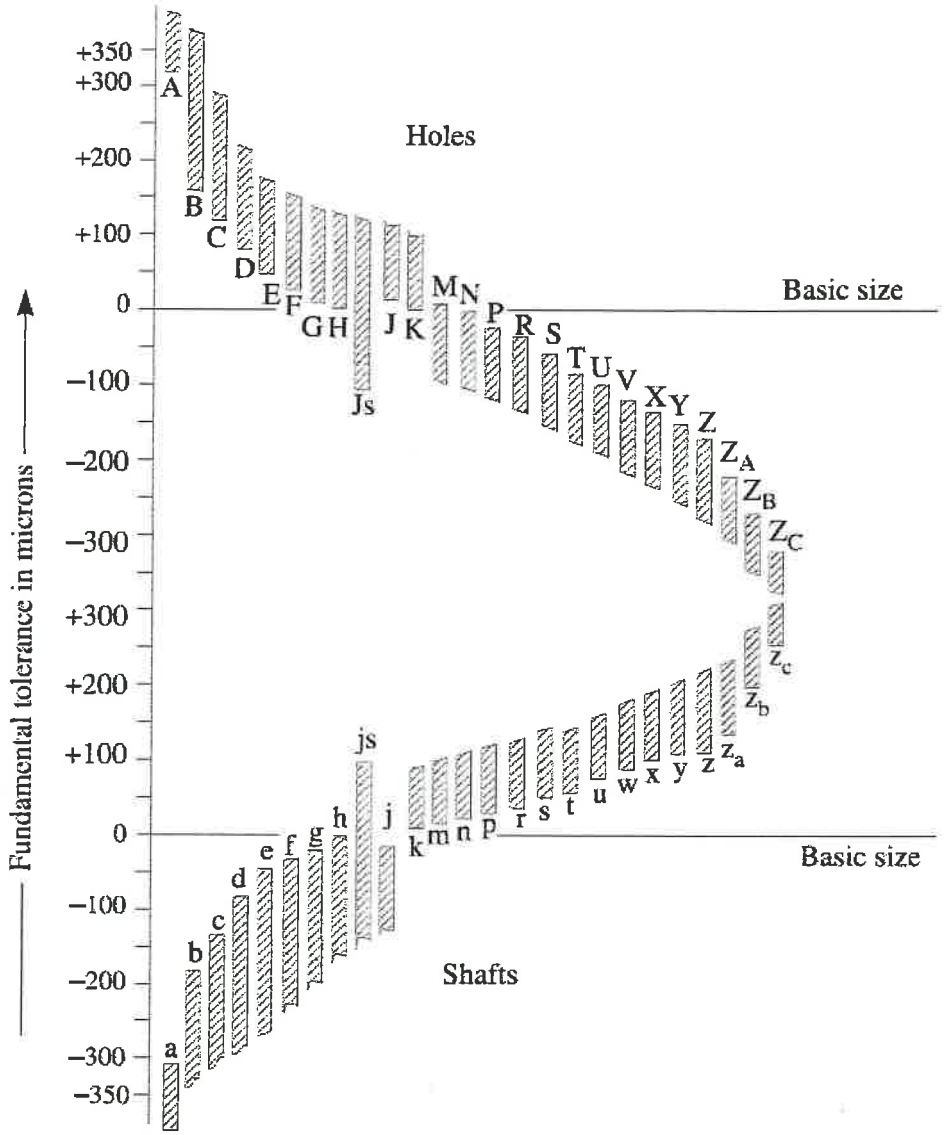

Figure Q1 The alphabetical representation of fundamental deviations for the basic shaft and basic hole system