UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: December 2020

Module Number: ME 5303 **Module Name: Mechanical Engineering Design (C-18)**

[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 requirement of "Parts Interchangeability" in mass production of machine components

[2.0 Marks]

b) With the aid of labled sketches, explain the three different types of fits used in the manufacturing industry.

[3.0 Marks]

c) Figure Q1 shows the alphabetical representation of fundamental deviations for basic shaft and basic hole system. Compare graphical interpretations for the following two fits and explain the functionality of the two fits.

i) 150 H6/g5

ii) 50 M5/k5

[2.0 Marks]

d) Some time, spare parts for a certain machine are not available in the market and you will have to produce them inhouse. Explain three different problems that would occur if the correct fit was not maintained during such inhouse production.

[3.0 Marks]

Q2 a) Discuss the social value and economic value of ergonomics.

[2.0 Marks]

b) Posture and movements of a person are the key factors considered for practicing ergonomics. Discuss four biomechanical aspects used for practicing ergonomics.

[2.0 Marks]

c) Your company asked you to design an adjustable computer chair which is suitable for the middle 90% of the population. Use the data given in Table Q2 and Figure Q2, answer the following questions.

i) Specify the minimum height and maximum height of the seat from floor. Consider that 45mm should be added as high heel foot ware height and 25mm as flat shoes for females and 25mm for males. Write the arguments that you made to get the decision.

[4.0 Marks]

ii) Calculate the width between the armrests. You are asked to add 65mm as clearance. Write the argument/s that you made to get the decision.

[2.0 Marks]

Q3 a) Classification of Bearings can be done in many ways based on different point of views. Discuss the classification of bearing under four main categories based on load and contact, with essential details and sketches.

[1 Mark]

b) The sliding contact bearings may also be classified, according to the thickness of the layer of the lubricant between the bearing and the journal. Discuss this in detail.

[1 Mark]

c) i) Discuss the assumptions in Hydrodynamic Lubrication.

[1 Mark]

ii) Briefly discuss the four Properties of Sliding Contact Bearing Materials.

[1 Mark]

d) Discuss the variation of coefficient of friction with bearing characteristic number with suitable details.

[2 Marks]

e) Discuss the design procedure of a Journal Bearing (in point form), to find out mass of the lubricating oil required for artificial cooling. The following details are given.

Load on the journal = 20000 N; Speed of the journal = 900 rpm; Type of oil is SAE 10, for which the absolute viscosity at 55°C = 0.017 kg / m-s; Ambient temperature of oil = 15.5 °C; Maximum bearing pressure for the pump = 1.5 N / mm^2. Take Heat dissipation coefficient = 1232 $W/m^2/°C$ and rise of temperature of oil be limited to 10°C.

[4 Marks]

Q4 a) Describe 3 advantages and 3 disadvantages of gear drives when compared with belt drives.

[2 Marks]

b) Describe 4 different modes of failure of gear drives

[2 Marks]

c) A Spur gear drive must be designed with the following requirements.
Power to be transmitted: 25kW, Speed of the pinion wheel: 300rpm, Speed ratio:3, Maximum static pressure σ_o on the pinion material: 120 MPa, Number of teeth on the pinion: 15, width of the gear is 14 times its module. Find the module of the gear drive.
You may use the following relationships.
Tooth form Factor $y=0.154-0.912/No\ of\ teeth$
Velocity Factor $C_v=3/(3+V)$, where V is the surface speed of gears in m/s
Working static stress $\sigma_w = C_v . \sigma_o$
Tangential tooth load $W_T = \sigma_w.b.\pi\ m.y$, where b is the width of the gear wheel

[4 Marks]

d) Describe two possible design changes in the above gear drive for it to transmit 40kW at the same speed. Design calculations are **not** expected in your answer.

[2 Marks]

Q5 You are required to design an electromechanical system for a swing gate (such as the main gate of the Faculty of Engineering, University of Ruhuna) of a commercial facility. The gate has two flaps, each weighing 4000N, 3m wide and 4m high. At present both flaps are manually operated. With the aid of clear sketches, answer the following questions.

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

[2 Marks]

b) What are the operational requirements and respective operational parameters of the gate? (eg. opening the gate wide open is a requirement for easy passage of wide vehicles. Then, the respective operational parameter would be each flap should swing open by an angle greater than 90^{o}).

[2 Marks]

c) State two main safety issues you would anticipate and what are the design features that you propose to address those safety issues?

[2 Marks]

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

[2 Marks]

e) Explain design features of manual override during a possible power outage.

[2 Marks]

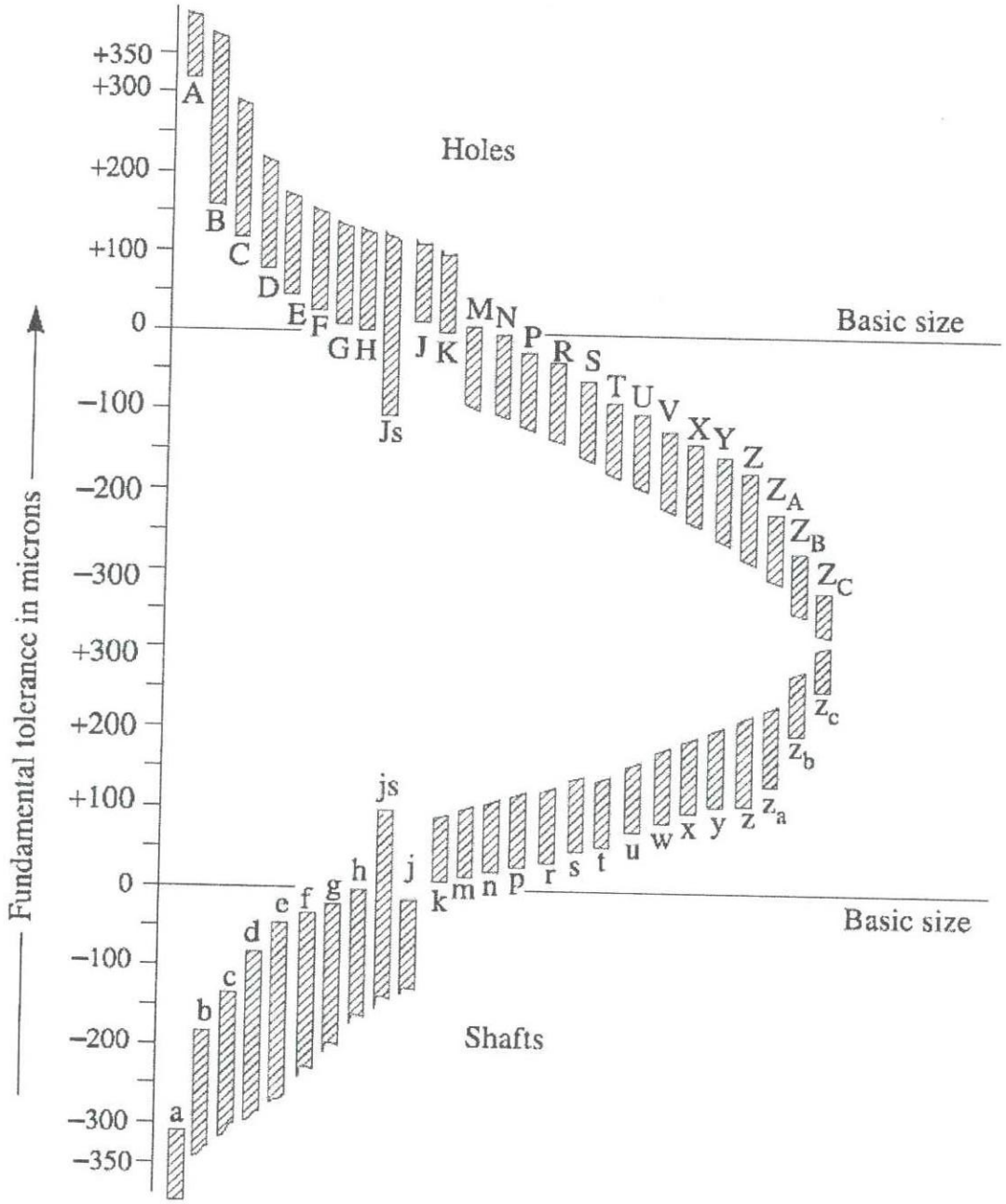

Figure Q1 The alphabetical representation of fundamental deviations for basic shaft and basic hole system

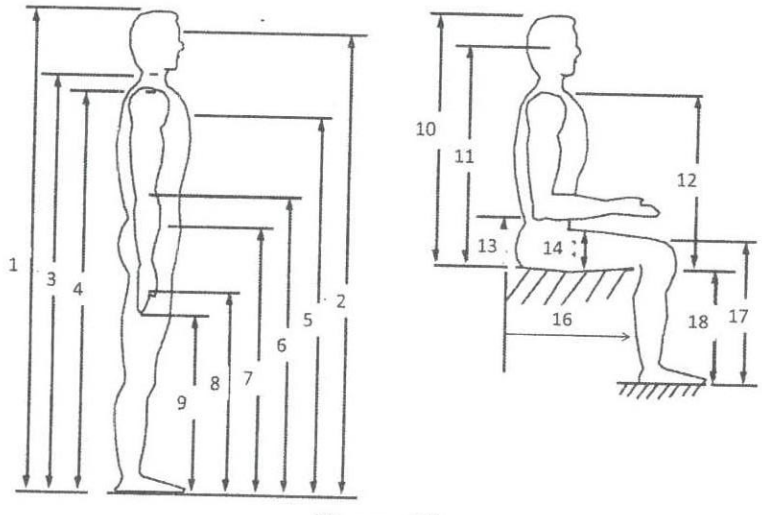

Figure Q2

Table Q2 Dimensions (in mm) related to the measurements in Figure Q2

	Men			Women		
	5th %le	50th %le	95th %le	5th %le	50th %le	95th %le
1. *Stature*	1625	1740	1855	1505	1610	1710
2. *Eye height*	1515	1630	1745	1405	1505	1610
3. *Neck height*	1375	1485	1595	1280	1375	1470
4. *Shoulder height*	1315	1425	1535	1215	1310	1405
5. *Chest height*	1175	1270	1365	1080	1170	1255
6. *Elbow height*	1005	1090	1180	930	1005	1085
7. *Hip height*	840	920	1000	740	810	885
8. *Knuckle height*	690	755	820	660	720	780
9. *Fingertip height*	590	655	720	560	625	685
10. *Sitting height*	850	910	965	795	850	910
11. *Sitting eye height*	730	790	845	685	740	795
12. *Sitting shoulder height*	540	595	645	505	555	610
13. *Sitting elbow height*	190	245	295	185	235	280
14. *Thigh thickness*	135	160	185	125	155	180
15. *Buttock-knee length*	545	595	645	520	570	620
16. *Buttock-popliteal length*	440	495	550	435	480	530
17. *Knee height*	495	545	595	455	500	540
18. *Popliteal height*	395	440	490	355	400	445
19. *Shoulder breadth (bideltoid)*	420	465	510	355	395	435