BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

ME G532: MACHINE TOOL ENGINEERING

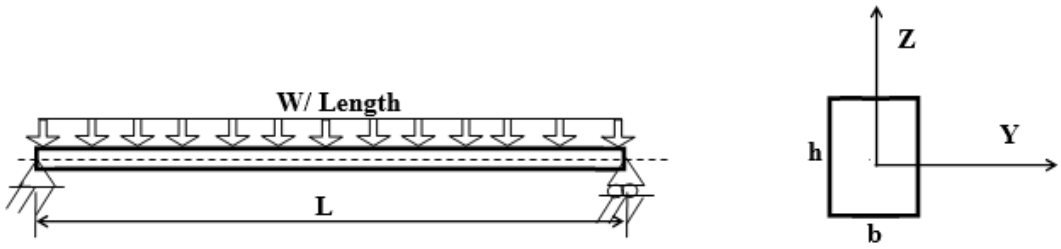
Comprehensive Examination: Closed Book

Max Marks: 40 **Duration: 3 hours.** **Date: 20/12/2023**

Assume data wherever necessary with proper justification

Q1.

a) For the given loading condition shown in figure below:



i) Derive an expression of optimum L^2/h ratio for a solid rectangular structure of height h and width b. **[5]**

ii) If the failure of the beam is determined by the normal stresses under tensile loading, which material (A or B) will you prefer to withstand the same load (explain on the basis of volume of material required). Justify your preference analytically on the basis of following data. **[3]**

Material A: $E = 3 \times 10^4$ kgf/mm^2, $[\sigma] = 20$ kgf/mm^2, $[\delta] = 0.001$ mm.

Material B: $E = 2 \times 10^4$ kgf/mm^2, $[\sigma] = 6$ kgf/mm^2, $[\delta] = 0.001$ mm.

b) A milling machine consists of four blocks (one stationary denoted by o and three moving blocks denoted by x, y and z). x block represents the table travel, y represents cross slide travel, z represents knee travel and o represents the column. The different layout versions are given in the table below. The machine tool is used for machining heavy parts with a high degree of accuracy. Suggest the best layout(s) from the given layouts shown in table for the following constraints. **[2]**

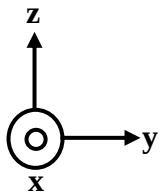
i) Machine tool table should not be given any vertical displacement.

ii) To prevent the weight of the part from affecting the accuracy, the work piece is kept stationary

iii) To prevent the weight of the part from affecting the accuracy, the work piece is provided only one horizontal displacement.

iv) Following all the above constraints.

zxyo	zxoy	zoyx	ozyx	
zyox	zyxo	ozxy	zoxy	
xzyo	yzox	yozx	yxoz	
yzxo	xzoy	oyzx	xozy	
xyzo	yxzo	oyxz	oxyz	
yxoz	xyoz	zxoy	xoyz	



Q2.

a) Which cutting edge of a right hand single point cutting tool, you will recommend during the precise facing operation on a center lathe machine tool? Justify your recommendation. **[2]**

b) Comment on the following statement: "Range ratio (R_n) values are generally recommended lower for centre lathe as compare to automatic lathe" (True/False). Justify in either case. **[2]**

c) Which shape (cross section) will you recommend for designing machine tool structures? Justify your recommendation. **[2]**

d) Show graphically the different energy consumption states with respect to time for a CNC lathe machine tool during machining (Include two different operations) of a workpiece. Justify the selection and significance of each state. **[4]**

Q3.

You are intended to design an eighteen-speed gearbox for conventional lathe machine tool to be also used for **drilling**. Machine tool can accommodate the drilling bits of 110, 120, 130, 140 and 150 mm diameters of different materials. It should also accommodate the rods of diameter ranging from 20 – 200 mm and cutting velocity ranging from 10 m/min to 50 m/min. The minimum number of cluster gears should be mounted on the first shaft of the gearbox due to certain design constraints. The machine tool is powered by a 7.5 kW motor running at 1000 rpm and is connected to the gearbox through a belt drive. The input shaft of the gearbox is rotating at 315 rpm. The gears are to be made from 0.6% C steel and shafts from mild steel of permissible shear strength of 120 kgf/cm^2. Suggest an economical design for the gearbox using following steps.

Note: Use standard values of progression ratio and corresponding spindle speeds.

i) Draw a speed chart on the basis of **material saving**. **[7]**

ii) Determine the number of teeth of gears. Assume $Z_{min} = 17$. **[3]**

iii) Shaft and gear dimensions. Assume the value of coefficient to account for overloading of the motor = 1.2, $\lambda = 10$ and C =4. **[5]**

iv) Draw the actual gearing diagram according to the gear dimensions. **[3]**

v) If the value of progression ratio is increase by 25%, then draw the modified speed chart. **[2]**

Standard Spindle speeds

ϕ = 1.12	**ϕ = 1.26**	**ϕ = 1.41**	**ϕ = 1.58**	**ϕ = 1.78**
10	10	11.2	10	10
11.2	12.5	16	16	18
12.5	16	22.4	25	31.5
14	20	31.5	40	56
16	25	45	63	100
18	31.5	63	100	180
20	40	90	160	315
22.4	50	125	250	560
25	63	180	400	1000
28	80	250	630	1800
31.5	100	355	1000	
35.5	125	500	1600	
40	160	710	2500	
45	200	1000		
50	250	1410		
56	315	2000		
63	400			
71	500			
80	630			
90	800			
100	1000			
112	1270			
125	1600			
140	2000			
160				
180				
200				
224				
250				
280				
315				
355				
400				
450				
500				
630				
800				
900				
1000				

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