Total No. of Questions: 23

Enrollment No : _____

MEDICAPS UNIVERSITY

Faculty of Engineering

End Semester Examination May 2025

ME3CO39 Machine Design

Programme	:	B.Tech.	**Branch/Specialisation**	:	ME
Duration	:	3 hours	**Maximum Marks**	:	60

Note: *All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary. Notations and symbols have their usual meaning.*

Section 1 (Answer all question(s))

		Marks	CO	BL
Q1.	Which of the following is a common method to reduce stress concentration in a component? ○ Adding sharp corners ○ Increasing the load ◉ Adding fillets or rounded corners ○ Reducing the material strength	1	1	1
Q2.	Notch sensitivity is a measure of- ○ The ability of a material to withstand cyclic stresses ◉ The effect of stress concentration on the fatigue strength of a material ○ The ductility of a material ○ The hardness of a material	1	1	1
Q3.	Which of the following is the primary stress induced in a shaft subjected to a twisting moment? ○ Tensile stress ○ Compressive stress ○ Bending stress ◉ Shear stress	1	2	1
Q4.	In the design of shafts, the equivalent bending moment (Me) is used to account for- ○ Only the twisting moment ○ Only the bending moment ◉ The combined effect of twisting and bending moments ○ The axial load	1	2	2
Q5.	The Lewis equation is used to calculate- ○ The surface strength of gear teeth ◉ The beam strength of gear teeth ○ The wear resistance of gear teeth ○ The hardness of gear materials	1	3	1
Q6.	Surface strength and wear resistance of gear teeth can be improved by- ◉ Applying surface treatments like carburizing or nitriding ○ Using softer materials ○ Increasing the gear size ○ Reducing the load on the gear	1	3	1
Q7.	The torque transmitting capacity of a single disc clutch is directly proportional- ○ The mean radius of the clutch plate ○ The coefficient of friction between the clutch surfaces ○ The axial force applied on the clutch ◉ All of the above	1	4	1
Q8.	In a band brake, the self-energizing condition occurs when- ◉ The applied friction force assists the applied force ○ The applied friction force opposes the applied force ○ The brake band is made of a soft material ○ The brake drum is rotating at high speed	1	4	1
Q9.	Which type of lubrication occurs when a full fluid film separates the moving surfaces? ○ Boundary lubrication ○ Mixed lubrication ◉ Hydrodynamic lubrication ○ Elasto-hydrodynamic lubrication	1	5	1

Q10. The life of a rolling-element bearing is typically defined as- **1 5 1**

- ○ The time until the bearing fails completely
- ◉ The number of revolutions until the first sign of fatigue appears
- ○ The time until the bearing needs lubrication
- ○ The number of revolutions until the bearing reaches thermal equilibrium

Section 2 (Answer all question(s))

Marks CO BL

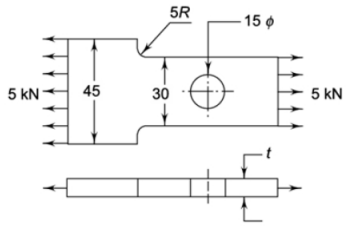
Q11. Define stress concentration and factor of safety. Give one example of each. **2 1 1**

Rubric	Marks
Stress Concentration definition with example	1
Factor of Safety definition with example	1

Q12. What are the three criteria used in designing the component subjected to fatigue load? Show them on stress amplitude vs mean stress graph. **3 1 1**

Rubric	Marks
Name of the three criterias	1
Showing the lines of criteria on graph	2

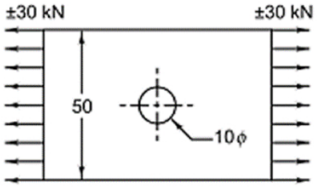
Q13. (a) A flat plate subjected to a tensile force of 5 kN. The plate material is grey cast iron FG 200 ($\sigma_{ult.}$= 200 N/mm^2) and the factor of safety is 2.5. Determine the thickness of the plate. **5 1 3**



Rubric	Marks
Calculation of Permissible Tensile stress	1
Calculation of max. induced stress at - a) the fillet section and b) at the hole	3
Calculation of thickness by using max. value of induced stress	1

(OR)

(b) A plate made of steel 20C8 (S_{ut} = 440 N/mm^2) in hot rolled and normalized condition. It is subjected to a completely reversed axial load of 30 kN. The notch sensitivity factor q can be taken as 0.8 and the expected reliability is 90%. The size factor is 0.85. The factor of safety is 2. Determine the plate thickness for infinite life.



Rubric	Marks
Calculation of Endurance Limit stress and axial load for plate	3
Calculation of amplitude of permissible stress	1
Calculation of Plate thickness	1

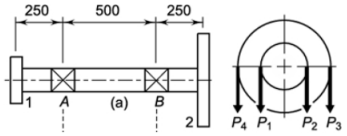
Section 3 (Answer all question(s))

Marks CO BL

Q14. Explain the any three types of shafts used in industrial machines with sketches. **4 2 1**

Rubric	Marks
Explaination of Three types of shafts	3
Sketches	1

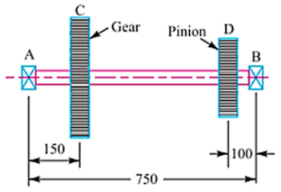
Q15. (a) The layout of a shaft carrying two pulleys 1 and 2, and supported on two bearings A and B. The shaft transmits 7.5 kW power at 360 rpm from the pulley 1 to the pulley 2. The diameters of pulleys 1 and 2 are 250 mm and 500 mm respectively. The masses of pulleys 1 and 2 are 10 kg and 30 kg respectively. The belt tensions act vertically downward and the ratio of belt tensions on the tight side to slack side for each pulley is 2.5:1. The shaft is made of plain carbon steel 40C8 ($Syt=380N/mm^2$) and the factor of safety is 3. Estimate suitable diameter of shaft. If the permissible angle of twist is 0.5° per metre length, calculate the shaft diameter on the basis of torsional rigidity. Assume $G = 79300N/mm^2$. **6 2 3**



Rubric	Marks
calculation of Permissible shear stress and torsional moment	1
Calculation of Bending Moment at bearing A by the load on smaller pulley	2
Calculation of Bending Moment at bearing B by the load on larger pulley	2
Calculation of shaft diameter on strength basis and rigidity basis	1

(OR)

(b) A steel solid shaft transmitting 15 kW at 200 r.p.m. is supported on two bearings 750 mm apart and has two gears keyed to it. The pinion having 30 teeth of 5 mm module is located 100 mm to the left of the right hand bearing and delivers power horizontally to the right. The gear having 100 teeth of 5 mm module is located 150 mm to the right of the left hand bearing and receives power in a vertical direction from below. Using an allowable stress of 54 MPa in shear, determine the diameter of the shaft. Assume torques at C and D are same. All dimension are in mm.



Rubric	Marks
Calculation of Torque	1
Calculation of tangential forces at C and D	1
Calculation of vertical reactions at A and B	1
Calculation of horizontal reactions at A and B	1
Horizontal Bending moments at C and D	1
Resultant B.M. at the two gears and calculation of equivalent Twisting moment and calculation of diameter.	1

Section 4 (Answer all question(s))

Marks CO BL

Q16. Explain the different causes of gear tooth failure. 4 3 1

Rubric	Marks
Four causes of failure of 1 Mark each	4

Q17. (a) A pair of straight teeth spur gears is to transmit 20 kW when the pinion rotates at 300 r.p.m. The velocity ratio is 1:3. The allowable static stresses for the pinion and gear materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its face width is 14 times the module. Determine module, face width and pitch circle, diameters of both the pinion and the gear from the standpoint of strength only, taking into consideration the effect of the dynamic loading. The tooth form factor `Y' can be taken as y ={0.154- 0.912/No. of teeth} and the velocity factor Cv as Cv ={3/(3+v)} where v is expressed in m/s [Assume Service Factor Cs as 1] 6 3 3

Rubric	Marks
CCalculation of Tangential Tooth Load WT	1
Calculation of Tooth Form Factor for Pinion and Gear to evaluate the weaker of the two gears	1
Calculation of Module using Lewis equation for weaker gear and selecting nearest value of standard gear.	1
Calculation of Face Width `b'	1
Calculation of Pitch Circle Diameters of Gear and Pinion.	2

(OR)

(b) A gear drive is required to transmit a maximum power of 22.5 kW. The velocity ratio is 1:2 and r.p.m. of the pinion is 200. The approximate centre distance between the shafts may be taken as 600 mm. The teeth has 20° stub involute profiles. The static stress for the gear material (which is cast iron) may be taken as 60 MPa and face width as 10 times the module. Find the module, face width and number of teeth on each gear. Check the design for dynamic and wear loads. The deformation or dynamic factor in the Buckingham equation may be taken as 80 and the material combination factor for the wear as 1.4

Rubric	Marks
Calculation of Pitch Circle Diameters of pinion and gear	1
Calculation of Velocity Factor and Tooth form factor for pinion	2
Calculation of Tangential Load and Module	1
Calculation of Dynamic load and Wear Load	1
Calculation of endurance strength of tooth and Max. load for wear	1

Section 5 (Answer all question(s))

Marks CO BL

Q18. What are the characteristics of the friction materials used in clutches? 2 4 1

Rubric	Marks
Four characteristics	2

Q19. Give classification of brakes 3 4 2

Rubric	Marks
Three brakes of 1 mark each !	3

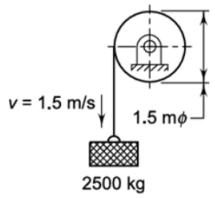
Q20. (a) An automotive plate clutch consists of two pairs of contacting surfaces with an asbestos friction lining. The torque transmitting capacity of the clutch is 550 N-m. The coefficient of friction is 0.25 and the permissible intensity of pressure is 0.5 N/mm^2. Due to space limitations, the outer diameter of the friction disk is fixed as 250 mm. Using uniform wear theory, calculate (i) the inner diameter of the friction disk; and (ii) the spring force required to keep the clutch in an engaged position

5 4 3

Rubric	Marks
Calculation of Inner diameter of friction disc	3
Calculation of Spring Force	2

(OR)

(b) A mass of 2500 kg is lowered at a velocity of 1.5 m/s from the drum. The mass of the drum is 50 kg and its radius of gyration can be taken as 0.7 m. On applying the brake, the mass is brought to rest in a distance of 0.5 m. Calculate (i) the energy absorbed by the brake; and (ii) the torque capacity of the brake.



Rubric	Marks
Energy absorbed by the brake	3
Torque absorbed by brake	2

Section 6 (Answer any 2 question(s))

Marks CO BL

Q21. A single-row deep groove ball bearing is subjected to a pure radial force of 3 kN from a shaft that rotates at 600 rpm. The expected life L10h of the bearing is 30000 h. The minimum acceptable diameter of the shaft is 40 mm. Select a suitable ball bearing for this application

5 5 3

Rubric	Marks
Dynamic Load Capacity	3
Selection of bearing	2

Q22. The load on the journal bearing is 150 kN due to turbine shaft of 300 mm diameter running at 1800 r.p.m. Determine the following (i) Length of the bearing if the allowable bearing pressure is 1.6 N/mm^2, and (ii) Amount of heat to be removed by the lubricant per minute if the bearing temperature is 60°C and viscosity of the oil at 60°C is 0.02kg/m-s and the bearing clearance is 0.25 mm.

5 5 3

Rubric	Marks
Length of the bearing	2
Amount of heat removed by lubricant	3

Q23. Differentiate between viscosity and oiliness of lubricating oil. Explain hydrodynamic film lubrication with neat diagram.

5 5 2

Rubric	Marks
Difference between Lubricant and Oiliness.	2
Explaination of hydrodynamic film lubrication	2
Diagram of Hydrodynamic Lubrication	1

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