Total No. of Questions: 21

Enrollment No : _____

MEDICAPS UNIVERSITY

Faculty of Engineering

End Semester Examination May 2025

EN3ES31 Engineering Design

Programme	:	B.Tech.	**Branch/Specialisation**	:	AU
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 type of lubrication is preferred in sliding contact bearings for high load and low speed? **1 1 1**

Rubric	Marks
Boundary lubrication	1

- ○ Hydrodynamic lubrication
- ○ Hydrostatic lubrication
- ◉ Boundary lubrication
- ○ Elastohydrodynamic lubrication

Q2. What is the primary advantage of rolling contact bearings over sliding contact bearings? **1 1 1**

Rubric	Marks
Lower friction and wear	1

- ○ Higher friction
- ◉ Lower friction and wear
- ○ Higher cost
- ○ Complex design

Q3. The diameter of a solid shaft subjected to torque varies as the- **1 2 1**

Rubric	Marks
Cube root of torque	1

- ○ Square root of torque
- ◉ Cube root of torque
- ○ Fourth root of torque
- ○ Directly proportional to torque

Q4. A hollow shaft is preferred over a solid shaft because it- **1 2 1**

Rubric	Marks
Has higher strength-to-weight ratio	1

- ○ Is cheaper
- ◉ Has higher strength-to-weight ratio
- ○ Has lesser strength-to-weight ratio
- ○ Is easier to manufacture

Q5. Involute profile is preferred for gear teeth because it ensures- **1 3 1**

Rubric	Marks
Constant velocity ratio	1

- ◉ Constant velocity ratio
- ○ Low manufacturing cost
- ○ High friction
- ○ Variable speed transmission

Q6. The Lewis equation in gear design is used to determine- 1 3 1

Rubric	Marks
Bending strength of gear teeth	1

- (•) Bending strength of gear teeth
- ( ) Surface hardness of gears
- ( ) Gear speed
- ( ) Gear efficiency

Q7. The stiffness of a spring is defined as- 1 4 1

Rubric	Marks
Load per unit deflection	1

- (•) Load per unit deflection
- ( ) Load per unit mass
- ( ) Load per unit length
- ( ) Deflection per unit load

Q8. The Wahl factor is used in the design of- 1 4 1

Rubric	Marks
Helical springs	1

- ( ) Leaf springs
- ( ) Torsion springs
- (•) Helical springs
- ( ) Disc springs

Q9. Which of the following is the primary function of a clutch? 1 5 1

Rubric	Marks
Transmit power from engine to gearbox	1

- ( ) Increase engine power
- (•) Transmit power from engine to gearbox
- ( ) Reduce engine noise
- ( ) Lubricate the transmission system

Q10. The torque transmitted by a friction clutch depends on- 1 5 1

Rubric	Marks
All of the above	1

- ( ) Radius of friction surface
- ( ) Coefficient of friction
- ( ) Axial force applied
- (•) All of the above

Section 2 (Answer all question(s))

Marks CO BL

Q11. Explain the classification of bearings based on their design and load-bearing capacity. 4 1 1

Rubric	Marks
Classification based on their design	3
Classification on load bearing capacity	1

Q12. (a) The load on the journal bearing is 150kN due to turbine shaft of 300mm diameter running at 1800 r.p.m. Determine the following: 1. Length of the bearing if the allowable bearing pressure is 1.6 N/mm^2, and 2. 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 0.25mm.

6 1 3

Rubric	Marks
Length L = 312.5 mm	2
Coefficient of friction = 0.011	2
Heat Generated = Q_g = 47 kW	2

(OR)

(b) In which conditions the rolling contact bearing are preferred? Discuss the advantages and limitations of rolling contact bearings.

Rubric	Marks
Conditions, where the rolling contact bearing are preferred	3
Advantages and limitations	3

Section 3 (Answer all question(s))

Marks CO BL

Q13. Derive the equation for shear stress in a shaft subjected to pure torsion.

4 2 3

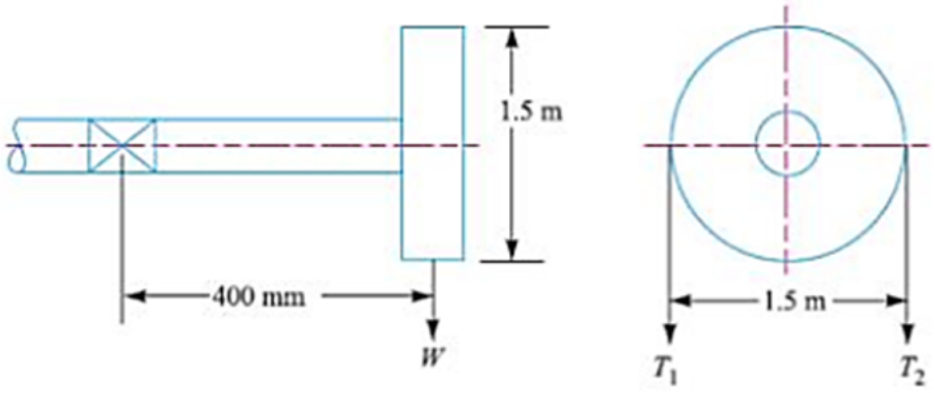
Rubric	Marks
Derivation	4

Q14. (a) A shaft made of mild steel is required to transmit 100 kW at 300 r.p.m. The supported length of the shaft is 3 m. It carries two pulleys each weighing 1500 N supported at a distance of 1 m from the ends respectively. Assuming the safe value of stress, determine the diameter of the shaft. **6 2 1**

Rubric	Marks
Reactions R_A and R_B = 1500 N	2
Twisting Moment = 3519 N-m	2
Diameter d = 70 mm	2

(OR)

(b) A line shaft is driven by means of a motor placed vertically below it. The pulley on the line shaft is 1.5 m in diameter and has belt tensions 5.4 kN and 1.8 kN on the tight side and slack side of the belt respectively. Both these tensions may be assumed to be vertical. If the pulley be overhang from the shaft, the distance of the centre line of the pulley from the centre line of the bearing being 400 mm, find the diameter of the shaft. Assuming maximum allowable shear stress of 42MPa.



Rubric	Marks
Torque T = 2700 N-m	1
Load W= 7200 N	1
M = 2880 N-m	1
Te = 3950 N-m	1
Diameter d = 80 mm	2

Section 4 (Answer any 2 question(s))

Marks CO BL

Q15. Define and explain the following gear terminologies: **5 3 1**

- Pitch circle
- Module
- Addendum and Dedendum
- Circular pitch
- Pressure angle

Rubric	Marks
1 Mark for Each Definition	5

Q16. A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4 : 1. The allowable static stresses for the bronze pinion and cast iron gear are 84 MPa and 105 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm. Find the power that can be transmitted from the standpoint of strength. **5 3 3**

Rubric	Marks
Velocity v = 4.02 m/s 1 mark Cv = 0.427 1 mark YP = 0.097 1 mark YG = 0.14 1 mark Power P = 31.64 kW 1 mark	5

Q17. Derive the Lewis formula for the beam strength of a gear tooth for spur gears. **5 3 3**

Rubric	Marks
Derivation	5

Section 5 (Answer all question(s))

Marks CO BL

Q18. Define the solid length, spring index, free length and pitch in relation to spring terminologies. **4 4 1**

Rubric	Marks
1 Mark for each definition	4

Q19. (a) Derive the formula for shear stress in a helical spring subjected to static axial load. **6 4 3**

Rubric	Marks
Derivation	6

(OR)

(b) A helical compression spring is made of a steel wire of diameter 8 mm and has a mean coil diameter of 50 mm. The spring has 10 active coils and is subjected to a static axial load of 200 N. Find: The maximum shear stress in the spring. The deflection of the spring if the modulus of rigidity G=80 GPa.

Rubric	Marks
Shear Stress = 61.9	3
Deflection = 6.1 mm	3

Section 6 (Answer all question(s))

Marks CO BL

Q20. What is the difference between uniform pressure and uniform wear theory in clutches? Which one is more realistic? **4 5 2**

Rubric	Marks
Difference between clutches theories	3
Justification for realistic theory	1

Q21. (a) A single plate clutch, effective on both sides, is required to transmit 25 kW at 3000 r.p.m. Determine the outer and inner diameters of frictional surface if the coefficient of friction is 0.255, ratio of diameters is 1.25 and the maximum pressure is not to exceed 0.1 N/mm^2. Also, determine the axial thrust to be provided by springs. Assume the theory of uniform wear. **6 5 3**

Rubric	Marks
r_1 = 120 mm, r_2 = 96 mm	2
W = 1447 N	4

(OR)

(b) A centrifugal clutch is to be designed to transmit 15 kW at 900 r.p.m. The shoes are four in number. The speed at which the engagement begins is 3/4th of the running speed. The inside radius of the pulley rim is 150 mm. The shoes are lined with Ferrodo for which the coefficient of friction may be taken as 0.25. Determine: 1. mass of the shoes, and 2. size of the shoes. Assuming that the centre of gravity of the shoe lies at a distance of 120 mm from the centre of the spider and the arc of contact of the shoes subtend an angle of $\theta = 60°$ or $\pi / 3$ radians, at the centre of the spider.

Rubric	Marks
Angular running speed = 94.26 rad/s	1
Torque T = 159 N-m	2
mass m = 2.27 kg	1
b = 1058 / 15.7 = 67.4 mm	2

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