*Total No. of Questions: 22*

**Enrollment No :** _____

MEDICAPS UNIVERSITY

# Faculty of Engineering

# End Semester Examination May 2025

## AU3CO31 Machine 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.** Failure of a material is called fatigue when it fails- **1 1 1**

| Rubric | Marks |
|---|---|
| Below the yield point | 1 |

- ○ At the elastic limit
- ○ Below the elastic limit
- ○ At the yield point
- ◉ Below the yield point

**Q2.** When a material is subjected to fatigue loading, the ratio of the endurance limit to the ultimate tensile strength is- **1 1 1**

| Rubric | Marks |
|---|---|
| 0.50 | 1 |

- ○ 0.20
- ○ 0.35
- ◉ 0.50
- ○ 0.65

**Q3.** The usual proportion for the width of key is- **1 2 1**

| Rubric | Marks |
|---|---|
| d/4 | 1 |

- ○ d/8
- ○ d/6
- ◉ d/4
- ○ d/2

**Q4.** The type of stresses developed in the key is/are- **1 2 1**

| Rubric | Marks |
|---|---|
| Both shear and bearing stresses | 1 |

- ○ Shear stress alone
- ○ Bearing stress alone
- ◉ Both shear and bearing stresses
- ○ Shearing, bearing and bending stresses

**Q5.** Two shafts will have equal strength, if- **1 3 1**

| Rubric | Marks |
|---|---|
| Twisting moment of both the shafts is same | 1 |

- ○ Diameter of both the shafts is same
- ○ Angle of twist of both the shafts is same
- ○ Material of both the shafts is same
- ◉ Twisting moment of both the shafts is same

**Q6.** The maximum shear stress theory is used for- 1 3 1

| Rubric | Marks |
|---|---|
| Ductile materials | 1 |

- ○ Brittle materials
- ◉ Ductile materials
- ○ Plastic materials
- ○ Non-ferrous materials

**Q7.** Which of the following spring is used in a mechanical wrist watch? 1 4 1

| Rubric | Marks |
|---|---|
| Torsion spring | 1 |

- ○ Helical compression spring
- ○ Spiral spring
- ◉ Torsion spring
- ○ Bellevile spring

**Q8.** In leaf springs, the longest leaf is known as- 1 4 1

| Rubric | Marks |
|---|---|
| Master leaf | 1 |

- ○ Lower leaf
- ◉ Master leaf
- ○ Upper leaf
- ○ None of these

**Q9.** When the speed of belt increases- 1 5 1

| Rubric | Marks |
|---|---|
| The power transmitted will increase | 1 |

- ○ The coefficient of friction between the belt and pulley increases
- ○ The coefficient of friction between the belt and pulley decreases
- ○ The power transmitted will decrease
- ◉ The power transmitted will increase

**Q10.** When a belt drive is transmitting maximum power- 1 5 1

| Rubric | Marks |
|---|---|
| Driving tension in tight side is twice the centrifugal tension | 1 |

- ○ Effective tension is equal to the centrifugal tension
- ○ Effective tension is half of the centrifugal tension
- ○ Driving tension in slack side is equal to the centrifugal tension
- ◉ Driving tension in tight side is twice the centrifugal tension

## Section 2 (Answer all question(s))

Marks CO BL

**Q11.** Define the following with diagrams- 4 1 2

- Static load
- Dynamic Load
- Endurance stress
- Variable stress

| Rubric | Marks |
|---|---|
| definition and diagrams of all points | 4 |

**Q12. (a)** A 25 mm diameter shaft is made of forged steel 30C8 having ultimate strength of 600 MPa. There is a step in the shaft and the theoretical stress concentration factor at the step is 2.1. The notch sensitivity factor is 0.84. Determine the endurance limit of the shaft if it is subjected to a reversed bending moment. **6 1 3**

| Rubric | Marks |
|---|---|
| Answer: 59.67 MPa | 6 |

**(OR)**

**(b)** Determine the wall thickness of a pressure vessel of 1200 mm mean diameter subjected to an internal pressure that fluctuates between $5N/mm^2$ and $10\ N/mm^2$. Take yield strength of the material as 200 MPa and endurance limit of 160 MPa and a factor of safety of 2.

| Rubric | Marks |
|---|---|
| Answer:65 mm | 6 |

## Section 3 (Answer all question(s))

**Marks CO BL**

**Q13.** Explain different types of keys with diagrams. **4 2 1**

| Rubric | Marks |
|---|---|
| Key types with diagrams | 4 |

**Q14. (a)** Design and draw a cast iron flange coupling for a mild steel shaft transmitting 90 kW at 250 r.p.m. The allowable shear stress in the shaft is 40MPa and the angle of twist is not to exceed 1° in a length of 20diameters. The allowable shear stress in the coupling bolts is 30MPa. **6 2 1**

| Rubric | Marks |
|---|---|
| Shaft Diameter | 2 |
| Bolts diameter | 2 |
| Thickness of flange | 1 |
| Diameter of flange | 1 |

**(OR)**

**(b)** The shaft and the flange of a marine engine are to be designed for flange coupling, in which the flange is forged on the end of the shaft. The following particulars are to consider in the design:
Power of the engine = 3 MW
Speed of the engine = 100 r.p.m.
Permissible shear stress in bolts and shaft = 60 MPa
Number of bolts used = 8
Pitch circle diameter of bolts = 1.6 × Diameter of shaft
Find the diameter of shaft, diameter of bolts, thickness of flange and diameter of flange.

| Rubric | Marks |
|---|---|
| Shaft diameter | 2 |
| Bolts diameter | 2 |
| Thickness of flange | 1 |
| Diameter of flange | 1 |

## Section 4 (Answer all question(s))

**Marks CO BL**

**Q15.** Explain the causes of failure of shaft. **2 3 1**

| Rubric | Marks |
|---|---|
| at least 2 causes | 2 |

**Q16.** A shaft running at 400 r.p.m. transmits 10 kW. Assuming allowable shear stress in shaft as 40 MPa, find the diameter of the shaft. **3 3 1**

| Rubric | Marks |
|---|---|
| Maximum shear stress theory | 2 |
| Shaft diameter 35 mm | 1 |

**Q17. (a)** A shaft is supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu$ = 0.24. Determine the suitable diameter for a solid shaft, allowing working stress of 63 MPa in tension and 42 MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley. **5 3 1**

| Rubric | Marks |
|---|---|
| Diagram | 1 |
| Total vertical load = 3308 N<br>Total horizontal load = 4964 N | 2 |
| equivalent twisting and bending moment<br>diameter of shaft = 55 mm | 2 |

**(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.

| Rubric | Marks |
|---|---|
| Diagram | 1 |
| Calculate the reactions at support in horizontal and vertical direction<br>calculation of bending moment | 2 |
| diameter of shaft = 50 mm | 2 |

## Section 5 (Answer all question(s))

**Marks CO BL**

**Q18.** Derive the relation for stress in circular wire. **4 4 1**

| Rubric | Marks |
|---|---|
| diagram | 1 |
| nomenclature of parameters | 1 |
| Derivation | 2 |

**Q19. (a)** Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm$^2$. Use Wahl's stress factor for design. **6 4 1**

| Rubric | Marks |
|---|---|
| Mean diameter of the spring coil | 2 |
| Number of turns of the coils | 2 |
| Free length of the spring | 1 |
| Pitch of the coil | 1 |

**(OR)**

**(b)** Design and draw a valve spring of a petrol engine for the following operating conditions:
Spring load when the valve is open = 400 N
Spring load when the valve is closed = 250 N
Maximum inside diameter of spring = 25 mm
Length of the spring when the valve is open = 40 mm
Length of the spring when the valve is closed = 50 mm
Maximum permissible shear stress = 400 MPa

| Rubric | Marks |
|---|---|
| Mean diameter of the spring coil | 2 |
| Number of turns of the coil | 2 |
| Free length of the spring | 1 |
| Pitch of the coil | 1 |

## Section 6 (Answer any 2 question(s))

**Marks CO BL**

**Q20.** Write the difference between belt, rope and chain drive along with applications. **5 5 1**

| Rubric | Marks |
|---|---|
| At least 3 differences with 2 applications | 5 |

**Q21.** Two parallel shafts whose centre lines are 4.8 m apart, are connected by an open belt drive. The diameter of the larger pulley is 1.5 m and that of smaller pulley 1 m. The initial tension in the belt when stationary is 3 kN. The mass of the belt is 1.5 kg / m length. The coefficient of friction between the belt and the pulley is 0.3. Taking centrifugal tension into account, calculate the power transmitted, when the smaller pulley rotates at 400 r.p.m. **5 5 1**

| Rubric | Marks |
|---|---|
| T1= 3341 N<br>T2 = 1336 N | 3 |
| Power = 42.1 Kw | 2 |

**Q22.** Design a chain drive to actuate a compressor from 15 kW electric motor running at 1000 r.p.m., the compressor speed being 350 r.p.m. The minimum centre distance is 500 mm. The compressor operates 16 hours per day. The chain tension may be adjusted by shifting the motor on slides. **5 5 1**

| Rubric | Marks |
|---|---|
| T2 = 72 | 1 |
| Pitch = 19.05 mm | 1 |
| velocity v1 = 7.96 m/s | 1 |
| Load on the chain W = 1844 N | 1 |
| Length of the chain = 2.096 m | 1 |

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