POSTAL Book Package 2023

Mechanical Engineering

Objective Practice Sets

Machine Design

Contents

MADE EASY Publications

4 CHAPTER
Clutches

MCQ and NAT Questions

Q.1 In designing a plate clutch, assumption of uniform wear conditions is made because
(a) it is closer to real life situation
(b) it leads to a safer design
(c) it leads to cost effective design
(d) no other assumption is possible

Q.2 In a multi-plate clutch with n_0 number of outer discs and n_i number of inner discs, the number of pairs of active surfaces is
(a) $n_i + n_0$ (b) $n_i + n_0 + 1$
(c) $n_i + n_0 - 1$ (d) $n_i + n_0 - 2$

Q.3 In a multiple disc clutch. If there are 6 discs on the driving shaft and 5 discs on the driven shaft, then the number of pairs of contact surfaces will be equal to
(a) 11 (b) 12
(c) 10 (d) 22

Q.4 On the motors with low starting torque, the type of the clutch to be used is
(a) Multiple-plate clutch
(b) Cone clutch
(c) Centrifugal clutch
(d) Single-plate clutch with both sides effective

Q.5 In cone clutch,
(a) outer cone is keyed to driving shaft and inner cone is free to slide on driven shaft
(b) inner cone is keyed to driven shaft & outer cone is free to slide on driving shaft.
(c) outer cone is free to slide to driving shaft & inner cone is keyed to driving shaft
(d) outer cone is keyed to driven shaft & inner cone is free to slide on driving shaft

Q.6 Which one of the following statement is incorrect about centrifugal clutches?
(a) It engages the load when driving member has attained a particular speed
(b) It permits the engine to start, warm-up & accelerate to the operating speed without load.
(c) These clutches are particularly useful for IC engines.
(d) The centrifugal force increases with decrease in speed

Q.7 Match **List-I** with **List-II** and select the codes given below the lists:

List-I
A. Single-plate friction clutch
B. Multi-plate friction clutch
C. Centrifugal clutch
D. Jaw clutch

List-II
1. Scooters
2. Rolling mills
3. Trucks
4. Mopeds

Codes:

	A	B	C	D
(a)	1	3	4	2
(b)	1	3	2	4
(c)	3	1	2	4
(d)	3	1	4	2

Q.8 Consider the following statements regarding a centrifugal clutch:
1. It need not be unloaded before engagement
2. It enables the prime mover to start up under no-load conditions
3. It picks up the load gradually with the increase in speed
4. It will not slip to the point of destruction
5. It is very useful when the power unit has a low starting torque

Which of these are the advantages of a centrifugal clutch?
(a) 1, 2 and 4 (b) 1, 3 and 5
(c) 2, 3 and 5 (d) 1, 3 4 and 5

(c) Energy lost in the slipping of the clutch is 1665.5 J.
(d) Angle turned by the flywheel before attaining the full speed is 425 rad.

Q.30 A multiplate clutch transmit 60 kW power at 1400 rpm and the intensity of pressure cannot exceed 0.2 MPa. Inner radius of friction lining is 0.1 m and is 0.75 times of outer radius. Coefficient of friction is 0.12.
Which of the following options is/are correct? Use UWT. (Number of discs must be an integer)
(a) Number of discs on driver shaft is 4.
(b) Number of discs on driven shaft is 3.
(c) Actual axial force on each friction surface is 2.31 kN.
(d) Total torque transmitted is 409.28 N-m

■■■■

Answers Clutches

1. (b)	**2.** (c)	**3.** (c)	**4.** (c)	**5.** (a)	**6.** (d)	**7.** (d)	**8.** (c)	**9.** (d)
10. (a)	**11.** (b)	**12.** (d)	**13.** (a)	**14.** (a)	**15.** (a)	**16.** (c)	**17.** (b)	**18.** (a)
19. (a)	**20.** (d)	**21.** (a)	**22.** (36.52)	**23.** (54.25)	**24.** (15707.96)		**25.** (367.21)	**26.** (4)
27. (317.73)		**28.** (a, b, c)		**29.** (a, b, c)		**30.** (a, b, d)		

Explanations Clutches

1. (b)
For the safe design of clutches (old or worn out clutches) it is better to use uniform wear theory (UWT) because pressure is non-uniformly distributed when clutch surfaces come into service and clutches are used to transmit power by utilising frictional forces.

2. (c)
Number of pairs of active surfaces = $n_i + n_o - 1$

3. (c)
Number of surfaces in contact = $n_1 + n_2 - 1$

4. (c)
Centrifugal clutches are used when power unit has a low starting torque.

5. (a)
In cone clutch, outer cone is keyed to driving shaft and inner cone is free to slide axially on driven shaft due to splines. The axial force required to engage the clutch is provided by means of helical compression spring. In engaged position, power is transmitted from the driving shaft to the outer cone by means of the key. Power is then transmitted from the outer cone to the inner cone by means of friction. Finally, power is transmitted from the inner cone to the driven shaft by means of the splines.

6. (d)
The centrifugal force increases with increase in speed. With increase in spring stiffness, the restoring force on clutch will increase and hence velocity of engagement will be more.

7. (d)
- Single-plate friction clutch – Trucks
- Multi-place friction clutch – Scooters
- Centrifugal clutch – Moped
- Jaw clutch – Rolling mills

8. (c)
It will slip to the point of destruction

9. (d)
Torque transmitting capacity,
$$T_f = \mu W R_{mean}$$

10. (a)
$$\text{Mean radius, } r = \frac{2}{3}\left\{\frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}\right\}$$

$$= \frac{2}{3}\left\{\frac{(100)^3-(50)^2}{(100)^2-(50)^2}\right\} = 77.78 \text{ mm}$$

11. (b)

As per uniform wear theory,

$$Pr = \text{constant}$$

$$\therefore \quad P = \frac{C}{r} \leftarrow \text{Hyperbolic variation}$$

12. (d)

A major portion of the life of friction lining comes under uniform wear criterion.

13. (a)

$$\frac{d}{D} = x$$

$$M_t = \frac{\pi \mu P_a D}{8}(D^2 - d^2)$$

(Assuming uniform wear theory)

$$M_t = \frac{\pi \mu P_a D^3}{8}[x(1-x^2)]$$

for maximum M_t,

$$\frac{\partial}{\partial x}[x(1-x^2)] = 0 \Rightarrow 1 - 3x^2 = 0$$

$$x = \frac{1}{\sqrt{3}} = 0.577$$

14. (a)

$$T = \frac{1}{2}\mu W(R_o + R_i)$$

$$= \frac{1}{2}\mu \times \left[p_{per} \times 2\pi R_i (R_o - R_i)\right](R_o + R_i)$$

$$[\because W = 2\pi R_i (R_o - R_i) P_{per}]$$

$$T = \frac{1}{2}\mu \times \left[1\times 10^6 \times 2\pi \times 10 \times \frac{(30-20)}{2} \times 10^{-4}\right]\frac{(30-20)}{2} \times 10^{-2}$$

$$440 = \frac{1}{2}\mu \times 100\pi \times 25$$

$$\mu = \frac{880 \times 7}{25 \times 100 \times 22}$$

$$= \frac{0.4 \times 7}{25} = 0.112$$

Alternate solution:

$$T = \mu\, p_{per}\, r_i \times \pi(r_o^2 - r_i^2)$$

$$\Rightarrow \quad 440 = \mu \times 1 \times 0.1 \times \pi(150^2 - 100^2)$$

$$\mu = \frac{440}{0.1 \times \pi \times 12500}$$

$$= \frac{440 \times 7}{0.1 \times 22 \times 12500}$$

$$= \frac{14}{125} = 0.112$$

15. (a)

Given: $W = 5$ kN, $r_2 = 50$ mm, $r_1 = 100$ mm

Average pressure,

$$P_{av} = \frac{W}{\pi\left[r_1^2 - r_2^2\right]} = \frac{5000}{\pi\left[100^2 - 50^2\right]}$$

$$= \frac{5000}{\pi \times 150 \times 50} = \frac{2}{3\pi} \text{ N/mm}^2$$

$$= 0.21 \text{ N/mm}^2$$

16. (c)

Given: $n_1 + n_2 = 5$, $n = 4$, $p = 0.12$ N/mm^2, $N = 700$ rpm, $r_1 = 125$ mm, $r_2 = 75$ mm, $\mu = 0.25$

Axial force required to engage the clutch,

$$W = 2\pi r_2 p(r_1 - r_2)$$

$$= 2\pi \times 75 \times 0.12(125 - 75)$$

$$= 900\pi \text{ N}$$

Mean radius, $R = \frac{r_1 + r_2}{2} = \frac{125 + 75}{2}$

$$= 100 \text{ mm}$$

Torque transmitted,

$$T = n \times \mu \times W \times R$$

$$= 4 \times 0.25 \times 900\pi \times 0.1$$

$$= 90\pi$$

Power transmitted,

$$P = \frac{T \times 2\pi N}{60} = \frac{90\pi \times 2\pi \times 700}{60}$$

$$= 20726.17 \text{ W} = 20.7 \text{ kW}$$

17. (b)

For Uniform pressure theory,

$$W = P \times \pi\left(R_0^2 - R_i^2\right)$$

$$\Rightarrow \quad P = \frac{W}{\pi\left(R_0^2 - R_i^2\right)}$$