

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-VII (OLD) EXAMINATION – WINTER 2023****Subject Code:2171909****Date:08-12-2023****Subject Name: Machine Design****Time:10:30 AM TO 01:30 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1 (a)** How will you designate worm and worm gear drive? Explain this. **03**
- (b)** Explain the gear tooth failures in detail. **04**
- (c)** Design a bevel gear pair (90°) to transmit 7.5 kW power from an electric motor shaft running at 1440 rpm to a machine shaft from the following specifications: **07**
- Tooth system = 20° full depth involute
Number of teeth on pinion = 18
Speed reduction ratio = 4:1
Service factor = 1.50
Material of pinion and gear -CI
Design bending stress pinion material = 166 MPa
Design bending stress gear material = 55 MPa
Endurance strength of the material = 550 MPa
Take $b = R/3$
Lewis form factor $y = 0.154 - 0.912/Z_f$ for 20° pressure angle involute tooth system
Dynamic load factor $C = 145.37 \text{ N/mm}$
Modulus of elasticity = $1.0 \times 10^5 \text{ MPa}$
Velocity factor = $6 / (6 + V)$, where V is the pitch line velocity in m/s.
- Q.2 (a)** List the Standard system of gear tooth profiles and explain any one of them (which is widely used in industries). **03**
- (b)** Explain the selection of gear material in detail. **04**
- (c)** Design a spur gear pair to transmit 100 kW power from an electric motor shaft running at 750 r.p.m. to a machine shaft from the following specifications: **07**
- Tooth system = 20° full depth involute
Number of teeth on pinion = 20
Speed reduction ratio = 5:1
Service factor = 1.50
Material of pinion- Forged steel
Material of gear -CI grade 35
Design bending stress pinion material = 166MPa
Design bending stress gear material = 116MPa
Surface hardness of pinion = 145 BHN
Surface hardness of gear = 160 BHN
Lewis form factor $y = 0.154 - 0.912/\text{No. of teeth}$ for 20° pressure angle involute tooth system
Average endurance strength of the material = 350 MPa

Dynamic load factor $C = 342 \text{ N/mm}$

Modulus of elasticity $= 1.1 \times 10^5 \text{ MPa}$

Velocity factor $= 4.5 / (4.5 + V)$, where V is the pitch line velocity in m/s.

Assume pitch line velocity as 7.5 m/sec for module calculation.

OR

- (c) Design a pair of helical gears to transmit 50 kW at a speed of 1000 rpm to a shaft required to run at 250 rpm. The helix angle is approximately 30° and 20° full depth teeth are used. The pinion (forged steel) and gear (cast steel) are having permissible bending stress 175 N/mm^2 and 140 N/mm^2 respectively. Take minimum number of teeth on pinion 20. The Surface hardness of pinion and gear are 150 and 180 BHN respectively. Check your design for dynamic load and determine minimum hardness of teeth required. Service factor $= 1.875$. Velocity factor $= 6 / (6 + V)$, where V is the pitch line velocity in m/s. Take $b = 12 \text{ m}$, Dynamic load factor $C = 442.9 \text{ N/mm}$ and average endurance strength of the material $= 384 \text{ MPa}$ **07**

- Q.3** (a) Write a short note on piston materials. **03**
(b) Draw a neat sketch of valve-gear mechanism and explain its working. **04**
(c) Draw a eight speeds gear box (the structure and speed diagram only) from the following given data: **07**
The output speeds are 100 r.p.m. minimum and 1120 r.p.m. maximum.
The motor power is 15 kw and motor speed is 1000 r.p.m. Input shaft speed for gear box is 625 r.p.m.

OR

- Q.3** (a) Draw a neat sketch of truncated piston. Label each part in it. **03**
(b) What are the merits and demerits of wet and dry cylinder liners? **04**
(c) Design a connecting rod of petrol engine from the following data: **07**
Cylinder bore $= 90 \text{ mm}$, Yield point strength of material $= 330 \text{ MPa}$, Max. Explosion pressure $= 2.2 \text{ MPa}$, Factor of safety $= 5$, Modulus of elasticity $= 2.1 \times 10^5 \text{ MPa}$, Rankine's constant $= 1/7500$, Length of connecting rod $= 300 \text{ mm}$. Determine the size of I-section ($5t \times 4t \times t$ size) for connecting rod.

- Q.4** (a) Explain the design of hook in brief. **03**
(b) Explain the design of drum in detail. **04**
(c) Select a suitable wire rope and design a drum for an EOT crane from the following given data: **07**
Maximum load to be lifted $= 60 \text{ kN}$ Weight of lifting tackle $= 21.2 \text{ kN}$
Lifting height $= 8 \text{ m}$ Number of rope falls $= 04$
Pulley efficiency $= 0.94$ wire rope type 6×37
Braking load $= 430 d_{\text{rope}}^2$ wire rope area $A_r = 0.38 d_{\text{rope}}^2$
Wire dia. $= 0.045 d_{\text{rope}}$ Modulus of elasticity $= 0.84 \times 10^5 \text{ MPa}$
Drum diameter is 30 times rope diameter
Allowable stress for cast iron $= 25 \text{ MPa}$

OR

- Q.4** (a) Explain the basic principles used in selection of material handling system. **03**
(b) Write a short note on stress induced in steel wire ropes. **04**
(c) Classify material handling equipments. State the different applications of crane, hoist and conveyors. Draw the neat sketch of belt conveyor. **07**
- Q.5** (a) Differentiate between sliding contact and rolling contact bearing. **03**
(b) Define and explain the static load carrying capacity, dynamic load carrying capacity and equivalent dynamic load. **04**

- (c) Design a hydrodynamic journal bearing from the following given data for 4 - 07
stroke diesel engine:
Journal diameter = 80 mm L/D ratio = 2
Radial load = 20 kN Journal speed = 1200 r.p.m.
r / c ratio = 1000 constant C = 2.85
Design bearing pressure = 1 to 2 MPa k = 0.002
Ambient temp of oil = 22°C Outlet temp of oil = 82°C
Use SAE 30 oil and viscosity is 12×10^{-3} at 82 °C
Heat dissipation coefficient = 1200 W/m² °C

OR

- Q.5 (a) Explain the effect of pressure and temperature on viscosity of the lubricants. 03
(b) Explain the various factors to be considered for selection of rolling contact bearing. 04
(c) Select a suitable deep groove bearing for a 70 mm diameter shaft running at 400 r.p.m. The load acting on the bearing are $F_r = 7500$ N and $F_a = 4875$ N. The desired life of bearing is 2400 hrs at 94 % reliability. The load is light shock load and inner race rotates. 07

Bearing No	D in mm	C _o in kN	C in kN
6014	70	24.5	29
6214	70	37.5	47.5
6314	70	63	80

F _a / C _o	F _a / F _r ≥ e		e
	X	Y	
0.025	0.56	2.0	0.22
0.04		1.8	0.24
0.07		1.6	0.27
0.13		1.4	0.31
