BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)

FOURTH YEAR FIRST SEMESTER EXAM 2025

Subject: MACHINE DESIGN IV

Marks: 100 Time: 3 hrs

(Answer **Q. no. 1** and any **five** from the rest)

Q. no. 1:

1.1): Bearing characteristics number in a hydrodynamic bearing depends upon: a) length, width and load. b) length, width and speed. c) viscosity, speed and load. d) viscosity, speed and bearing pressure.

1.2): In a full length journal bearing, radius of the friction circle increases with the increase in: a) load. b) radius of the journal. c) speed of the journal. d) viscosity of the lubricant.

1.3): A full length journal bearing having clearance to radius ratio of 1/100, using a lubricant with $\mu = 28 \times 10^{-3}$ N.s/m^2 supports the shaft journal at n=2400 rpm. If the bearing pressure is 1.4 MPa, the Sommerfeld number is:

a) 8×10^{-3}. b) 8×10^{-5}. c) 0.48. d) 0.48×10^{-2}

1.4): In thick cylinders, the tangential stress across the thickness of cylinder:

a) Remains uniform throughout
b) Varies from internal pressure at the inner surface to zero at the outer surface
c) Varies from maximum value at the inner surface to minimum value at the outer surface
d) Varies from maximum value at the outer surface to minimum value at the inner surface

1.5): The thickness of high-pressure oil and gas pipes is determined by:

a) Lame's equation
b) Clavarino's equation
c) Birnie's equation
d) Barlow's equation

1.6): In the assumptions of Petroff's law:

a) Radial load is almost zero
b) Viscosity of the lubricant is very high
c) Journal speed is very high
d) Journal speed is very low

1.7): For radial load "W", bearing radius "R" and length "L", unit bearing pressure "P" is

a) WR/L b) 2W/RL c) W/2RL d) WL/R

1.8): Which one of the following is a criterion in the design of hydrodynamic journal bearing?

a) Sommerfeld number. b) Rating life. c) specific dynamic capacity. d) rotation factor

1.9) A journal bearing has shaft diameter of 40 mm and a length of 40 mm. The shaft is rotating at 20 rad/s and the viscosity of the lubricant is 20 MPa.s. The clearance is 0.020 mm. Loss of torque due to fluid action is:

a) 0.040 Nm b) 0.25 Nm c) 0.08 Nm d) 0.025 Nm

[Turn over

1.10) Hydrodynamic lubrication depends on:
a) Lubricant's pressure
b) Clearance between journal and bearing
c) Journal speed only
d) Adequate lubricant supply in the clearance

1.11) Elasto-hydrodynamic lubrication exhibits in:
a) Cam-follower mating surfaces
b) Mating gears
c) Rolling bearings
d) None of the above

1.12) Units of kinematic viscosity is
a) Poise b) Centi-poise c) Stoke d) Pa.s

1.13) If the length to diameter ratio (l/d) increases, then:
a) Side flow increases
b) Heat dissipation increases
c) Resulting film pressure increases
d) Susceptible to metal to metal contact at edges

1.14) Unit bearing pressure for starting condition should not exceed:
a) 3 N/mm^2 b) 1.5 N/mm^2 c) 4 N/mm^2 d) 2 N/mm^2

1.15) The ratio of longitudinal stress to tangential stress in case of cylindrical shell is:
a) 1.5 b) 2.0 c) 1.0 d) 0.5

[15x2=30]

Q. no. 2:
i) Considering the maximum principal stress theory drive Lame's equation for brittle material ii) Drive the Clavarino's equation considering the St. Venant Theory and from there deduce the Brine's equation.

[6+8=14]

Q. no. 3:
A hydraulic cylinder with an internal diameter 250 mm is subjected to an internal pressure of 12 MPa. Determine the wall thickness based on a) Maximum principal stress theory, b) Maximum strain theory of failure. Compare the results of wall thickness calculated based on thin cylinder assumption. Assume the yield stress of the cylinder material to be 60 MPa.

[14]

Q. no. 4:
i) Derive the Petroff's equation. Also state all assumptions for deriving this equation. ii) Expalin the A. A Raimondi and J.Boyd solution over Renold's equation.

[7+7=14]

Q. no. 5:
Following data are given for a hydrostatic thrust bearing:
Thrust load = 550 kN; Shaft speed = 720 rpm; Shaft diameter = 500 mm; Recess diameter = 300 mm; Film thickness = 0.15 mm; Viscosity of lubricant = 160 SUS; Specific gravity = 0.86;
Calculate: (a) Supply pressure
(b) Flow requirement
(c) Power loss

[6+4+4=14]

Q. no. 6:
Show that the resultant load *P* on the bolted joint (using gasket) for the cylinder and cylinder head of pressure vessel is given by:

$P=P_i + P_i [k_b/(k_b+ k_c)]$, where all the parameters have usual meaning.

[14]

Q. no. 7:

a) Describe McKee's investigation.

b) What is stable lubrication?

c) What is Sommerfeld Number? How it is related to bearing modulus?

[4+4+6=14]

Dimensionless performance parameters for full journal bearing with side flow

$\left(\frac{l}{d}\right)$	ε	$\left(\frac{h_0}{c}\right)$	S	ϕ	$\left(\frac{r}{c}\right)f$	$\left(\frac{Q}{rcn,l}\right)$	$\left(\frac{Q_s}{Q}\right)$	$\left(\frac{p}{p_{max}}\right)$
∞	0	1.0	∞	(70.92)	∞	π	0	–
	0.1	0.9	0.240	69.10	4.80	3.03	0	0.826
	0.2	0.8	0.123	67.26	2.57	2.83	0	0.814
	0.4	0.6	0.0626	61.94	1.52	2.26	0	0.764
	0.6	0.4	0.0389	54.31	1.20	1.56	0	0.667
	0.8	0.2	0.021	42.22	0.961	0.760	0	0.495
	0.9	0.1	0.0115	31.62	0.756	0.411	0	0.358
	0.97	0.03	–	–	–	–	0	–
	1.0	0	0	0	0	0	0	0
1	0	1.0	∞	(85)	∞	π	0	–
	0.1	0.9	1.33	79.5	26.4	3.37	0.150	0.540
	0.2	0.8	0.631	74.02	12.8	3.59	0.280	0.529
	0.4	0.6	0.264	63.10	5.79	3.99	0.497	0.484
	0.6	0.4	0.121	50.58	3.22	4.33	0.680	0.415
	0.8	0.2	0.0446	36.24	1.70	4.62	0.842	0.313
	0.9	0.1	0.0188	26.45	1.05	4.74	0.919	0.247
	0.97	0.03	0.00474	15.47	0.514	4.82	0.973	0.152
	1.0	0	0	0	0	0	1.0	0
$\left(\frac{1}{2}\right)$	0	1.0	∞	(88.5)	∞	π	0	–
	0.1	0.9	4.31	81.62	85.6	3.43	0.173	0.523
	0.2	0.8	2.03	74.94	40.9	3.72	0.318	0.506
	0.4	0.6	0.779	61.45	17.0	4.29	0.552	0.441
	0.6	0.4	0.319	48.14	8.10	4.85	0.730	0.365
	0.8	0.2	0.0923	33.31	3.26	5.41	0.874	0.267
	0.9	0.1	0.0313	23.66	1.60	5.69	0.939	0.206
	0.97	0.03	0.00609	13.75	0.610	5.88	0.980	0.126
	1.0	0	0	0	0	–	1.0	0
$\left(\frac{1}{4}\right)$	0	1.0	∞	(89.5)	∞	π	0	–
	0.1	0.9	16.2	82.31	322.0	3.45	0.180	0.515
	0.2	0.8	7.57	75.18	153.0	3.76	0.330	0.489
	0.4	0.6	2.83	60.86	61.1	4.37	0.567	0.415
	0.6	0.4	1.07	46.72	26.7	4.99	0.746	0.334
	0.8	0.2	0.261	31.04	8.8	5.60	0.884	0.240
	0.9	0.1	0.0736	21.85	3.50	5.91	0.945	0.180
	0.97	0.03	0.0101	12.22	0.922	6.12	0.984	0.108
	1.0	0	0	0	0	–	1.0	0