B. E. MECHANICAL ENGINEERING 4TH YEAR 1ST SEMESTER EXAMINATION, 2019

MACHINE DESIGN IV

Time: 3 hours Full Marks: 100

(Assume data if required)

CO 1: (Full marks 30)

1. A) Derive the general expression of stresses in a thick cylinder subjected to both internal and external pressures. Show the radial and circumferential stress distributions in the cylinder for external pressure only.

OR

A cylinder with external diameter 300 mm and internal diameter 200 mm is subjected to an internal pressure of 25 MPa. Compare the relative merits of a single thick walled cylinder and a composite cylinder with the inner cylinder whose internal and external diameters are 200 mm and 250 mm respectively. A tube of 250 mm internal diameter and 300 mm external diameter is shrunk on the main cylinder. The safe tensile yield stress of the material is 110 MPa and the stress set up at the junction due to shrinkage should not exceed 10 MPa.

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B) (a) What are the types of end closure for cylindrical pressure vessel? Give sketches.
(b) What are the objectives of providing openings in pressure vessel?
(c) Explain with sketches advantages of pre-stressing a cylinder.

OR

Make a preliminary estimate of dead load and wind load for fabricating a plate thickness required for column of diameter 2.5 m and 60m in height. Skirt support height is 2.5 m; 100 sieve plates are equally spaced in the column; Insulation wall thickness = 70 mm; Operating pressure = 11 bar (absolute); Joint factor = 1; Column is made of stainless steel, with design stress and design temperature of 130 N/mm2 and 210^{0}C respectively. Take CV=1.15.

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CO 2: (Full marks 20)

2. A) (a) Explain briefly different types of lubrication.
(b) What do you understand by stable lubrication?

OR

Derive Petroff's equation.

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B) A 75 mm long full journal bearing of diameter 75 mm supports a load of 8 kN on a journal turning at 1400 rpm. Assuming (r/c) ratio of 1000 and oil having viscosity of 0.02 Ns/m^2 determine the coefficient of friction by using Petroff's equation.

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CO 3: (Full marks 30)

3. A) Derive the Reynold's equation. Also state all assumptions for deriving the Reynold's equation.

OR

Assuming the relevant velocity profile of the fluid flow between two parallel plates, prove that the load carrying capacity of a hydro-static bearing

$$W = \frac{\pi P_i}{2}\left[\frac{R_o^2 - R_i^2}{\log_e\left(\frac{R_o}{R_i}\right)}\right]$$

where P_i is the inlet pressure and R_o and R_i are the outer are inner radii respectively.

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B) Design a full hydrodynamic journal bearing with the following specification for machine tool application: journal diameter =75 mm; radial load = 10 kN; journal speed = 1440 rpm; minimum oil film thickness = 22.5 microns; inlet temperature = 40^0C; bearing material = Babbitt; Determine the length of the bearing and select a suitable oil for this application. Assume permissible bearing pressure for machine tool application is 2 N/mm^2.

OR

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

15

CO 4: (Full marks 20)

4. A) What are the differences between "pulley driving belt" and "belt driving pulley"? Sketch a regenerative single pulley drive at head end of conveyor with snub pulley. Why are carrying run idlers more in number than return run idlers?

OR

Write down the working principle and algorithm of **any one** of the following optimization techniques i) point estimation method ii) Golden Section method

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B) What is unimodal function? Compute two steps for optimizing the given function using bisection method $f(x) = x^2 - 6x + 18$ in the range $(0, 5)$.

OR

What are the characteristics of linear programming (LP) problem? Define concave and convex functions. Write down the fundamental rules of region elimination methods.

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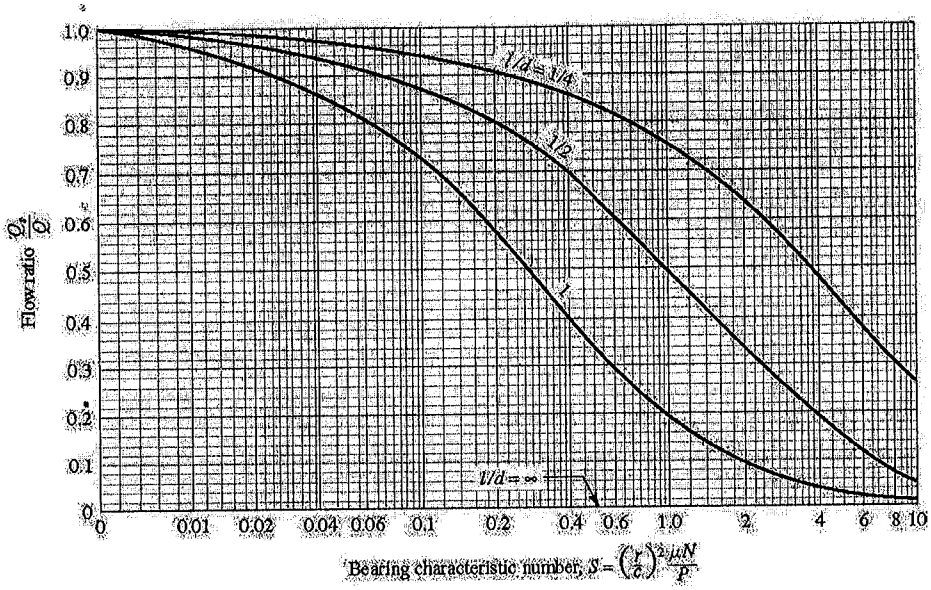
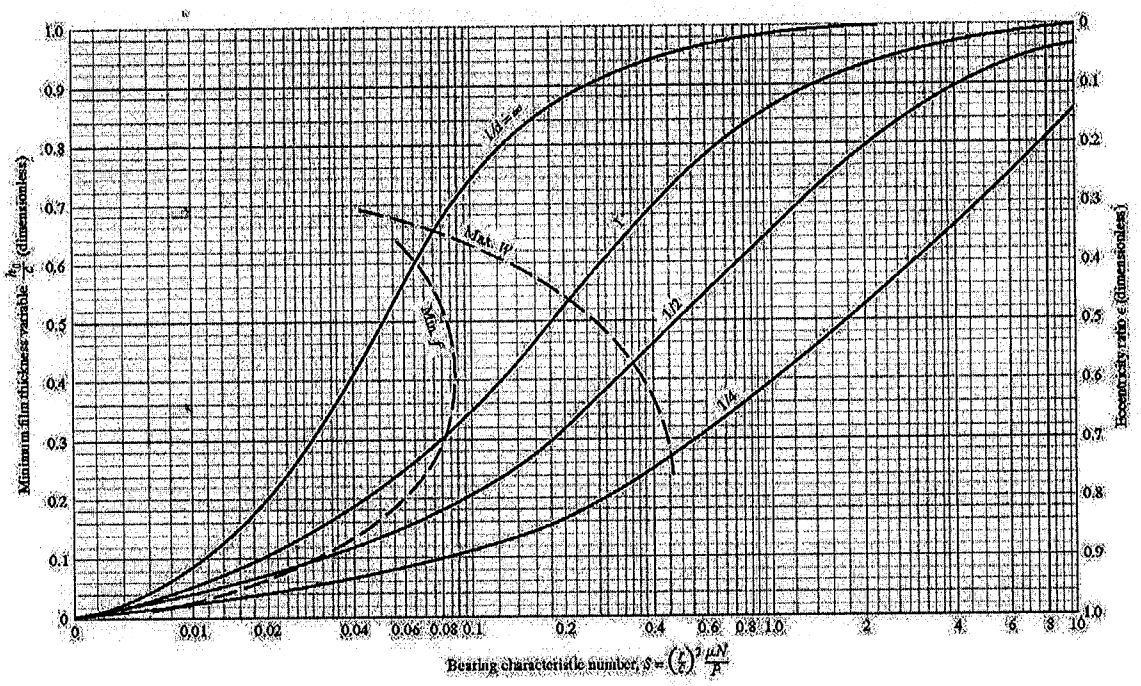
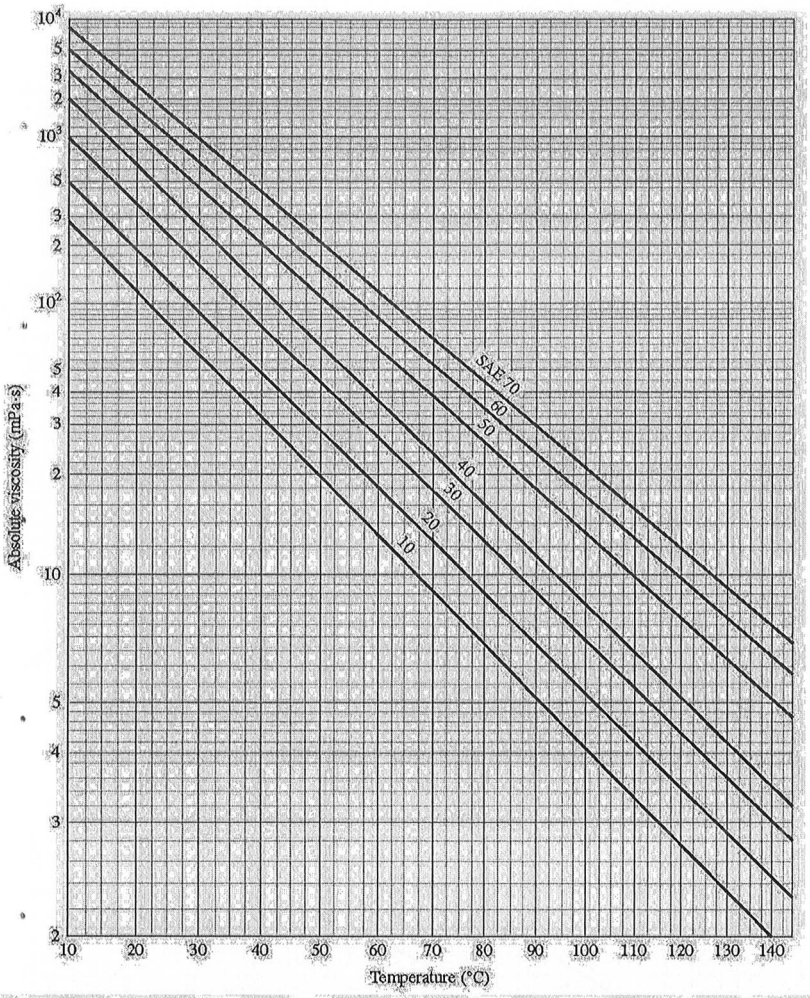
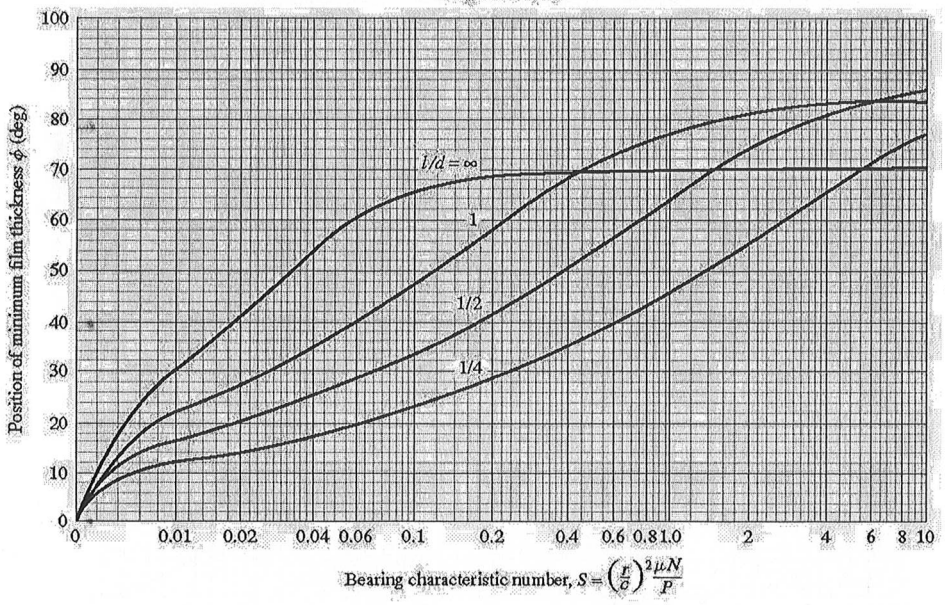
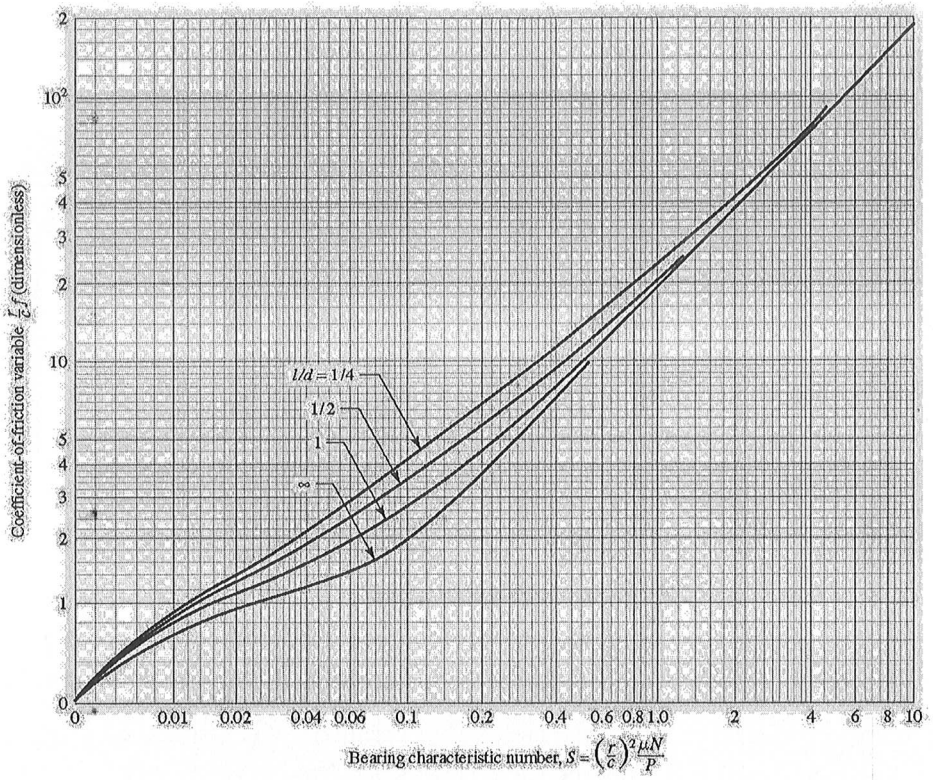
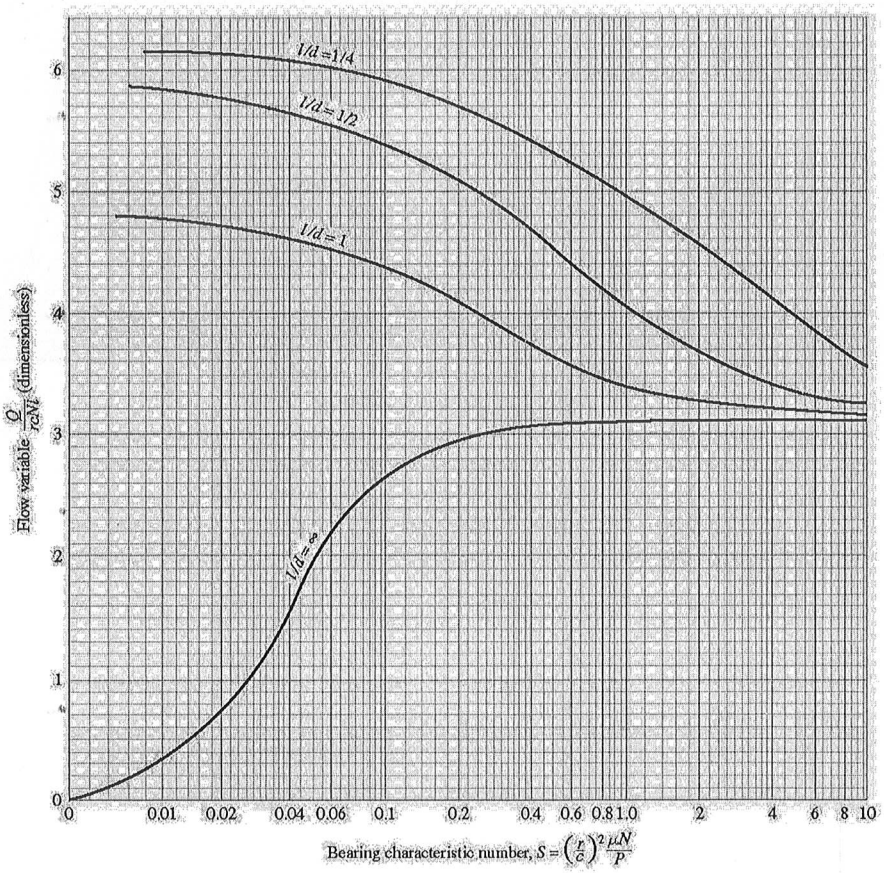

Flow ratio $\frac{Q_s}{Q}$
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
l/d = 1/4
1/2
1
l/d = ∞
0
0.01
0.02
0.04
0.06
0.1
0.2
0.4
0.6
1.0
2
4
6
8
10
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$

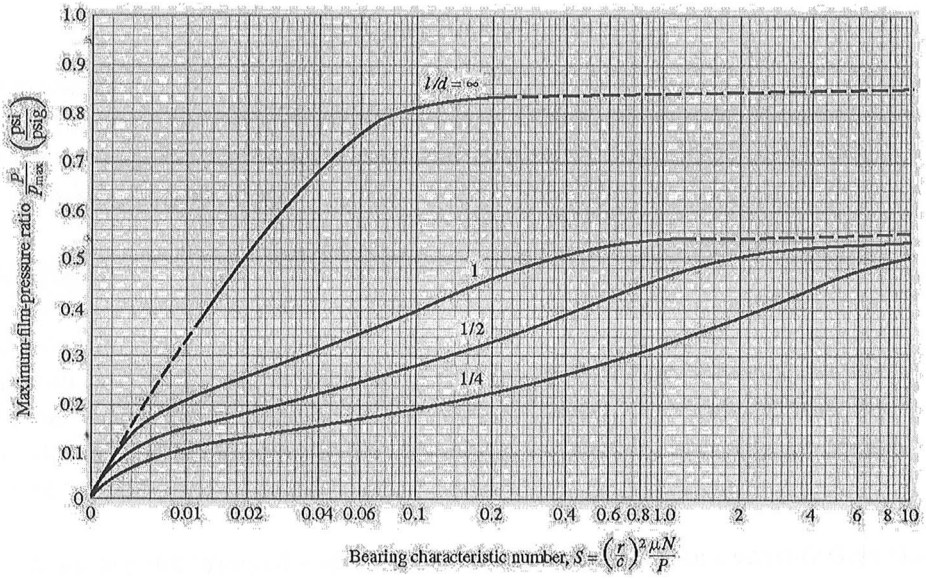

Minimum film thickness variable $\frac{h_0}{c}$ (dimensionless)
Eccentricity ratio ε (dimensionless)
l/d = ∞
Max. W
Max. f
1
1/2
1/4
0
0.01
0.02
0.04
0.06
0.08
0.1
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$

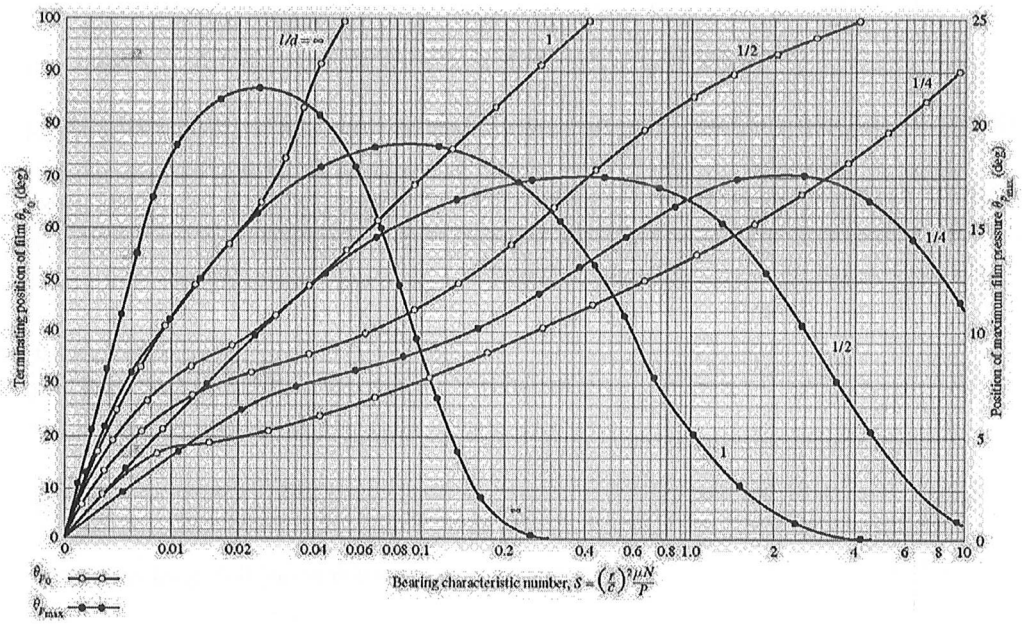

Absolute viscosity (mPa·s)
Temperature (°C)
SAE 70
60
50
40
30
20
10


Position of minimum film thickness ϕ (deg)
$l/d = \infty$
1
1/2
1/4
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$


Coefficient-of-friction variable $\frac{r}{c}f$ (dimensionless)
$l/d = 1/4$
1/2
1
∞
0 0.01 0.02 0.04 0.06 0.1 0.2 0.4 0.6 0.8 1.0 2 4 6 8 10
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$


Flow variable $\frac{Q}{rcNl}$ (dimensionless)
$l/d = 1/4$
$l/d = 1/2$
$l/d = 1$
$l/d = \infty$
0 0.01 0.02 0.04 0.06 0.1 0.2 0.4 0.6 0.8 1.0 2 4 6 8 10
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$


Maximum-film-pressure ratio $\frac{p}{p_{max}}$ $\left(\frac{psi}{psig}\right)$
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
l/d = ∞
1
1/2
1/4
0
0.01
0.02
0.04
0.06
0.1
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$


Terminating position of film θ_{F_0} (deg)
Position of maximum film pressure $\theta_{p_{max}}$ (deg)
l/d = ∞
1
1/2
1/4
1/4
1/2
1
∞
0
10
20
30
40
50
60
70
80
90
100
0
5
10
15
20
25
0.01
0.02
0.04
0.06
0.08
0.1
0.2
0.4
0.6
0.8
1.0
2
4
6
8
10
Bearing characteristic number, $S = \left(\frac{r}{c}\right)^2 \frac{\mu N}{P}$
θ_{F_0}
$\theta_{p_{max}}$