EML 3005:Homework #1, SOLUTION

CASE 1: Freeway Condition (Oil inlet temp = 180F, 3000 rpm)

Select Journal Radius (Inch), Length (Inch), Load (lbf), and Oil Inlet Temp (F)

$r := \frac{0.75}{2}$ $L := .75$ $W := 93.0$ $T1 := 180.0$ $rpm := 3000$

Define Radial Clearance Range (0.0002 - 0.0026 inch)

$c := 0.0004, 0.0006 .. 0.0028$

Define Journal Speed (rev/sec)

$N := \frac{rpm}{60}$

Define Average Oil Temperature (F), i.e., Tavg = T1 + DT/2 (Guess on oil DT, and iterate on calculated value)

$DTGUESS(c) := 45 \cdot \left(\frac{0.0004}{c}\right)^{1.2}$

$T(c) := T1 + \frac{DTGUESS(c)}{2}$

Define Viscosity (Reyns) vs. Temp for **10W30** oil

$\mu(c) := 0.7323 \cdot T(c)^{-2.4735}$

Define Unit Load Capacity (P)

$P := \frac{W}{2 \cdot L \cdot r}$

Define Sommerfeld Number (S) as a function of clearance (c), since c is a design variable

$S(c) := \left(\frac{r}{c}\right)^2 \cdot \mu(c) \cdot \frac{N}{P}$

Define bearing performance parameters in terms of curve fits provided

(a) Min Film Thickness, ho

$ho(c) := c \cdot \left(0.0247 + 4.2606 \cdot S(c) - 10.2144 \cdot S(c)^2 + 11.4556 \cdot S(c)^3 - 4.664 \cdot S(c)^4\right)$

(b) Friction Factor, f

$f(c) := \frac{c}{r} \cdot \left(0.7316 + 18.9931 \cdot S(c) + 0.1877 \cdot S(c)^2\right)$

(c) Flow Variable Q

$Q(c) := (r \cdot c \cdot N \cdot L) \cdot \left(4.8281 - 4.6055 \cdot S(c) + 5.9194 \cdot S(c)^2 - 2.7516 \cdot S(c)^3\right)$

(d) Side Flow Qs

$Qs(c) := Q(c) \cdot \left(0.9614 - 2.6056 \cdot S(c) + 3.4272 \cdot S(c)^2 - 1.6012 \cdot S(c)^3\right)$

CASE 1

Calculate Oil Temp Rise

$$DT(c) := \frac{0.103 \cdot P}{\left(1 - 0.5 \cdot \frac{Qs(c)}{Q(c)}\right)} \cdot \left(\frac{r}{c}\right) \cdot \frac{f(c)}{\frac{Q(c)}{(r \cdot c \cdot N \cdot L)}}$$

Print the variable values

c =	S(c) =	ho(c) =	c) =	Q(c) =	Qs(c) =
$4 \cdot 10^{-4}$	0.38397	$2.8073 \cdot 10^{-4}$	0.00859	0.02124	0.00798
$6 \cdot 10^{-4}$	0.19016	$3.22923 \cdot 10^{-4}$	0.00696	0.03499	0.02026
$8 \cdot 10^{-4}$	0.11268	$3.12588 \cdot 10^{-4}$	0.00613	0.04928	0.03494
0.001	0.07432	$2.89503 \cdot 10^{-4}$	0.00572	0.06353	0.04993
0.0012	0.05263	$2.66735 \cdot 10^{-4}$	0.00554	0.07765	0.06473
0.0014	0.0392	$2.47355 \cdot 10^{-4}$	0.00551	0.09168	0.07925
0.0016	0.03031	$2.31621 \cdot 10^{-4}$	0.00558	0.10561	0.09352
0.0018	0.02413	$2.19088 \cdot 10^{-4}$	0.00571	0.11948	0.1076
0.002	0.01966	$2.09207 \cdot 10^{-4}$	0.00589	0.13331	0.12151
0.0022	0.01633	$2.01487 \cdot 10^{-4}$	0.00611	0.14709	0.13529
0.0024	0.01377	$1.95526 \cdot 10^{-4}$	0.00636	0.16085	0.14897
0.0026	0.01177	$1.91003 \cdot 10^{-4}$	0.00662	0.17457	0.16256
0.0028	0.01018	$1.87663 \cdot 10^{-4}$	0.00691	0.18828	0.17609

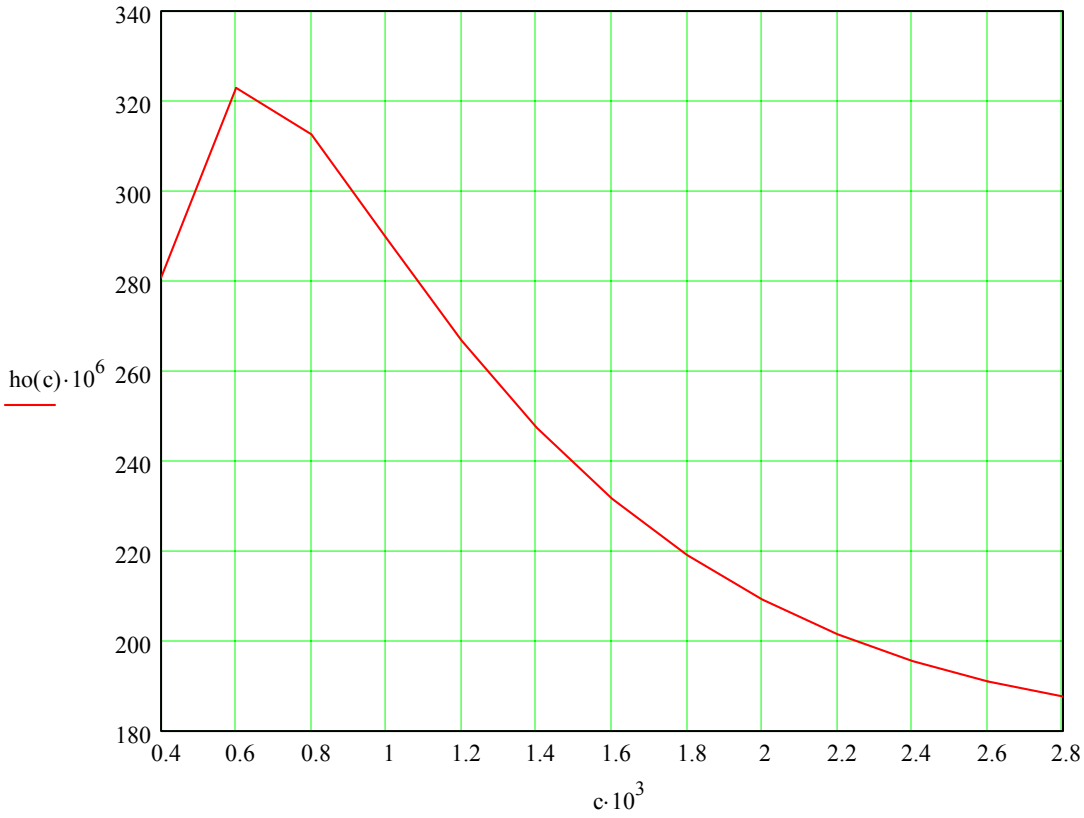
Print Oil Temperature Rise (guess and calculated), Average Oil Temp, and oil Viscosity

Guess	(Calculated DT)	Avg oil temp	
DTGUESS(c) =	DT(c) =	T(c) =	$\mu(c) \cdot 10^6$ =
45	44.70173	202.5	1.4446
27.66324	25.13623	193.83162	1.6097
19.58739	17.31041	189.79369	1.69574
14.98596	13.31719	187.49298	1.74767
12.04112	10.98795	186.02056	1.78209
10.00762	9.50911	185.00381	1.80642
8.52591	8.51223	184.26295	1.82443
7.40214	7.80908	183.70107	1.83827
6.52302	7.29504	183.26151	1.84919
5.81805	6.90817	182.90902	1.85802
5.2412	6.60989	182.6206	1.86529
4.7612	6.37518	182.3806	1.87136
4.35607	6.18724	182.17804	1.87652

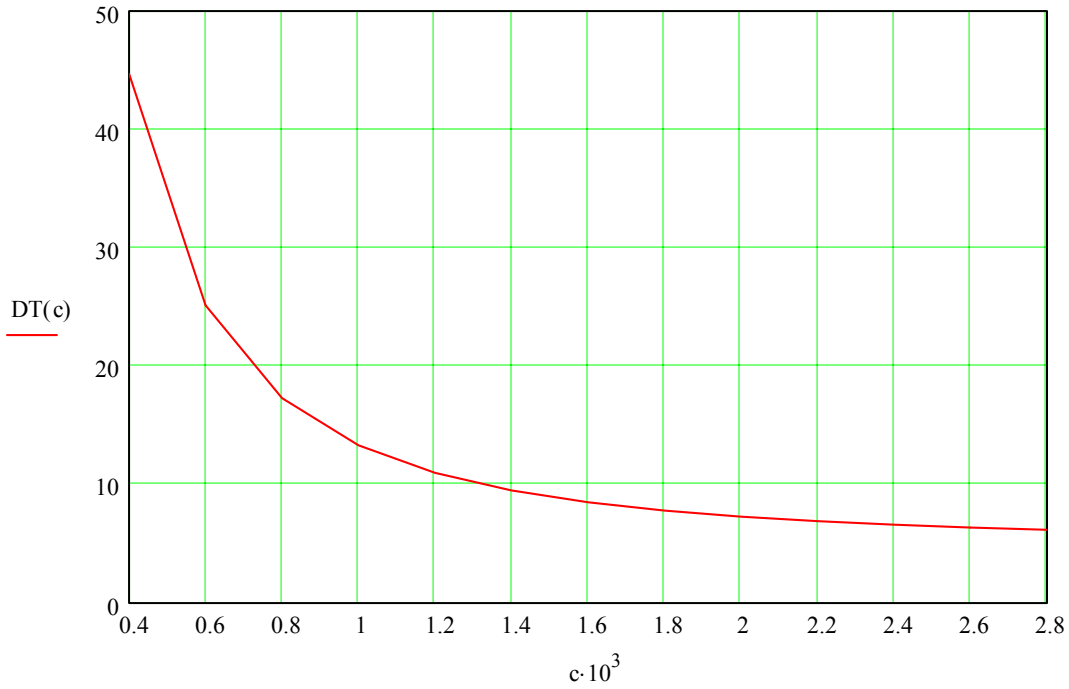
CASE 1

Plot Variables

Min Film Thickness Vs. Clearance



Oil Temp Rise (F) Vs. Clearance


50
40
30
20
10
0
DT(c)
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
c·10^3