UNIVERSITY OF JOHANNESBURG

PROGRAM	:	B ENG TECH *PHYSICAL 7 EXTRACTION METALLURGY*
SUBJECT	:	**HEAT & MASS TRANSFER II**
CODE	:	**HMTMTA2**
DATE	:	EXAMINATION 01 June 2019
DURATION	:	08:30 - 11:30
WEIGHT	:	40 : 60
TOTAL MARKS	:	100

EXAMINER	:	MR GA COMBRINK	Sanso Number
MODERATOR	:	MR J Prozzi	File Number 5113
NUMBER OF PAGES	:	9 PAGES	

INSTRUCTIONS	:	ALL THE ANSWERS MUST BE COMPLETED IN THE EXAM SCRIPS AND HANDED IN QUESTION PAPERS MUST BE HANDED IN.
REQUIREMENTS	:	1 POCKET CALCULATOR NO CORRECTION FLUID SHALL BE USED ALL WORK SHALL BE HANDED IN.

QUESTION 3 Reynolds Number

What is the flow regime for oil of density 0.953kg/litre and that has a kinematic viscosity at 40°C of 46cSt if it flows at 8kg per second in a tube with a circular profile of diameter 80mm. $1cSt = 10^{-6}\ m^2/s$

[8]

QUESTION 4

4. A stainless-steel ball (18% Cr, 8% Ni) 150 mm in diameter is initially at a uniform temperature of 18°C and is suddenly immersed in an oil liquid at 220°C with h= 136 $W/m^{2}{}^{\circ}C$. Using the lumped-capacity method of analysis, calculate the time necessary for the ball temperature to reach 200°C

[13]

QUESTION 5 IGNORE THE EFFECTS OF RADIATION IN THIS EXERCISE!

5 On one side of a concrete wall a heat flux of $1430W/m^2$ is transferred into the wall (i.e. that is what enters the wall). The wall is 20 cm thick and has an average value of thermal conductivity of 0.75W/m°C.

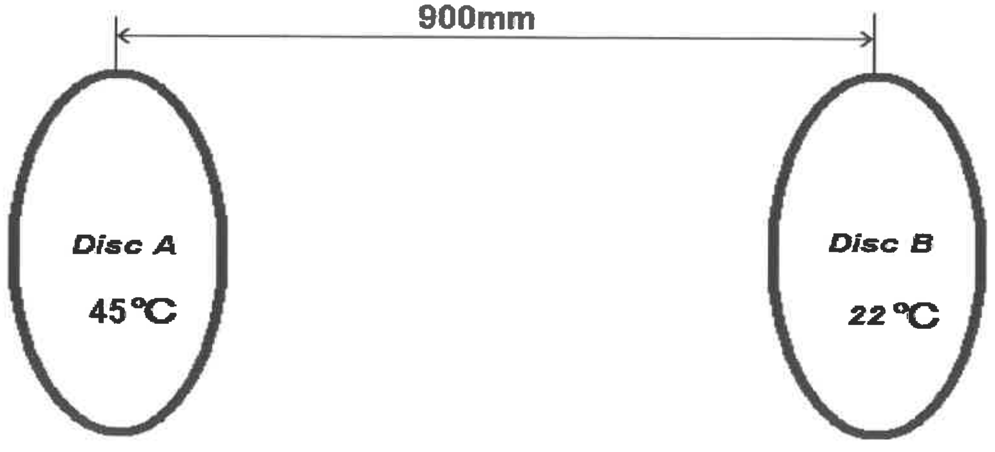
5.1 What will be the change in temperature over the wall (i.e. the temperature gradient) under steady state conditions (ΔT). *(7marks)*

5.2 Now determine the walls surface temperatures when the opposite side of the wall is exposed to air at 47°C. (take $h = 63W/m^{2}{}^{\circ}C$). *(8marks)*

[15]

QUESTION 6

Two similar sized (20 cm diameter) tin discs that are parallel to each other are buried in crushed iron ore, (see sketch below). They are 900 mm apart and Disc A is kept at 45°C whereas disc B is at 22°C. Using shape factors calculate what is the heat transfer between the two discs in the sketch? Use data in the appendices and the thermal conductivity provided in question 5 below.



[16]

10/...

Appendix A "erf" Function values

Table The error function.

$\frac{x}{2\sqrt{\alpha\tau}}$	erf $\frac{x}{2\sqrt{\alpha\tau}}$	$\frac{x}{2\sqrt{\alpha\tau}}$	erf $\frac{x}{2\sqrt{\alpha\tau}}$	$\frac{x}{2\sqrt{\alpha\tau}}$	erf $\frac{x}{2\sqrt{\alpha\tau}}$
0.00	0.00000	0.76	0.71754	1.52	0.96841
0.02	0.02256	0.78	0.73001	1.54	0.97059
0.04	0.04511	0.80	0.74210	1.56	0.97263
0.06	0.06762	0.82	0.75381	1.58	0.97455
0.08	0.09008	0.84	0.76514	1.60	0.97636
0.10	0.11246	0.86	0.77610	1.62	0.97804
0.12	0.13476	0.88	0.78669	1.64	0.97962
0.14	0.15695	0.90	0.79691	1.66	0.98110
0.16	0.17901	0.92	0.80677	1.68	0.98249
0.18	0.20094	0.94	0.81627	1.70	0.98379
0.20	0.22270	0.96	0.82542	1.72	0.98500
0.22	0.24430	0.98	0.83423	1.74	0.98613
0.24	0.26570	1.00	0.84270	1.76	0.98719
0.26	0.28690	1.02	0.85084	1.78	0.98817
0.28	0.30788	1.04	0.85865	1.80	0.98909
0.30	0.32863	1.06	0.86614	1.82	0.98994
0.32	0.34913	1.08	0.87333	1.84	0.99074
0.34	0.36936	1.10	0.88020	1.86	0.99147
0.36	0.38933	1.12	0.88079	1.88	0.99216
0.38	0.40901	1.14	0.89308	1.90	0.99279
0.40	0.42839	1.16	0.89910	1.92	0.99338
0.42	0.44749	1.18	0.90484	1.94	0.99392
0.44	0.46622	1.20	0.91031	1.96	0.99443
0.46	0.48466	1.22	0.91553	1.98	0.99489
0.48	0.50275	1.24	0.92050	2.00	0.995322
0.50	0.52050	1.26	0.92524	2.10	0.997020
0.52	0.53790	1.28	0.92973	2.20	0.998137
0.54	0.55494	1.30	0.93401	2.30	0.998857
0.56	0.57162	1.32	0.93806	2.40	0.999311
0.58	0.58792	1.34	0.94191	2.50	0.999593
0.60	0.60386	1.36	0.94556	2.60	0.999764
0.62	0.61941	1.38	0.94902	2.70	0.999866
0.64	0.63459	1.40	0.95228	2.80	0.999925
0.66	0.64938	1.42	0.95538	2.90	0.999959
0.68	0.66278	1.44	0.95830	3.00	0.999978
0.70	0.67780	1.46	0.96105	3.20	0.999994
0.72	0.69143	1.48	0.96365	3.40	0.999998
0.74	0.70468	1.50	0.96610	3.60	1.000000

Heislar and other charts

Figure 4-10 | Temperature as a function of center temperature in an infinite plate of thickness 2*L*, from Reference 2.

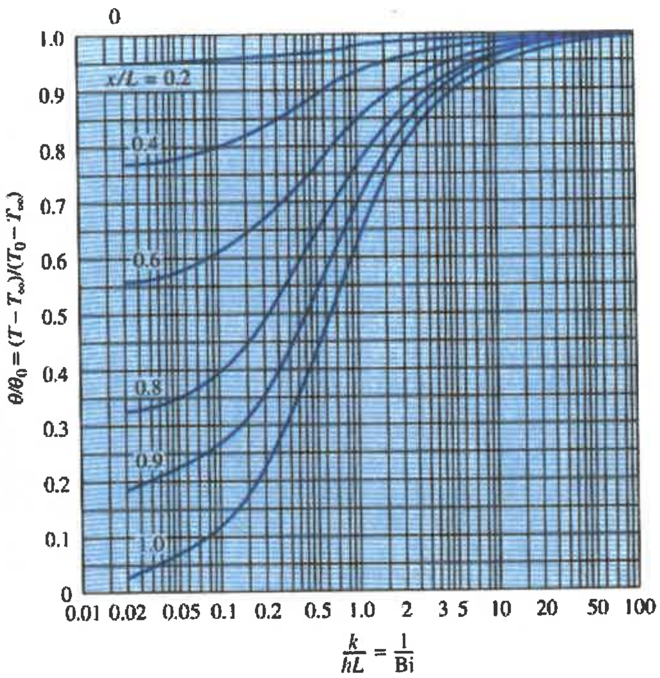


Figure 4-14 | Dimensionless heat loss Q/Q_0 of an infinite plane of thickness $2L$ with time, from Reference 6

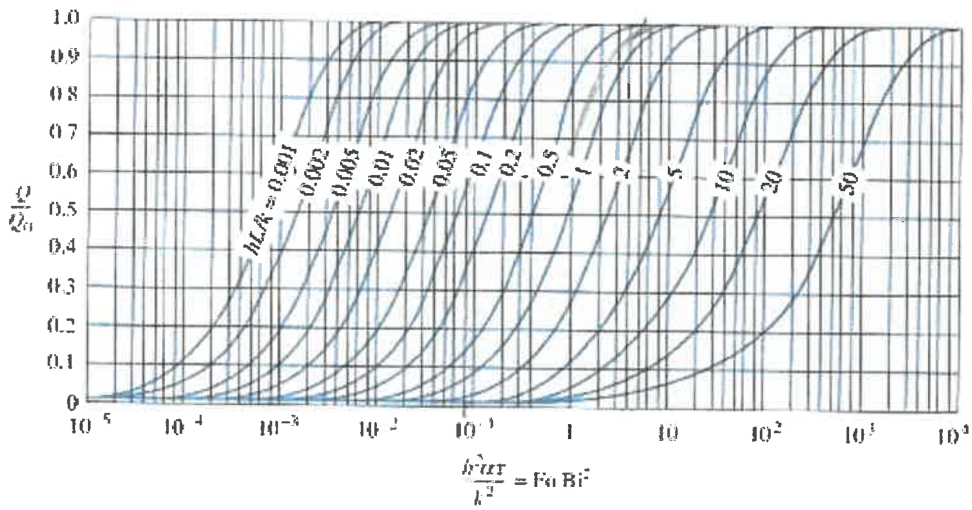
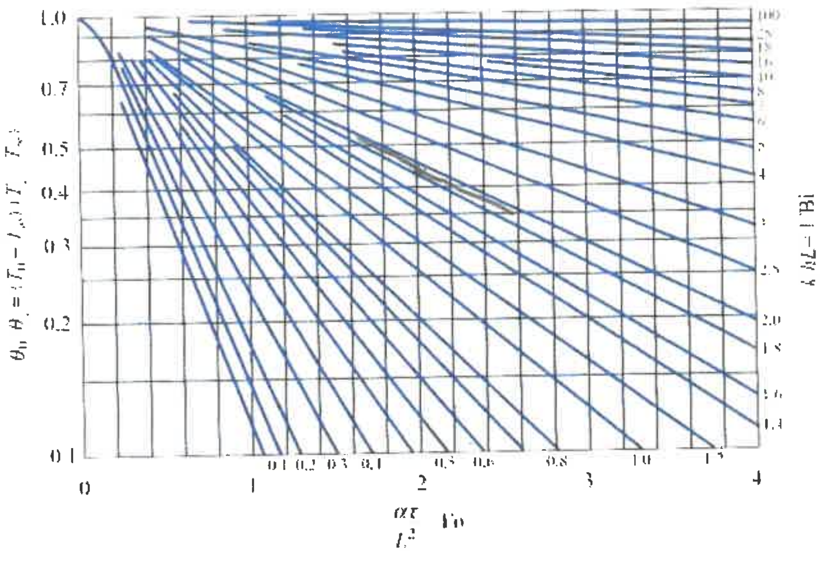


Figure 4-7 | (*Continued*) (*b*) expanded scale for 0 < Fo < 4, from Reference 2



(*b*)

Figure 4-5 | Temperature distribution in the semi-infinite solid with convection boundary condition.