ชื่อ-สกุล.....รหัส.....

มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

ข้อสอบกลางภาค: ภาคการศึกษาที่ 1 ปีการศึกษา: 2552

วันที่สอบ: 28 กรกฎาคม 2552 เวลา: 9.00-12.00

วิชา: 230 –466 ห้องสอบ: com 1

ทุจริตในการสอบ โทษขั้นต่ำ คือ ปรับตกในรายวิชาที่ทุจริต และพักการเรียน 1 ภาคการศึกษา

- ไม่อนุญาตให้นำ เครื่องคำนวณ แผ่นข้อมูล flash drive เข้าห้องสอบ
- อนุญาตให้นำเอกสารทุกชนิดเข้าห้องสอบได้ (ใช้ดินสอทำข้อสอบได้)
- ห้ามหยิบยืมเอกสารจากผู้อื่น
- ข้อสอบทั้งหมดมี 4 ข้อ (9 แผ่น รวมปก) ทำทุกข้อในกระดาษคำตอบ เขียนชื่อ รหัส บนกระดาษคำตอบทุกแผ่น

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ข้อ	คะแนนเต็ม	คะแนนที่ได้
1	20	
2	20	
3	25	
4	25	
รวม	90	

ผศ.ดร.ลือพงศ์ แก้วศรีจันทร์

ผู้ออกข้อสอบ

ชื่อ-สกุล.....รหัส.....

1. (20 points) A steel company makes four different types of steel alloys, called A1, A2, A3 and A4. Each alloy contains small amounts of chromium (Cr), molybdenum (Mo), titanium (Ti) and Nickel (Ni). The required composition of each alloy is given below.

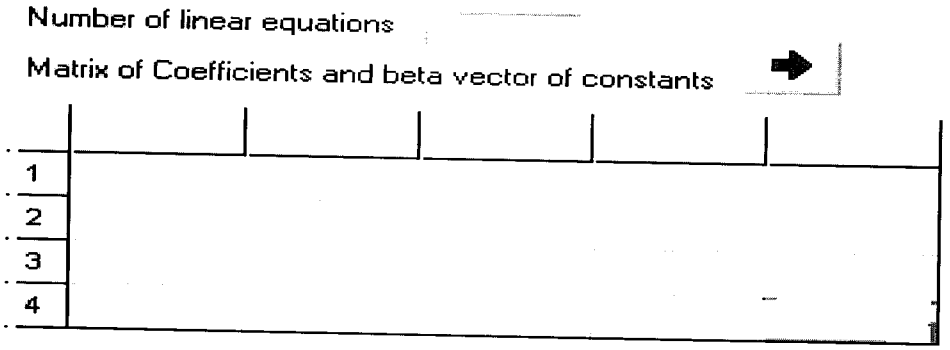
Alloy	Cr (%)	Mo (%)	Ti (%)	Ni (%)
A1	1.6	0.7	1.2	0.3
A2	0.6	0.3	1.0	0.8
A3	0.3	0.7	1.1	1.5
A4	1.4	0.9	0.7	2.2

Suppose the alloying materials are available in the following amounts:

Material	Availability (kg/day)
Cr	1200
Mo	800
Ti	1000
Ni	1500

Using Polymath, determine the production rate for each alloy, in metric ton per day (1 metric ton = 1000 kg).

Figure 1. Fill in the work sheet of problem 1



Show all linear equations by hand writing and fill in the solution in the following table:

Result of calculation (metric ton per day of each alloy)

Alloy	A1	A2	A3	A4
Metric ton/day				

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2. (20 points) Calculate the friction loss in unit of velocity head ,

$$F_f = 2f_F \frac{\Delta L v^2}{D} \quad (F_f = \text{friction loss in unit of vel.head}),$$

of a flow of water at 27 °C in (a) a smooth pipe, (b) a rough pipe of ε/D = 0.001. Density and viscosity of water are 999.4 kg/m^3 and 8.6x10^{-2} kg/m-s, respectively. Others data are given as follows: fluid flow rate = 3.0 m/s, pipe diameter = 0.3 m and length of the pipe = 300 m.
Hint: If *Re* is less than 2100 the value of $fF = 16/Re$ otherwise,

$$\frac{1}{\sqrt{f_F}} = 4.0\log\left(\mathrm{Re}\sqrt{f_F}\right) - 0.4 \quad \text{(Nikuradse Eq.)}$$

and $$\frac{1}{\sqrt{f_F}} = -4.0\log\left(\frac{\varepsilon}{D} + \frac{4.67}{\mathrm{Re}\sqrt{f_F}}\right) + 2.28 \quad \text{(Colebrook and White Eqs.)}$$

for smooth pipe and rough, respectively.
(c) Determine fluid flow rate for which the velocity head ratio of rough pipe to smooth pipe equals 1.5 ($\frac{vel\_head\_rough}{vel\_head\_smooth} = 1.5$.) Diameter and length of the both pipes are as same as in part (a) and (b).

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Solution: Fill in value, units, etc in the tables

	Mathematical formula	unit
f(fF)= *smooth pipe*		dimensionless
f(fF)= *rough pipe*		dimensionless
rho=		
v =		
D =		
vis =		
Re =		
L =		
ε / D =		dimensionless
velHead = smooth pipe		
velHead = rough pipe		

(c) Determine the flow rate (velocity, m/s) for which $\frac{vel\_head\_rough}{vel\_head\_smooth} = 1.5$

	Smooth pipe	Rough pipe	unit
velocity			
velocity head			

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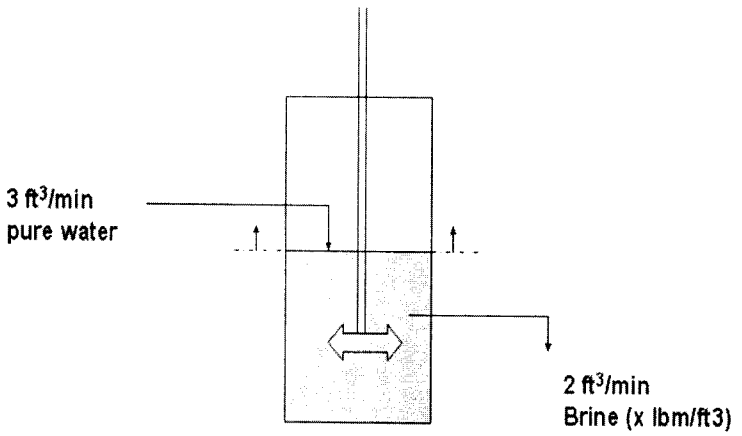
3. (25 points) A stirred tank, initially containing 20 ft^3 of brine solution, concentration of 2 lb_m/ft^3, is fed pure water at rate of 3 ft^3/min. The tank discharges at 2 ft^3/min. (a) what is the salt concentration when the tank contains exactly 30 $ft^3$of brine solution ? (b) How long will the brine concentration in the tank is 0.40 lb_m/ft^3, assume the volume of the stirred tank is very large (no overflows).



V(0) = 20 ft^3, brine concentration of 2 lbm/ft^3
Assume: density of brine = density of pure water = 63 lbm/ft^3
@ t = 0, start feeding pure water into the tank

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Solution: Let M = mass of solution in the tank (lbm)

Variables	Unit
M= mass of brine solution in the tank	lb_m
V = volume of solution in the tank	ft^3
S= mass of NaCl in the tank	lb_m
SaltConc= mass concentration of salt	lb_m/ft^3
rho = density of brine solution = density of pure water	lb_m/ft^3

Fill the mathematical function and comments in blanks:

	mathematical function	comments
d□/dt =		
dS/dt =		
SaltConc=		

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Fill the calculating results in blanks :

Solution of part (a)

POLYMATH Report No Title
Ordinary Differential Equations 29-มี.ค.-2552

Calculated values of DEQ variables

	Variable	Initial value	Minimal value	Maximal value	Final value
1	M				
2	rho	63.	63.	63.	63.
3	S				
4	SaltConc				
5	t	0			
6	V	20.	20.	30.	30.

Differential equations

1 d( )/d(t) =

2 d(S)/d(t) =

total salt in tank 1, lbm

Explicit equations

1 rho = 63

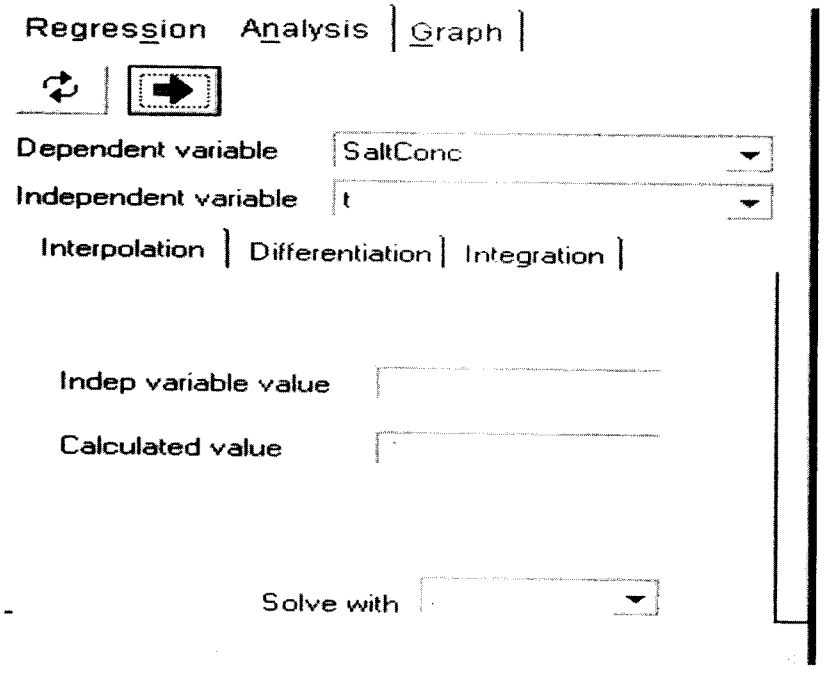
solution density lbm/ft^3

2 V =

3 SaltConc =

mass of salt per volume of solution in outlet stream

Solution of parrt (b)



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4. (25 points) Determine the most appropriate correlation for the heat transfer data in the given table. Evaluate expressions that have the general form of

(a) $\log(Nu) = \log(a_0) + a_1 \log(Re) + a_2 \log(Pr) + a_3 \log(\mu / \mu_w)$ by multiple linear regression.

(b) $Nu = a_o \, Re^{a_1} \, Pr^{a_2} \, (\mu / \mu_W)^{a_3}$ by non-linear regression

Point	Re	Pr	μ/μ_w	Nu	Point	Re	Pr	μ/μ_w	Nu
1	368	545	0.109	15.7	14	67.2	520	0.161	12.5
2	381	535	0.112	14.1	15	269	507	0.121	13.5
3	875	345	0.076	16.0	16	655	436	0.114	15.3
4	645	348	0.074	15.0	17	22.6	3550	3.43	25.0
5	90.4	385	0.094	10.5	18	23.8	3160	5.28	21.0
6	90.8	390	0.101	10.7	19	20.9	3620	6.02	18.0
7	545	151	0.052	14.6	20	26.6	2780	6.30	21.2
8	1005	167	0.050	16.1	21	24.7	3100	6.62	18.0
9	978	168	0.050	16.2	22	29.6	2510	6.62	22.6
10	1523	160	0.051	17.4	23	26.5	2860	8.10	22.5
11	1560	158	0.051	17.3	24	29.2	2470	8.80	21.7
12	2100	159	0.053	21.2	25	27.8	2770	9.75	23.0
13	2110	159	0.056	21.4					

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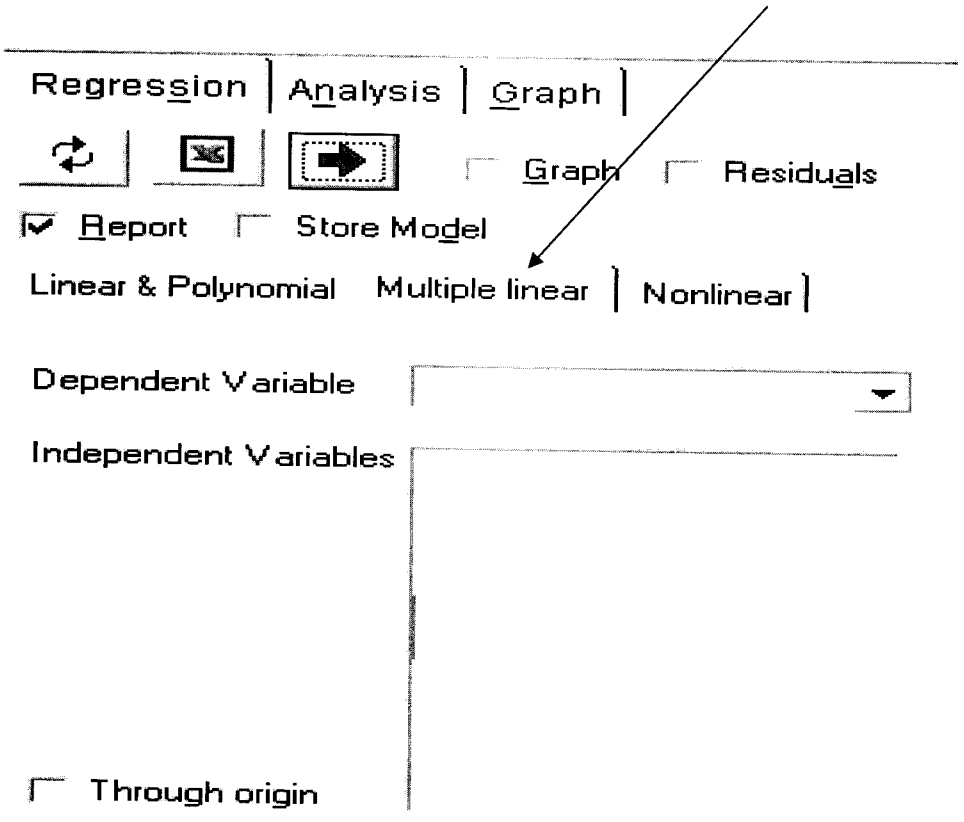
Solution: Part (a)



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Part (a) Multiple Linear regression

Model: logNu =

Variable	Value	95% confidence
a0		
a1		
a2		
a3		

General
Number of independent variables =
Regression including a free parameter
Number of observations =

Statistics
R^2
R^2adj
Rmsd
Variance

Solution Part (b) Write down the nonlinear regression model, its intitial guess and the results.

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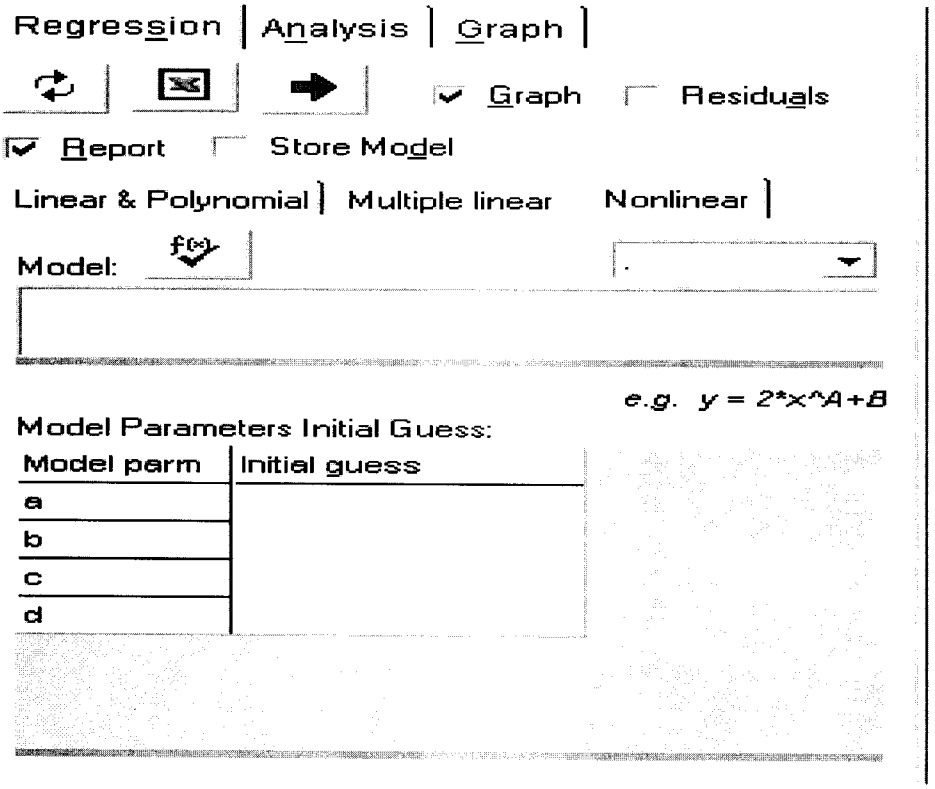
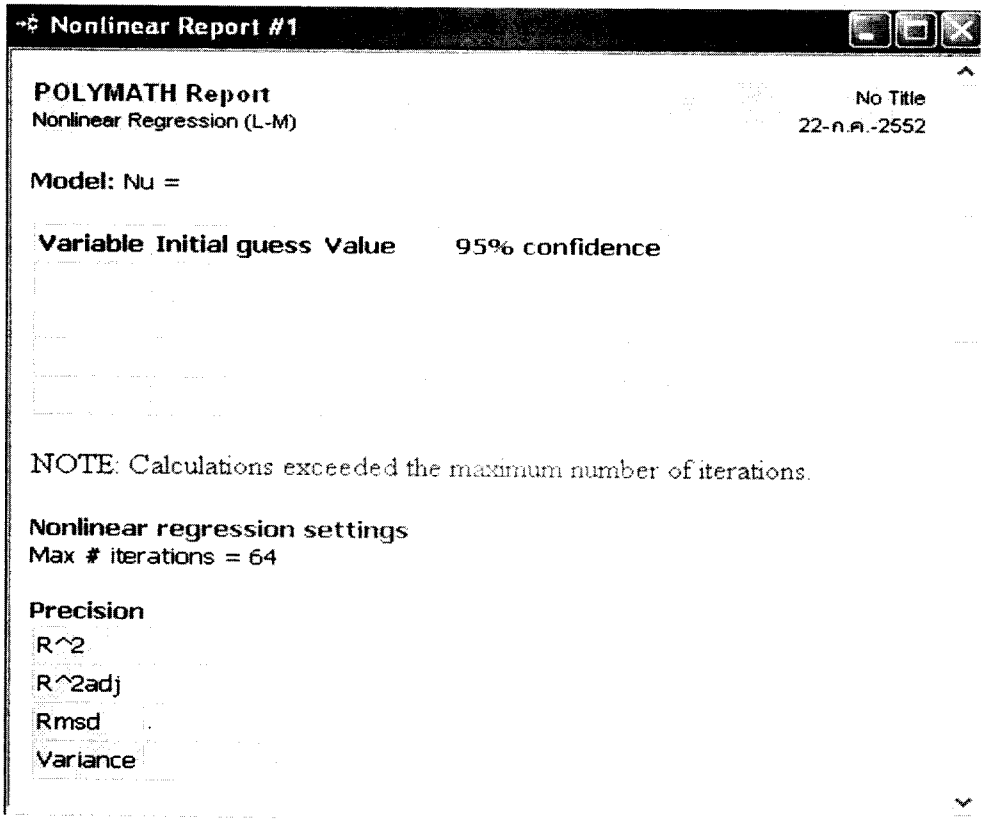

Regression
Analysis
Graph
Graph
Residuals
Report
Store Model
Linear & Polynomial
Multiple linear
Nonlinear
Model:
e.g. y = 2*x^A+B
Model Parameters Initial Guess:
Model parm
Initial guess
a
b
c
d


Nonlinear Report #1
POLYMATH Report
Nonlinear Regression (L-M)
No Title
22-ก.ค.-2552
Model: Nu =
Variable Initial guess Value 95% confidence
NOTE: Calculations exceeded the maximum number of iterations.
Nonlinear regression settings
Max # iterations = 64
Precision
R^2
R^2adj
Rmsd
Variance

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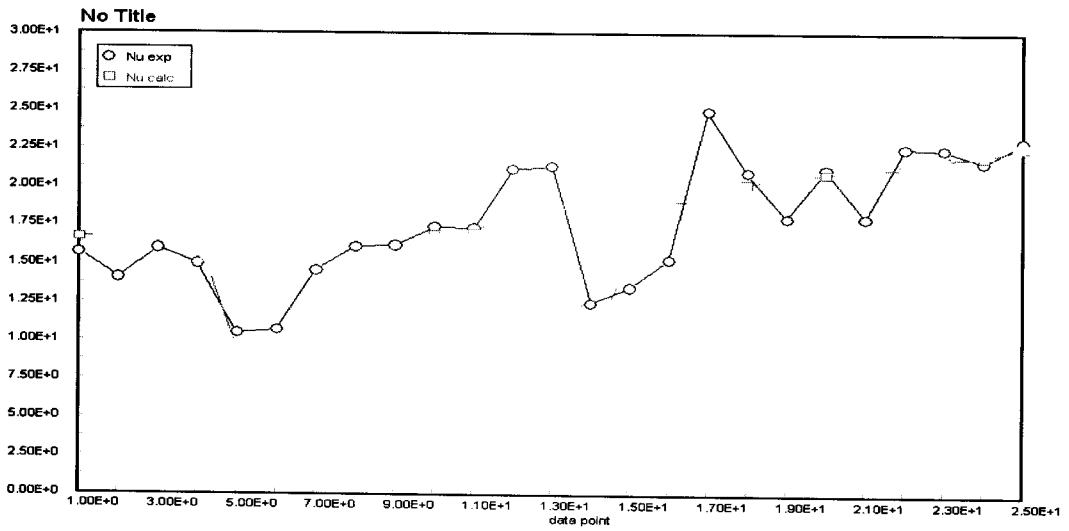
Mark the calculation values of Nu in the figure (mark with □ symbol on the figure only at select points number 3, 7, 11, 17 and 23).



3 7 11 17 23