University of Technology	*Optimization*	*Date: 15/06/2009*
Chemical Engineering Dept.	*Final Exam*	*Time: 3 hrs.*
BSc. Fourth Year	*2008-2009*	*Dr. Nidhal Al-Azzawi*

Q1) ACME Bicycle Company produces two kinds of bicycles, mountain bikes and street racers. ACME wishes to determine the rate at which each type of bicycles should be produced in order to maximize the profits. It assumes that it can sell all the bicycles produced. The maximum production rate of the mountain bikes is 2 bikes/day, and of the street racer is 3 bikes/day. Producing a bicycle of either type requires the same amount of time on the metal finishing machine and this machine can process at most a total of 4 bicycles/day of either type. The company accountant estimates that mountain bikes are generating profit of $15/bicycle and the street racer of $10/bicycle. Formulate the objective function and the constraints then solve graphically. (20 marks)

Q2) A: Search for the optimum values for *THREE* of the following equations using analytical method:

1- $y = 5x_1^2 - 3x_1^2x_2 + x_2^2$
2- $M = 48 + 0.1\ N^{1.2} + 9100\ N^{-1}$
3- $R = 100 - (10 - P)^2 - (5 - Z)^2$
4- $y = \cos x + 4x \sin x \qquad \pi/4 \le x \le \pi/2$

B: Solve the following function using constrained variation method;

$$Z = 4x_1^2 + 5x_2^2$$

subjected to: $g_1 = 2x_1 - 3x_2 - 6 = 0$

(15 marks)

Q3) Answer *ONE* of the following:

A- Determine the optimum value of the following function using Dichotomous method.

$$y = 10\ x^2 - 3x + 5 \quad \text{for} \quad x^2 - 5 \le 0 \quad \text{and} \quad \delta = 0.01$$

B- Find the optimum value of the following function using Fixed Step metho and *DSC* method. Compare the results of the two methods.

$$y = 6\ (x^2 + 3)^{-1} \qquad -1 \le x \le 1 \quad \text{and} \quad S=0.1$$

(20 marks)

Q4) Find the maximum point of the following function using simplex metho starting from point (0.551, 1.612).

$$Z = [\ (1 + x)^2 + y^2\ ]^{-1} \qquad \text{take} \quad a = 0.5 \qquad \textbf{(15 marks)}$$

GOOD LUCK

أسم الطالب:-

University of Technology
Chemical Engineering Department

Final Exam / 1st Attempt — Dr.Farah Talib
BS.C. Class: 4th year — Time: 3 hour

Transport Phenomena

Answer Four Question Only

الاجابه بالقلم الجاف

Q-1 Answer One of the following from question one.

A- A single effect evaporator is used to concentrate 1.5 Kg/s of 8% caustic soda to 40% of solid. The feed enters at 291K. Steam is available at 185KN/m^2 and evaporation is takes place at 13KN/m^2 , the overall heat transfer coefficient is 1.25 KW/m^2.K.The heating surface is 1.61m below the liquid level. The **boiling point rise** will be considered and equal to **25K**
Cp of 8% solution =4 KJ/Kg.K
Cp of 40% solution =3.26 KJ/Kg.K
Cp of vapor 1.8 KJ/Kg.K , sp.gr of boiling liquid 1.39,

B- 1-Drive an expression for the simple Reynolds analogy for heat transfer .
2- Air at 320K ,flowing at 11m/s, enters a pipe of inner diameter 30mm, maintained at 420K.The drop of static pressure along the pipe is 90 N/m^2 per meter length. Using Reynolds analogy to estimate the temperature of the air 0.8m along the pipe. Take ρ_{air}=1.1Kg/m^3

Q-2 Answer One of the following from question two.

A- 1-Air containing 0.01kg $_{water\ vapor}$ /kg $_{dry\ air}$ is heated to 330K in a dryer and passed to the lower shelves. It leaves these shelves at RH 50% and is reheated to 330K and passed over another set shelves again leaving at RH 50% .This repeated for the 3rd to 4th sets of shelves after which reheated to 340K and the air leaving at RH 50% .The material on each shelves has reached to the wet –bulb temperature. Neglect heat losses. Determine: a-Temperature of material on each tray. b-amount of water removed if 8m^3/sec air leaves the dryer.
2- Drive the operating line equation for the cooling tower.

B- The relation between the velocity (u) and the distance of flow (y) in the stream line fluid can be expressed as : $u = u_o + ay + by^2 + cy^3$,
where the coefficients a ,b ,c are independent of y. Find the values of these coefficients using boundary condition. Calculate the thickness of the boundary layer ,point shear stress and the mean shear stress at a distance of 75 mm from the leading edge of a plane surface over which water is flowing at a rate of 3 m/s. Assume that the flow in the boundary layer is streamline. The viscosity of water is 1 mN s/m^2.

C- Find the thermal conductivity and diffusivity relations in a molecular diffusion

Q-3 A solution of 8 per cent acetaldehyde in toluene is to be extracted with water in a 4 stages co-current unit. If 30 kg water/100 kg feed is used, what is the mass of acetaldehyde extracted and the final concentration? The equilibrium relation is given by:
(kg acetaldehyde/kg water) = 2.20(kg acetaldehyde/kg toluene)

Q-4 A continuous counter–current dryer is being used to dry 450$Kg_{draysolid}/h$,containing 0.06$Kg_{\text{total moisture}}/Kg_{\text{dray solid}}$ to a value of 0.003$Kg_{\text{total moisture}}/Kg_{\text{dray solid}}$ .The granular solid enters at 27°C and is to be discharged at 63 °C. The dry solid has specific heat of 1.46KJ/Kg.K , which was assumed constant .Heating air enters at 94 °C ,having a humidity of 0.01 $kg_{H2O}/kg_{\text{dray air}}$, and is to leave at 38 °C. Calculate the air flow rate and the outlet humidity , assume no heat losses in the dryer.

Take:- C_a = 1.005 KJ / Kg .°C , C_w = 1.88 KJ / Kg .°C .

λ_o = 2501 KJ / kg , Cp_A=4.187 KJ / Kg .°C ,T_o=0°C.

Q-5 A Slurry is filtered in a laboratory vacuum leaf filter of 0.5 m^2 filtering surface area ,filtration is carried out at constant pressure throughout .The filtration pressure is 90KN/m^2 vacuum .The volume of filter collected in the first 300sec was 2500cm^3 and after 600sec an additional 1500cm^3 was collected and the cakes are completely formed .

The cakes are then washed at 30KN/m^2 for 450sec using simple washing .How much wash water is used .Assume the cake to be incompressible and the cloth resistance and initial layer deposit will be considered .

Absolute pressure (kN/m²)	Temperature (°C)	Temperature (K)	Enthalpy per unit mass (H_s) (kJ/kg)			Entropy per unit mass (S_s) (kJ/kg K)			Specific volume (v) (m³/kg)	
	θ	T	water	latent	steam	water	latent	steam	water	steam
1.0	6.98	280.13	29.3	2485.0	2514.4	0.1060	8.8706	8.9767	0.001000	129.21
2.0	17.51	290.66	73.5	2460.2	2533.6	0.2606	8.4640	8.7246	0.001001	67.01
3.0	24.10	297.25	101.0	2444.6	2545.6	0.3543	8.2242	8.5785	0.001003	45.67
4.0	28.98	302.13	121.4	2433.1	2554.5	0.4225	8.0530	8.4755	0.001004	34.80
5.0	32.90	306.05	137.8	2423.8	2561.6	0.4763	7.9197	8.3960	0.001005	28.19
6.0	36.18	309.33	151.5	2416.0	2567.5	0.5209	7.8103	8.3312	0.001006	23.74
7.0	39.03	312.18	163.4	2409.2	2572.6	0.5591	7.7176	8.2767	0.001007	20.53
8.0	41.54	314.69	173.9	2403.2	2577.1	0.5926	7.6370	8.2295	0.001008	18.10
9.0	43.79	316.94	183.3	2397.9	2581.1	0.6224	7.5657	8.1881	0.001009	16.20
10.0	45.83	318.98	191.8	2392.9	2584.8	0.6493	7.5018	8.1511	0.001010	14.67
12.0	49.45	322.60	206.9	2384.2	2591.2	0.6964	7.3908	8.0872	0.001012	12.36
14.0	52.58	325.73	220.0	2376.7	2596.7	0.7367	7.2966	8.0333	0.001013	10.69
16.0	55.34	328.49	231.6	2370.0	2601.6	0.7721	7.2148	7.9868	0.001015	9.43
18.0	57.83	330.98	242.0	2363.9	2605.9	0.8036	7.1423	7.9459	0.001016	8.45
20.0	60.09	333.24	251.5	2358.4	2609.9	0.8321	7.0773	7.9094	0.001017	7.65
25.0	64.99	338.14	272.0	2346.4	2618.3	0.8933	6.9390	7.8323	0.001020	6.20
30.0	69.13	342.28	289.3	2336.1	2625.4	0.9441	6.8254	7.7695	0.001022	5.23
35.0	72.71	345.86	304.3	2327.2	2631.5	0.9878	6.7288	7.7166	0.001025	4.53
40.0	75.89	349.04	317.7	2319.2	2636.9	1.0261	6.6448	7.6709	0.001027	3.99
45.0	78.74	351.89	329.6	2312.0	2641.7	1.0603	6.5703	7.6306	0.001028	3.58
150	111.37	384.52	467.1	2226.2	2693.4	1.4336	5.7897	7.2234	0.001053	1.159
155	112.36	385.51	471.3	2223.5	2694.8	1.4445	5.7679	7.2123	0.001054	1.124
160	113.32	386.47	475.4	2220.9	2696.2	1.4550	5.7467	7.2017	0.001055	1.091
165	114.26	387.41	479.4	2218.3	2697.6	1.4652	5.7261	7.1913	0.001056	1.060
170	115.17	388.32	483.2	2215.7	2699.0	1.4752	5.7061	7.1813	0.001056	1.031
175	116.06	389.21	487.0	2213.3	2700.3	1.4849	5.6867	7.1716	0.001057	1.003
180	116.93	390.08	490.7	2210.8	2701.5	1.4944	5.6677	7.1622	0.001058	0.977
185	117.79	390.94	494.3	2208.5	2702.8	1.5036	5.6493	7.1530	0.001059	0.952
190	118.62	391.77	497.9	2206.1	2704.0	1.5127	5.6313	7.1440	0.001059	0.929
195	119.43	392.58	501.3	220[illegible]	2705.1	1.[illegible]15	5.6138	7.1353	0.001060	0.907
200	120.23	393.38	504.7	2201.[illegible]	2706.3	1.[illegible]1	5.5967	7.1268	0.001061	0.885

U. of Technology	PROCESS CONTROL	Date 28 / 5 / 2009
Chem. Eng. Dep.		Time three hours
B.Sc. 4th year	Final Exam 2008/2009	Dr. Karima Marogi

ملاحظة:- اجب عن اربعة اسئله فقط على ان يكون السؤال الثالث من ضمنها.

Q.1

A. **A step change of magnitude 2 is introduced into a system having the transfer function:-**

$$\frac{Y(s)}{X(s)} = G(s) = \frac{15}{s^2 + 3s + 5}$$

Determine

1. **Percent Overshoot**
2. **Rise time**
3. **Maximum value of Y(t)**
4. **Ultimate value of Y(t)**
5. **Period of oscillation**

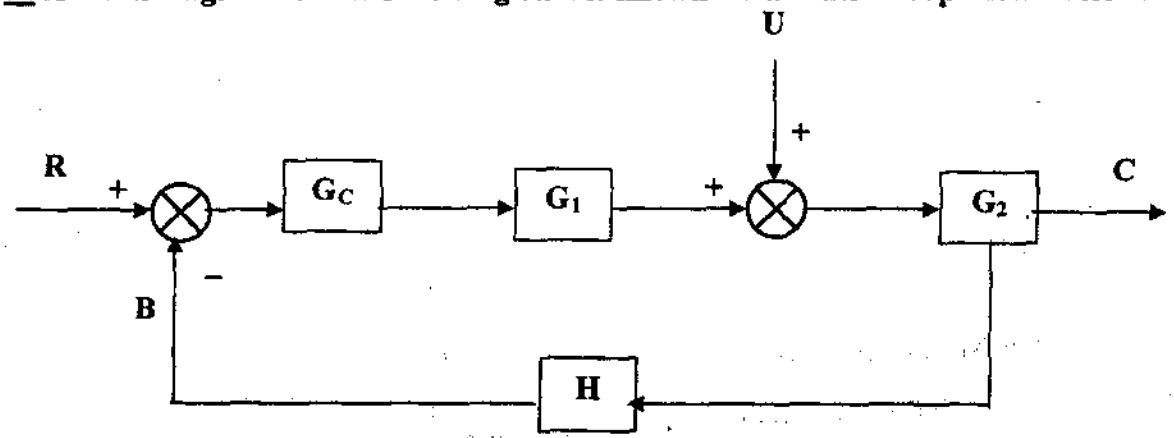
(10 Marks)

B. **Draw only one scheme for distillation column to control each output variable.**

(5 Marks)

Q.2

A. **A block diagram for the following data is known for a control loop shown below:-**



(a) The transfer function of the process is given by:

$$G_2 = \frac{1}{(0.1s^2 + 0.3s + 0.2)}$$

(b) The steady state gains of valve and measuring element are 0.4 and 0.6 units respectively.

(c) The time constants of both valve and measuring element may be considered negligible.

(d) It is proposed to use a proportional derivative controller PD with K_C =2 and τ_D =2 units. What is the amount of offset obtained when a unit step change in load is made (regulating problem).

(10 Marks)

B. **Show if the following system whose transfer functions below is stable or not.**

$$G_P = \frac{1}{(3s^2 + 2s + 1)} \qquad Kc = 2$$

(5 Ma)

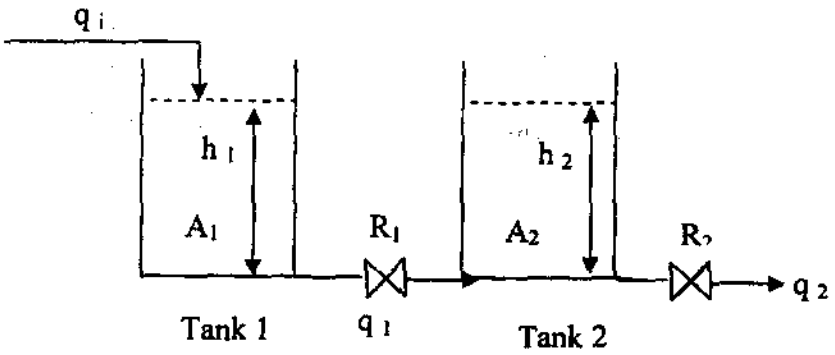
C Plot the Bode Diagram for the following transfer function:-

$$G(s) = \frac{12\left(1+\frac{1}{s}\right)\left(1+\frac{s}{8}\right)e^{-\frac{s}{10}}}{(s+3)}$$

(15 Marks)

Q.4

A. Determine the transfer function H(s)/Q(s) for the liquid-level system shown below. Resistances R_1 & R_2 are linear and the tanks are interacting with equal volume.



(10 Marks)

B. A proportional controller is used to control temperature within the range of 40 to 72°C. The controller is adjusted so that the output pressure goes from 3-15 psi as the measured temperature goes from 150-174 K with the set point held constant. Find the gain and the proportional band.

(5 Marks)

Q.5

A. Given a system with transfer function $\frac{Y(s)}{X(s)} = \frac{\tau 1+1}{\tau 2+1}$. Find

(a) Y(t) if X(t) is a step change function.

(b) If $\tau_1 = 7\tau_2$ sketch Y(t) versus $\frac{t}{\varepsilon_2}$.

(10 Marks)

B. Answer (True or False) for each of the following statements:-

(a) For a Routh Array if the roots of the first column are positive then the system is stable.

(b) The value of K_C that make the system stable is $K_C > \frac{17}{3}$ when the root is $\frac{17-3K_C}{2}$.

(c) A stable system defined as one for which output response is bounded for a bounded input.

(d) For a proportional controller when K_C increase the offset decrease.

(e) The effect of the integral action on the response of the controlled process is to eliminate the offset and increase the damping ratio (φ).

(5 Marks)

********* With my best wishes for success ********

الجامعة التكنولوجية	الامتحان النهائي /الدور الاول	المادة : تصفيه النفط
قسم الهندسة الكيماوية	2009-2008	مدرس المادة : د. عدنان عبد الجبار
المرحلة الرابعة/ تكرير		الزمن : ثلاثه ساعات

Answer There questions with Q1 included

Q1:4000 BPD of 35 ^{0}API crude oil having the given TBP data is available from a box furnace at 650 ^{0}F and to be processed in an atmospheric distillation column.

% vol. Distilled	TBP (^{0}F)	API	% S
1	85	110	---
12	180	63	---
16	385	49	0.1
22	510	38	0.3
12	620	23	0.5
10	750	20	0.8
11	1000	17	1.5
6	1000$^+$	11	2.3

Answer the followings questions:

A) Evaluate the given crude; TMABP=TVABP- 120 (^{0} F)

B) Select TBP cut temperature for the products to be obtained from distilling this crude in an atmospheric distillation column and estimate their yields.

C) Calculate the heat duty of the furnace if the crude oil inlet temperature is 300 ^{0}F?

D) If the furnace uses 11700 ft^3/ hr of fuel gas (NHV=1475 Btu/ft^3) and the radiant section contains 200 ft^3 of projected area, tube of 5 in OD, 12 ft length and spaced on 2 OD in one row, calculate % heat absorbed in radiation section if air/ fuel ratio is 25 ?

Given Cp (C.O) =0.7 Btu/lb ^{0}F

λ for (gasoline, naphtha, and kerosene and gas oil) are (120, 110, 100 and 90) respectively in Btu/lb

(36 marks)

Q/2: A) On processing 1000 ton / day of 27 ^{0}API catalyst cracker feed stock at a temperature of 450 ^{o}C, pressure =1.5 atm the following products were obtained:

Products	wt %	API	Mw
Gases	15	--	32
C5+ gasoline	60	63	110
TCGO	20	5	260
Coke	5	--	12

Given that: WHSV = 0.7 hr^{-1}, Linear velocity of vapor (U) = 0.3 m/s,
ρ catalyst = 420 Kg /m^3

Calculate: a) diameter of the cracker,
b) Weight of catalyst needed
c) Conversion.
d) Selectivity and e) efficiency.

(20 marks)

B) Answer the following questions:

1) Compare between Alklation and Iso-merization.

2) Compare between reforming and catalytic cracking. (Draw sketches if available)

3) State the advantages of zealots over the natural and synthesis amorphous catalyst when used in catalytic cracking?

(12 marks)

Q3: A) 1000 BPD of 32 ° API crude oil at 650 ° F is fed to an atmospheric distillation unit. Steam at a rate of 600 lb/hr and 530 ° F is used. The fraction obtained were 3500 lb/hr gasoline (MW=110, λ=120) at 310 ° F; 750 lb/hr naphtha (MW=155, λ=110) at 340 ° F; 3000 lb/hr kerosene (MW=185, λ=100) at 420 ° F; 1500 lb/hr gas oil (MW=240, λ=90) at 510 ° F. The residue is withdrawn at 510 ° F. Assume C_{PL}=0.7, C_{PV}=0.6 Btu/lb ° F.

1) Check the Kerosene plate temperature if the dew point Kerosene 445 °F, the pressure at the plate is 950 mm Hg.

2) Calculate the diameter of the tower if hot reflux is used. Given K=725, ρ_L = 42.6 lb/ft^3.

(20 marks)

B) Answer the following questions:

1) What are the main objectives of the finishing processes, suggest a process to achieve each of these objectives?

2) What are the main important properties of gasoline?

(12 marks)

Q/4: A) Consider the following gasoline blending streams are available from the various units.

1): Calculate the amount of n- butane needed for producing a 9.5 psi RVP gasoline?

2): Calculate the octane number of the final blend?

Component	BPSD	MON	RON	RVP	VPBI
LSR gasoline	5100	61.6	66.4	11.1	20.3
Light hydrocrackate	3000	82.4	82.8	12.9	24.4
Alkylate	4250	95.9	97.3	4.6	6.7
Heavy hydrocrackate	10280	67.3	67.6	1.1	1.24
C_5 FCC gasoline	14500	77.1	92.1	4.4	6.4
Reformate	14500	86.5	98.0	2.2	2.7
Polymer gasoline	2500	84	96.9	8.7	14.9

Given: For n- butane VPBI =138, MON=92 and RON=93

For 9.5 psi RVP, (VPBI) m = 17.6

(20 marks)

B) Answer the following questions: (draw sketches if available)

1) Explain in details the Deasphalting process.

2) Compare between Simple and complex refinery

(12 marks)

Good luck

ا لجامعة التكنولوجية	امتحان الدور الاول	المادة: صناعات بتروكيمياوية
قسم الهندسة الكيماوية	للعام 2008- 2009	الزمن: ثلاث ساعات
الصف الرابع /تكرير	2009/6/ 11	الممتحن:د. نجاة جمعة صالح

ملاحظة: اجب عن فرعين من كل سؤال والاجابة بالقلم الجاف فقط

س1 - أ- علل ما يلي:
1- سعة انتشار بوليمر البولي اثيلين(Polyethylene)
2- استخدام الزيولايت كمبادل ايوني؟
3-استعمال مفاعلين(الضغط والانفلاق) في إنتاج الفينول مع ذكر المعادلات الكيمياوية؟

ب- اشرح منظومة الطاقة (استهلاك واسترجاع) الطاقة في مجمع الاولفينات الواطئة؟

ج- في صناعة الاثيل بنزين(Ethylbenzene) (EB)، بين مايلي:
1- ارسم المخطط الانسيابي لإنتاجه موشرا على جميع الأجزاء؟ 2- المواد الأولية ومعادلة التفاعل 3- الظروف التشغيلية؟.

س2 أ- وضح مايلي:
1- ميزات الصناعة البتروكيمياوية ؟.
2- فصل الايزوبيوتيلين: مع المخطط الانسيابي (Isobutylene separation) ؟

ب- يبلمر مونيمر االفنيل كلوريد(Vinyl Chroide Monomer) إلى البولي (فنيل كلوريد)(P.V.C.)بعدة طرق ومنها بطريقة العوالق:
1-ارسم المخطط الانسيابي لإنتاجه مؤشرا على جميع الوحدات التي يضمها هذا المجمع.
2 - لماذا يستعمل مثبتات العوالق في إنتاجه. 3- ماهي المواد الأولية 4- الظروف التشغيلية؟

ج- وضح أربعة مما يلي: 1- البوليمر(Polymer) 2- LAB
3- الستارين(Styrene) 4-عملية التكسير البخاري(Steam cracking)
5-الغاز المصنع(Syn Gas)؟

س 3 أ- قارن بمخططات تفصيلية أو بالشرح لما يلي:
1- سرعة البلمرة التكثيفية(Condensation Polymerization) و بلمرة الإضافة (Addition Polymerization)؟
2- إنتاج الهيدروجين بطريقة التهذيب البخاري(Steam reforming) والأكسدة الجزيئية (Partial Oxidation)؟

←←←←←←←

ب –(1)- اذكر الاستخدامات الرئيسية للصناعات التالية:
1- الاثيلين كلايكول(EG) 2- (MTEB) ايثر مثيل بيوتيل الرباعي؟
3- حامض البنزويك(Benzoic acid)

(2)- اذكر المواد الاولية للصناعات التالية:
1- احادي ،ثنائي وثلاثي ايثانول امين MEA,DEA, and TEA 2- الميثانول (Methanol) 3 - الكيومين (Cumene 4- (EO)اوكسيد الاثيلين

ج -في صناعة الياف البولي استر بين مايلي:1- ارسم المخطط الانسيابي لإنتاجه موشرا على جميع الأجزاء 2- المواد الأولية 3- الظروف التشغيلية؟.

س 4- أ احسب Mn, Mw ,D ثم حدد نوعية التوزيع لما يلي :

البوليمر	الكسر الوزني	الوزن الجزيئي
أ	1	200
ب	2	400
ج	3	1000

ب- اجب بصح أو خطا مع تصحيح الخطأ أينما وجد لما يلي:
1-يستعمل مفاعل الطبقة الثابتة (Fixed Bed Reactor)في إنتاج الاولفينات العالية (HO) من الشمع البرافيني؟
2- في صناعة الاكريلوناتريل (Acrylonitrile) تستعمل الأكسدة الامونياكية للإيثان؟
3- يتم فصل الاروماتيات (aromatics) عن اللاروماتيات Nonaromatics) في وحدة(O_8) (THDA)؟

ج - اذا كان لديك مجمع بتروكيمياوي يعتمد على البروبلين كمادة أولية ارسم مخططا يوضح ذلك المجمع ،ماهي البتروكيمياويات الوسطية والنهائية المشتقة منه اذكرها مع صيغها الكيمياوية.؟

مع تمنياتي بالنجاح Good luck