

أجب علي الأسئلة التالية:

السؤال الأول

1. حالة A

إذا رغبت احدي شركات تجميع السيارات بأبو رواش تحديد حجم الإنتاج / المبيعات الذي يحقق نقطة التعادل Break-even Point، فإذا علمت أن قسم المبيعات والتسويق قدم المعلومات التالية:

- التكاليف الثابتة Fixed Cost ← 40.000.000 جنية
- التكاليف المتغيرة للوحدة Variable Cost ← 60.000 جنية
- سعر بيع الوحدة Unite Price ← 100.000 جنية

المطلوب:

1. احسب حجم التعادل بالوحدات.
2. احسب حجم التعادل بالجنيهات.
3. وضح التحليل السابق في شكل رسم توضيحي موضحا نقطة التعادل، ومنطقة الأرباح، ومنطقة الخسائر.
4. ما هو حجم الأرباح أو الخسائر المتوقعة إذا كانت المبيعات المتوقعة 1300 سيارة.

2. حالة B

إذا كان صافي الربح لشركة الاتحاد العربي 1.300.000 جنية، وبلغت إجمالي الأصول 12.000.000 جنية.

المطلوب:

1. احسب معدل العائد علي الأصول ROA.
2. إذا كان سعر الفائدة علي الإيداع المحدد من قبل البنك المركزي 12% فما هو تقييمك لأداء هذه الشركة.

3. حالة C

إذا كان سوق البرامج يسيطر عليه أربعة شركات كبرى، وكانت المبيعات الفعلية لكل شركة بالوحدات، وسعر بيع الوحدة كما يلي:

اسم الشركة	الوحدات المباعة	سعر بيع الوحدة
الشرق الأوسط	700.000 وحدة	2.5 جنية
مصر الدولية	450.000 وحدة	3 جنية
عبر المحيطات	810.000 وحدة	2 جنية
ماك بوينت	990.000 وحدة	2 جنية

المطلوب:

حدد الحصة السوقية Market Share لكل شركة من حيث (أو من منظور) العائد.

### السؤال الثاني

بصفتك احد المهندسين بشركة زيروكس آلات التصوير طلب منك مدير التسويق أن تقدم رسم توضيحي للعمليات والقضايا التالية:

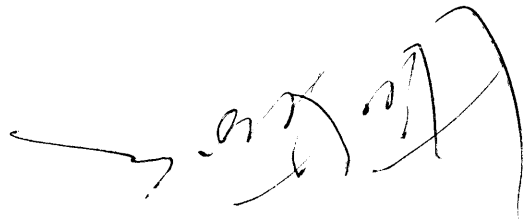
1. شكل هيكل ادارات الشركة (أو المنظمة) موضحا الأقسام الرئيسية المختلفة، وموقع إدارة التسويق منها، والأقسام الفرعية لإدارة التسويق، والترويج.
2. نموذج بناء العلامات التجارية لكيبلر 1993 Keller .
3. دور التسويق في تحقيق الأهداف المرحلية المختلفة لأي شركة أو منظمة.
4. تصنيف المنتجات الموجودة بالأسواق.
5. إستراتيجية الدفع Push وإستراتيجية الجذب Pull في عملية توزيع المنتجات.

### السؤال الثالث

عينت مهندس بقسم التسويق بشركة مصاعد وسلام متحركة، ونظرا لشدة المنافسة طلب منك مجلس إدارة الشركة تفعيل عدد من الآليات العلمية الهامة والقادرة علي مواجه المنافسة وتحقيق مركز متقدم في هذا السوق. فوضح ما المقصود بالمصطلحات والمفاهيم التالية (بصورة مختصرة للغاية).

1. المسؤولية الاجتماعية للشركة CSR
2. الاتصالات التسويقية المتكاملة IMC أو المزيج الترويجي Promotional Mix
3. المزيج التسويقي (الرباعي) 4Ps
4. قيمة العلامة التجارية Brand Equity
5. المنتج الأساسي Core Product
6. حاجات ورغبات المستهلك Consumer Needs & Wants
7. مفهوم دورة حياة المنتج Product Life Cycle
8. نموذج AIDA
9. المزيج التسويقي (السباعي) 7Ps
10. إستراتيجية كشط السوق Market Penetration

مع أطيب التمنيات بالنجاح والتوفيق ....





Hydraulic Circuits – Elective 3  
4th Year Mechanical  
Promotion Exam. (Allowed: 3 hr)

دوائر هيدروليكية – اختياري ٣  
السنة الدراسية: الرابعة ميكانيكا  
إختبار نهاية الفصل الدراسي (المدة ٣ ساعات)

Answer all questions. Neat papers will be appreciated.

**Question (1) (20 marks)**

- a) Plot (to scale) in the graph sheet and on the same diagram the  $p(\text{bar}) - Q(\text{lit/min})$  curves for  
1) pressure compensated unbalanced vane pump in a hydraulic circuit with no relief valve if the pump cut-off pressure is 200 bar and dead load pressure = 220 bar and 2) the flow through the relief valve if the pump is replaced with a balanced vane pump in addition to relief valve. The new pump has the same set volumetric displacement and speed of the replaced one ( $5 \times 10^5 \text{ mm}^3$  and 1500 rpm, respectively). Given that for both pumps:  $\eta_{\text{vol}} = 96\%$  (assumed constant at all pressures). Write down all operating marks on the drawings.  
Assume reasonable values for crack and full opening pressures for the relief valve so that the same performance of the circuit is obtained on using either arrangements.
- b) State name of valve in Fig.1? Draw its symbol. What is the name of equivalent part of surface C in a valve performing the same function of this valve but with poppet?  
If the length of notch in the spool of this valve is 36 mm, determine the percentage change in controlled flow discharge due to 11 mm movement of the spool to the right. Consider turbulent flow through the notch ( $h_f = 0.8 f L Q^2 / g d^5$ ).

**Question (2) (35 marks)**

The hydraulic circuit of a woodwork press is shown in figure 2.

- State the full name (describing function) of the numbered items in the circuit.
- Redraw the system, with valve (6) actuated, during **actual pressing interval**. Show on drawing (using arrows): flow directions, valves setting, actuators movement.
- Determine:
  - Pressing force in metric ton.
  - Pressure setting of valve (7) in bar.
  - Rated pump discharge in lit/min and electric motor shaft horsepower.
  - Size capacity in lit/min of valve (4).
  - Suggested size for the circuit **tanks**.

Given that:

Press beam working dimensions 1.2 m x 0.9m

Woodwork pressing stress:  $2800 \text{ kN/m}^2$

Cylinder (1): standard 10 cm piston diameter and 40 cm stroke.

Cylinder (2): 40 cm bore and 30 cm piston-rod diameter.

Press raising time: 20 sec.

Press lowering time until beam touches work-piece (95 % of the full stroke) = 40 sec.

Actual pressing time (5% of the full press stroke) = 30 seconds, assume at full

pressing pressure. Allow for 15 bar pressure loss in pipes, fittings and valves and 80% pump efficiency.

**Question (3) (20 marks)**

- What type of operation sequence the hydraulic circuit shown in Fig. 3 provide?
- If the right-hand side solenoid of valves (5), (6) and (7) are simultaneously energized, what stroke each one of the three cylinders make?
- If the three cylinders are all switched to the extension mode, will they extend simultaneously? If not, determine which cylinder operate first, which is the second and which is last operating one. **Given that** the loads on cylinders (8), (9), (10) during extension are 15, 20 and 33 metric ton, with oil demand of 120, 200 and 142 lit/min, respectively, and that cylinder bores are 100, 125 and 150 mm, respectively. The stiffness of spring in cylinder (10) is  $2 \times 10^4$  N/m, with initial (assembling) deflection of 35 mm.
- It is required to make cylinder (9) operate in REGENERATIVE extension mode **in addition to the normal extension** by changing only one valve in the circuit. Draw cylinder (9) part of circuit after modification. Now, with pump operating condition unaltered, determine the extension speed in both normal and regenerative modes (consider standard piston/pistonrod dimensions). Also determine the highest load through regenerative extension.

**Question (4) (20 marks)**

- Draw the symbol and write the name of the valves shown in figures (4.i) and (4.ii).
- Estimate the minimum value for the pressure in the pilot connection of valve 4(i) so that a controlled flow of 0.5 lit/s can be passed through the valve.  
Given that oil pressure in the right connection of the valve is 52.5 bar, maximum permissible flow velocity inside the valve is 3 m/s, spring compression with valve closed is 1.2 cm. Spring stiffness is 16 kN/m, valve seat internal diameter is 1.8 cm and the pilot piston diameter is 2.5 cm.
- What is the most important element in valve 4(ii) which makes it superior over any other hydraulic valve? Draw a schematic showing the electrohydraulic control system usually used with this valve. Write the name of each element in the system.
  - What type of control this system provides?

**Question (5) (20 marks)**

- State 3 functions of hydraulic fluids.
- Show by drawing why high viscosity index oil is preferred in hydraulic circuits.
- State the name of 4 pressure control valves.
- Why do we select pressure compensated flow control valve? Draw its symbol.
- What are the components of an FRL unit? Draw its symbol.
- Why working pressure in pneumatics is usually limited to  $\sim 6$  bar?
- Why pneumatics is preferred in some applications over hydraulics?
- State 3 limitations of pneumatics compared to hydraulics.
- What functional operating advantage the hydraulic fuses have over safety valves?
- State the advantages of servo-hydraulics compared with proportional hydraulics.



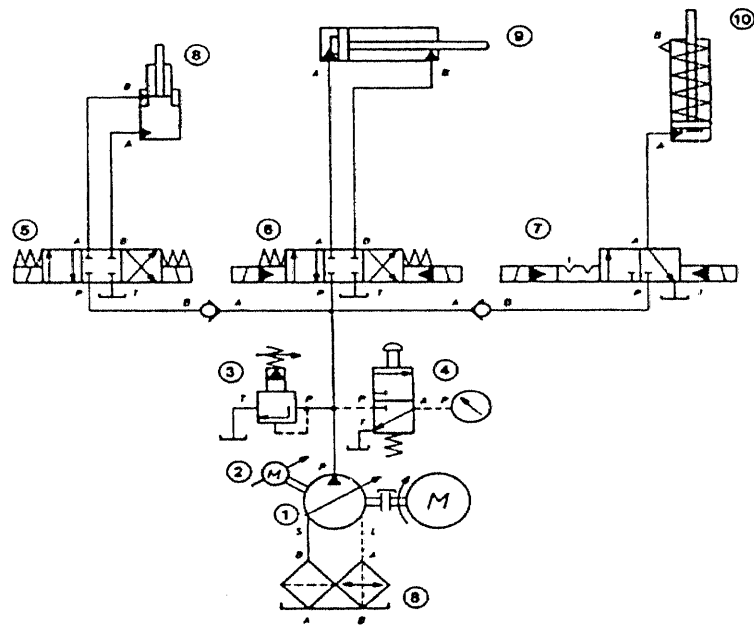


Fig. 3

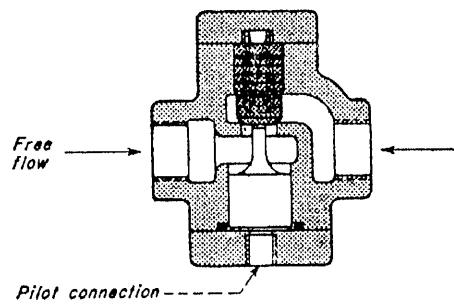


Fig. 4(i)

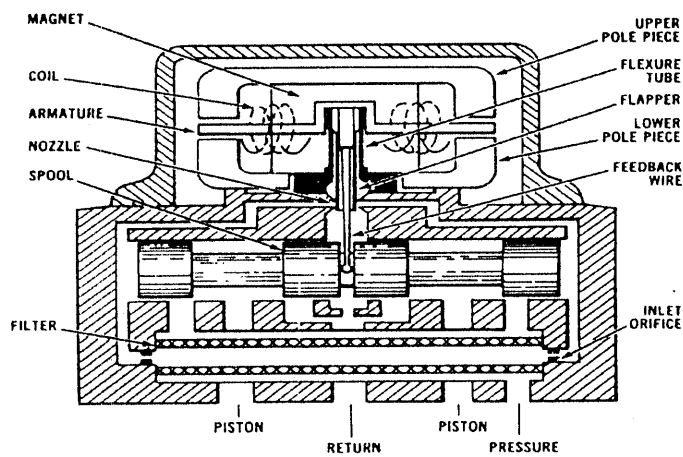


Fig. 4(ii)

Best wishes,  
Dr. Kamel Elshorbagy

30/1/20



ME 431: Energy and Environment

Solve all the following questions

**Question 1:**

**(25 points)**

- (a) Explain each of the following items:  
(PM -10) - (NSPS) - (EPA)
- (b) Explain in details the environmental phenomena: " Photochemical Smog "
- (c) Draw a neat sketch for explaining the particulate control method: " Fabric Filtration "
- (d) The "Federal Air Quality Standards " limit the sulfur dioxide (SO<sub>2</sub>) in atmospheric air to 1320 µg/m<sup>3</sup> at 1 atm and 25°C. Express this standard in (ppm).
- (e) Draw a neat sketch for sulfur dioxide (SO<sub>2</sub>) treatment of the exhaust gases in a coal-fired electric power plant. Then write the chemical equations that control this process.

**Question 2:**

**(20 points)**

A car with an SI-engine produces 50 kW indicated power, while using 8 kg of stoichiometric gasoline per 100 km traveled at 100 km/hr. The engine has a mechanical efficiency of 85% and average emissions upstream of the catalytic converter are:

1.2 g/km of NO<sub>2</sub>, 15 g/km of CO, and 1.6 g/km of HC.

The catalytic converter removes 92% of the emissions when it is at a steady - state temperature, calculate:

- (a) Specific emissions of HC upstream of the catalytic converter .....(g/kWh)
- (b) Specific emissions of CO downstream of the catalytic converter when it is at steady-state temperature .....(g/kWh)
- (c) Concentration of NO<sub>2</sub> in the exhaust upstream of the catalytic converter.....(ppm)

**Question 3:**

**(25 points)**

A chemical factory requires both electrical and thermal energy. Both energies are consumed at constant rates all over the day. The factory requires saturated steam at a temperature of 150°C for accomplishing its chemical operation. It has been decided to use both parabolic trough collectors and fuel cells to cover the energy demand of the factory. The factory has a limited area for installing the solar collectors. You are requested to do the following tasks:

- (a) How to use these two systems for providing the factory with its demands of electrical and thermal energy. Use a neat sketch illustrating a flow diagram for energy generation and storage if needed.

- (b) Select the fuel cell type that can be used in this case, showing how it works.
- (c) Explain how you can determine the capacity of the fuel cell and the share of the parabolic trough collectors in supplying the required load.

**Question 4:**

**(20 points)**

The irrigation system in the desert takes place during the night hours. On using wind energy, electricity generated during day time is used to produce hydrogen, which is stored to be utilized at night to generate electricity using fuel cells. For a land in the Egyptian desert an electric power of 200kW is required to run the irrigation pumps during the night. At the site of this land, the wind speed is 6 m/s at daytime and 7.5 m/s at night. You are requested to design a scheme containing a wind turbine and a fuel cell with their ancillary components. Applying a survey show how these elements are connected with each other. In designing the wind turbine, determine:

- (i) Number of blades
- (ii) Rotational speed
- (iii) The turbine diameter
- (iv) Tangential force
- (v) Axial thrust

Determine the amount of hydrogen to be stored and the power of the fuel cell (calorific value of hydrogen is 150,000 KJ/kg). Assume any missing data you, may involve in the calculations. You must make reasonable assumptions about the efficiencies of wind generator, inverter, the electrolyzer and fuel cell.

**Question 5:**

**(15 points)**

- (a) Show how the angle of attack of a horizontal axis wind turbine is kept constant along its blade/s from tip to root. Discuss the reason/s for keeping this angle constant.
- (b) Show how hydrogen is stored to be used in fuel cells.
- (c) Show by aid of a sketch how cold can be stored for use in a far distance from the side cold production.

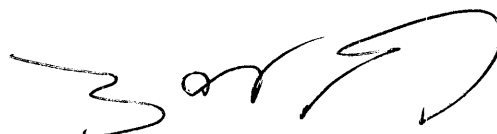
**Wind turbine**

$$P_i = \frac{1}{2} \rho A V^3$$

$$C_p = 4a(1-a)^2$$

$$F_{tx} = \frac{1}{2} \rho A V_i^2 [1 - (1-2a)^2]$$

$$\lambda_{opt} = \frac{4\pi}{n}$$





- 1- a) "Weight in a piston contributes directly to the reciprocating compressor shaking forces and must be controlled." How can you overcome this problem? [4M]  
 b) Draw the stepwise pressure drop through a 4 ring sets of the packing located around a reciprocating compressor Piston rod. [4M]  
 c) For a reciprocating compressor, What are the main solutions to the problem of Pressure Pulsations? [4M]  
 d) What are the factors affecting the Magnitude of Losses in a reciprocating compressor? [4M]

2- It is required to size a reciprocating compressor to compress 0.5 kg/s of air from 1 bara and 35° C to 10 bara. Find the minimum number of stages to keep the temperature in any stage below 150° C. Also find the maximum operating speed if the allowable piston speed for vibration and wear purposes is 6 m/s and the compressor frame used provides a 12 cm stroke. Calculate the cylinder diameter for each stage and the total power required given that:

Number of cylinders per stage: 1

All cylinders are double acting

Interstage temperature: 35° C

Rod diameter: 3.5 cm

Clearance ratio: 15 %

Slippage ratio: 0.05

Overall cylinder efficiency: 75% [15M]

- 3- a) What are the advantages of flooded Screw compressor? [4M]  
 b) What are the methods used for capacity control of rotary compressors? Show, using illustrations, the operation of each method. [4M]  
 c) What are the different methods used for anti-surge control of centrifugal compressor? [4M]

4- a) A centrifugal compressor compresses 5 kg/s of air to a pressure ratio of 3. If the compressor takes air from atmosphere at ambient pressure and temperature of 100 kPa abs and 25°C, and has isentropic and mechanical efficiencies of 90% and 80% respectively. Find the required motor power. [10M]

b) Make a preliminary selection of a compressor to handle 90,000 ICFM of air when inlet conditions are 14.3 psia, 90°F, and 70% relative humidity. Discharge pressure 22.3 psia, molecular weight = 28.59,  $k = c_p/c_v = 1.395$ . Assume an impeller diameter,  $D$ , of 55 in, and a rotating speed,  $N$ , of 3,550 rpm. Compressibility factors are unity. [10M]

$$H_{ad} = \left( \frac{z_s + z_d}{2} \right) \left( \frac{1,545}{M_w} \right) T_s \left[ \frac{r_c^{(k-1)/k} - 1}{(k-1)/k} \right]$$

$H_{ad}$  is Adiabatic Head, (ft-lb)/lb;

$\eta_{ad}$  is Adiabatic Efficiency;

$z_s$  is Compressibility Factor at Suction conditions,

$z_d$  is Compressibility Factor at Discharge conditions;

$M_w$  is Molecular Weight;

$T_s$  is Suction Temperature, °R;

$r_c$  is the Ratio of Compression, i.e.,  $p_d/p_s$

- 5) State briefly the features of Radial-blade type fan. [4M]  
 b) What make the Axial fans are less attractive than Centrifugal fans when flow variation are expected? Support your answer by a figure. [4M]  
 c) What are the methods used for capacity control of fans? [4M]  
 Which method is the most efficient?

6) Sketch a pumped storage installation. State its application. [5M]  
 A thermal power plant has a capacity of 100 MW; the daily power demand from the plant is 80 MW for 16 hr., 100 MW for 7 hr and 300 MW for the last hour. In order to meet the peak load, a pumped storage system under a head of 400 m is to be constructed. Estimate the minimum time for pumping during this day. Estimate the maximum peak load that can be covered by this combination. Estimate also the volume of suitable volume of upper storage reservoir. Given that overall efficiency of pipe and turbine system is 94% and overall efficiency of pipe and pump system is 90%. [10M]

7) Francis and Kaplan turbines can be generally considered suitable for hydropower sites where the available head 50m. Each type will be placed below the water downstream level. Compare operating efficiency and submergence of each type. Which type would you prefer and why? [5M]

ii) The following data are related to a Kaplan turbine installation:

Upstream level is 20 m above datum; turbine level is 3.5 m above Datum.

Downstream level is 4 m above datum. Output is 37 MW, Speed is 100 rpm.

a- Sketch the turbine installation.

b- What will be the allowable range of the variation in downstream level?

c- How high would you allow the upstream level be risen to?

d- If the upstream level rises to 25 m, what would be the effect on turbine power output?

You may use the following data:  $H_{at} - H_{vap} = 10$  m water. [10M]

Ns (S.I.)	400	600	800
Cav. factor	0.4	0.6	1.0



ورقة الامتحان من وجهين  
يسمح باستخدام جدول وخريطة البخار

**Question #1**

A large power plant 640 Mw power plant is built at an expense of 3500L.E/kW. The expected lifetime of the plant is 35 years and the capacity factor is 0.7. The scrap value equals to the cost of removal of scrap. The taxes and insurance rates are 2% each. The depreciation fund with rate 8% and the cost of money used is 12%. The average specific steam consumption is 3.2 kg/kWh. The steam generated at 180 bars and 540°C from feed water at 200°C. 90% of steam is reheated at 40 bars from 350°C to 540°C. The steam generator efficiency is 94% and the cost of fuel is 500 LE/ton. Take all other annual costs 1% from the plant initial cost. Calculate the cost of unit energy.

**Question #2**

A power plant feeds the electric energy for the following factories. the relation between the demand loads in MW and time is given in the following tables.

Time	2	6	8	10	12	14	16	18	20	22
Factory 1	20	40	30	50	90	30	35	35	60	20
Factory 2	20	15	10	10	20	25	15	40	30	20
Factory 3	30	35	50	40	60	30	40	45	40	30
Factory 4	40	50	80	30	60	50	50	30	20	40
Factory 5	30	40	50	90	70	60	55	55	50	30
Factory 6	60	30	80	10	30	15	40	40	30	60

The plant has 10 MW as a reserve and the connected load for the second factory is 100 MW. The average specific fuel consumption is 0.15 m<sup>3</sup>/kW.hr and the price of fuel 50 P.T/m<sup>3</sup>. Assuming the shut-off period is 30 days/year. Calculate the demand factor for the second factory, the group diversity factor, the peak diversity factor for each factory, the plant capacity, the plant use factor and the cost of fuel per year.

**Question #3**

A power plant has two power generating units with the following

Unit	Capacity in MW	
A	150	$I=10^6(10+4L+aL^2)$
B	150	$I=10^6(9+6L+bL^2)$

For maximum operating efficiency (minimum heat rate) complete the following table in your answer sheet after getting the values of both  $a$  and  $b$

Unit	Load (MW)	Load (MW)	Load (MW)	Load (MW)
A	42.5	50		
B	37.5	50		
Total	80	100	150	250

#### Question #4

In your answer sheet redraw the following table after complete it:

Statement	✓ or x	Corrected statement if needed
1. Boilers that were shut down for a long period must be given a hydrostatic test before being placed in service.		
2. When the power plant generators are synchronized with the grid the steam turbine operates in an isochronous control.		
3. Modern power plants operate by a fault tolerant governor with redundant processors		
4. Sliding-throttle pressure operation of steam turbines produces more efficient thermal energy conversion.		
5. For testing the emergency protection system an actual over speed test must be done.		
6. One element control of feed water is never used in boiler level control because of the swell-shrink phenomenon.		
7. Insufficient excess air will produce long flame.		
8. Due to energy conservation aspects reducing the required blowdown is beneficial.		
9. The time for bringing a boiler on load is decreased for forced circulation boilers compared to natural circulation boilers.		
10. erosion of boiler tubes is impossible while firing natural gas		

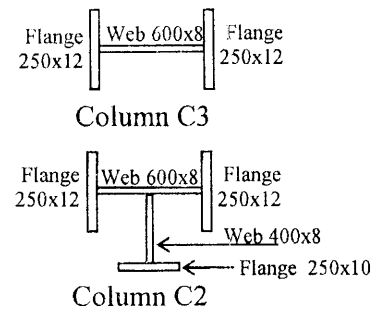
#### Question #5

Answer the following questions. ( لا تزيد الاجابه عن سطرين ويفضل وضع الاجابه في جدول )

1. In boiler oxygen trim technology what is the difference between single point (jackshaft) positioning actuator and parallel positioning.
2. What is the difference between a portable and a fixed gas analyzer?
3. What is the cause of short term overheating that is not common for long term overheating?
4. What is common between cold end corrosion and dew-point corrosion during idle periods?
5. Why turbine following control is not favourable control strategy in power plant operation?

**Given:**

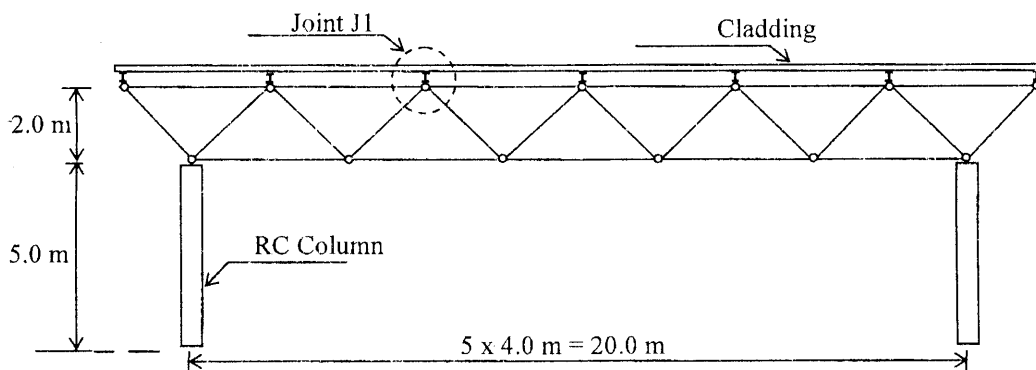
- Total load (DL + LL) =  $0.12 \text{ t/m}^2$
- The horizontal reaction at (A)  $X_A = 4.0 \text{ ton}$
- Wind load should be considered according to the Egyptian Code requirements.
- St (37) should be used  $F_y = 2.4 \text{ t/cm}^2$
- Bolt diameter = 20 mm, Grade (10.9), Gusset Plate thickness = 10 mm

**Required:**

- 1- Compute the maximum bending moment and normal force in the column C3 due to dead load and live load, then check its safety for the given section.
- 2- compute the force in the horizontal bracing members D1&D2.
- 3- Design the horizontal bracing members D1&D2 as two angels back-to-back.
- 4- Compute the additional normal force and bending moment "My" in the column C2 due to the wind load acting in perpendicular direction of the main structure.
- 5- Check the safety of the given section for the column C2 due to the effect of DL + LL + Wind.
- 6- Design and draw to scale 1:10 the joint (1) & joint (2). Assume any missing data.

**PART (B) 10%**

The shown figure represents the elevation of a space truss rested on RC columns. It is required to draw to scale 1:10 the details of Joint "J1" considering the following data:- Tube diameter = 150 mm., Node diameter = 250 mm., and bolt diameter = 16 mm. Assume any missing data.

**PART (C) 40 %**

- 1) Calculate the allowable axial compression capacity of a Concrete-Encased steel column having the following properties:  
 steel section : IPE 360      concrete section :  $60 \times 40 \text{ cm}$       longitudinal rft. :  $10 \Phi 16$   
 $L_{bx} = 7.0 \text{ m}$        $L_{by} = 4.0 \text{ m}$        $F_y = 3.6 \text{ t/cm}^2$  ( for both steel section and Rft)  
 $E_s = 2100 \text{ t/cm}^2$        $F_{cu} = 300 \text{ kg/cm}^2$
- 2) Check the safety of a concrete-filled tubular steel column subjected to an axial compression load of 400 ton. The column has the following properties:  
 Steel section : circular tube 8 mm thickness and 500 mm outer diameter  
 Buckling length = 6.00 m       $F_y = 3.6 \text{ t/cm}^2$        $F_{cu} = 350 \text{ kg/cm}^2$
- 3) Calculate the maximum allowable axial compression capacity of a hollow steel pipe 150 mm diameter and 1 mm thickness made of mild steel 37 for max buckling length of 4.0 m.
- 4) State the most important advantage and disadvantage of steel pipes as truss members.
- 5) Calculate the max allowable bending capacity of a steel pipe 40 cm diameter, 8 mm thickness. Use mild steel 37.

### Reciprocating Compressor

$$p_d = \frac{\pi}{4} D^2 s_t \left( \frac{N}{60} \right) \text{ single acting, } E_v = 0.97 - \left[ \frac{1}{f} r_p^{\left( \frac{1}{k} \right)} - 1 \right] C - L, \quad ,$$

$$Q = E_v * p_d, \quad \text{power} = \frac{p_1 Q_1}{\eta_{cyl.}} * \frac{k}{k-1} \left[ r_p^{\frac{k-1}{k}} - 1 \right]$$

### Centrifugal Compressor

$$\frac{W}{m^o} = C_{x2} u_2 - C_{x1} u_1, \quad C_{x2} = \sigma_s C_{x2} = \sigma_s u_2, \quad \sigma_s = 1 - \frac{0.63\pi}{z} \quad z = \text{no. of vanes}$$

$$\frac{\text{power}}{m^o} = \frac{\sigma_s u_2^2 \Psi}{\eta_{mech}} = \frac{h_{o2} - h_{o1}}{\eta_{mech}}, \quad \eta_{comp} = \frac{h_{o3s} - h_{o1}}{h_{o3} - h_{o1}}, \quad C_p T_{o1} = C_p T_1 + C_1^2/2, \quad a = \sqrt{\gamma R T}$$

$$U = \pi d N / 60$$

### Axial Compressor

$$\frac{W}{m^o} = C_p (T_{o3} - T_{o1}) = \lambda U C_a (\tan \beta_1 - \tan \beta_2)$$

$$h_2 + \frac{W_2^2}{2} = h_1 + \frac{W_1^2}{2}, \quad R = \frac{h_2 - h_1}{h_3 - h_1} = \frac{W_{x1} + W_{x2}}{2u} = C_a \frac{(\tan \beta_1 + \tan \beta_2)}{2u} = \phi \tan \beta_\infty$$

$$\frac{T_{oII}}{T_{oI}} = \frac{T_{oI} + N \Delta T_o}{T_{oI}} = \left( \frac{P_{oII}}{P_{oI}} \right)^{\frac{\gamma-1}{\eta_p \gamma}}$$

### Fans and Blowers

$$\text{Air hp.} = \frac{(144 \times 0.0361) Q h}{33000}$$

### Volume correction

$$Q_s = \left( \frac{14.7}{A} \right) \left( \frac{460 + T_1}{528} \right) V_{SCFM}$$

### Pressure correction:

$$r_s = \frac{A + P_2}{A}, \quad x_s = r_s^{0.283} - 1, \quad x_c = x_s \left( \frac{T_1 + 460}{528} \right), \quad r_c = (x_c + 1)^{3.53}, \quad P_{EA} = 14.7(r_c - 1)$$

### Horsepower correction:

$$HP_s = \left( \frac{A}{14.7} \right) \left( \frac{528}{460 + T_1} \right) HP_c, \quad H = ZRT \left( \frac{P_2}{P_1} \right)^B - \frac{1}{B}, \quad E_{hps} = \frac{HW}{33000N}, \quad B = \left( \frac{K-1}{K} \right) \left( \frac{r}{N} \right)$$

### Compressor selection

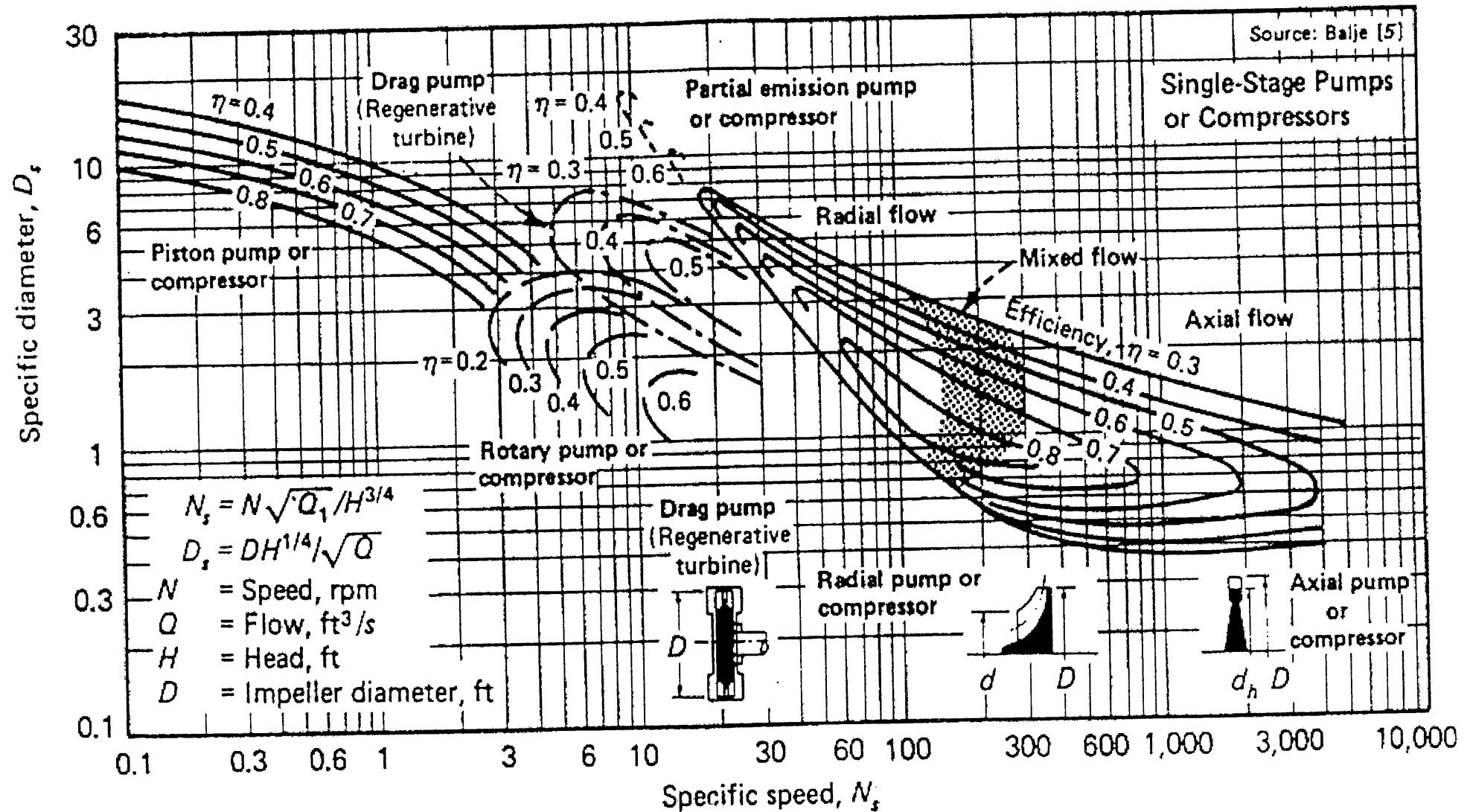
$$H_{ad} = \left( \frac{Z_s + Z_d}{2} \right) \left( \frac{1545}{M_w} \right) T_s \left[ \frac{r_c^{\frac{k-1}{k}} - 1}{\frac{k-1}{k}} \right], \quad T_{d(ad)} = T_s r_c^{\frac{k-1}{k}}, \quad T(\dot{R}) = \dot{R} + 460$$

$$N_s = \frac{N \sqrt{Q}}{H^{3/4}}, \quad D_s = \frac{DH^{1/4}}{\sqrt{Q}}, \quad Q(\text{ft}^3/\text{s}), \quad D(\text{ft}) = 12 \text{ in.}$$

$$\frac{N_1}{N_2} = \frac{Q_1}{Q_2} = \sqrt[2]{\frac{H_1}{H_2}} = \sqrt[3]{\frac{Bhp_1}{Bhp_2}}, \quad \frac{D_1}{D_2} = \frac{Q_1}{Q_2} = \sqrt[2]{\frac{H_1}{H_2}} = \sqrt[3]{\frac{Bhp_1}{Bhp_2}}$$

$$\eta_p = \left( \frac{k-1}{k} \right) \left( \frac{n}{n-1} \right), \quad \eta_{ad} = \frac{r_c^{\frac{k-1}{k}} - 1}{r_c^{\frac{n-1}{n}} - 1}, \quad HP_{g(ad)} = \frac{WH_{ad}}{33000 \eta_{ad}}$$

## Compressor Selection



**Fig. 2 Specific Speed and Specific Diameter**  
 Enable the **Selection** of a definite **Type** of Single-Stage Compressor