circular inlet to the rectangular exit of the draft tube is 1:5, determine the power lost due to friction in the tube.

If the turbine output power was reduced to 1.3 MW under the same rotational speed, estimate the vacuum gage reading.

(15 points)

5-

a- Explain briefly, aided with appropriate drawings, why a needle valve is recommended for controlling the discharge in Pelton turbine over a throttle valve.

b- Sketch the energy conservation diagram for a Francis turbine to convert a given hydraulic power into a useful mechanical power.

c- Why a Kaplan turbine is more efficient than a propeller turbine when it operates at part output power? Support your answer with the appropriate velocity triangular diagrams for each.

d- Classify the positive displacement pumps and mention three types for each class.

e- Sketch the total energy line along a hydraulic power station between the water surface of a high-level reservoir and a down-level tailrace for three cases of (i) free falling, (ii) using a constant area duct, and (iii) using a diffuser-shaped draft tube after the turbine runner to the tailrace.

(15 points)

د. أيمن بكري

انتهت الأسئلة،،، مع أطيب الأمنيات بالتوفيق،،،

Tanta University
Faculty of Engineering
B.Sc. year Power Mech. Eng. Dept.

Hydraulic Machines B – (MEP 4121)
Date: 2/6/2012
Time: 3 hours

__Please, answer the following questions (assume any missing data):-__

1- A single-acting, single-cylinder positive displacement pump, driven at 0.4 rev/s, has a bore of 200 mm and a stroke of 500 mm. The suction and discharge pipes are both 100 mm in diameter. The suction lift is 0.4 m and the suction pipe is 3 m long. The water is discharged at a point 20 m above the pump level by means of a pipe 200 m long, fitted with a large air vessel 20 m from the pump. Calculate the absolute pump cylinder pressures at the (i) start, (ii) end and (iii) mid stroke times for both (a) suction and (b) discharge assuming no slip at the pump and a friction factor of 0.032 for both pipes. Take atmospheric pressure as 10.3 m.

(15 points)

2- A Pelton wheel driven by two similar jets transmits 3750 kW to the shaft when running at 375 rev./min. The head from the reservoir level to the nozzles is 200 m and the efficiency of power transmission through the pipelines and nozzles is 90 percent. The jets are tangential to a 1.45 m diameter circle. The relative velocity decreases by 10 percent as the water traverses the buckets, which are so shaped that they would, if stationary, deflect the jet through 165°. Neglecting nozzles losses, find, the efficiency of the runner and the diameter of each jet. Take the mechanical efficiency of the runner as 93.3 percent.

(15 points)

3- In an inward-flow reaction turbine (Francis turbine), the supply head is 12 m and the maximum discharge is 0.28 m^3/s. The runner external diameter is twice the internal diameter and the velocity of flow is constant and equal to 0.15 $\sqrt{(2gH)}$. The runner vanes are radial at inlet (β_1=90°) and the runner rotates at 300 rpm. Determine (a) the guide vane angles, (b) the vane angle at exit for radial discharge, (c) widths of the runner at inlet and exit. The vanes occupy 10 percent of the circumference and the hydraulic efficiency is 80 percent.

(15 points)

4- A Kaplan turbine develops 2.6 MW under a net head of 7.5 m, it is provided by an elbow type draft tube with a circular inlet of 2.5 m diameter, the inlet is set at height of 1.5 m above the tailrace level. A vacuum gage connected to the draft tube inlet records a reading of 3.7 m. If the efficiency of the draft tube is 78 percent, calculate the turbine efficiency. If the ratio of area of a pressure = 15 MPa, Mechanical efficiency = 0.85, Volumetric efficiency = 0.9

If the pressure is increased to 22 MPa, calculate the internal leakage rate and the volumetric efficiency.

Question no. 3

1- Draw a scheme of a swash plate axial piston pump, explain briefly its function and give an expression for its displacement volume.

2- Discuss the different constructions of hydraulic cylinders.

3- A piston pump with inclined cylinder block has the following parameters:

No. of cylinders z = 7 cylinder dia. d=10mm γ = 22 deg.
Pitch circle dia. D = 70 mm, n= 3000 rpm mech. Efficiency = 0.9
Hydraulic efficiency = 1 input pressure = - 0.03 MPa
Resistance to internal leakage R_L = 258 GNs/m^5,

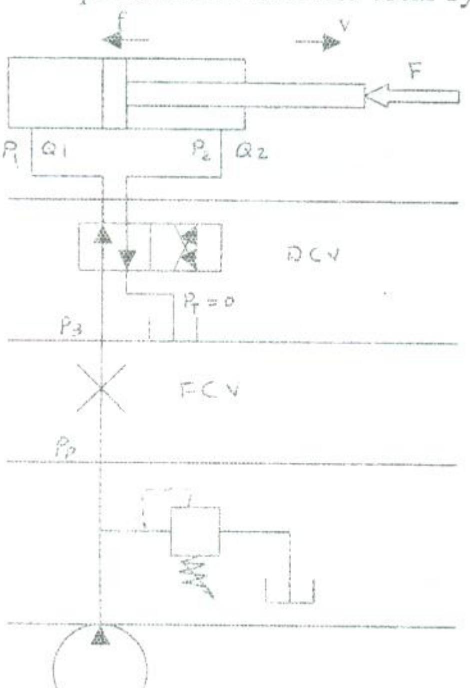
Calculate:

a- The geometric volume of pump.

b- The total efficiency of the pump at exit pressure of 10 MPa.

c- The maximum pressure in the delivery line if it is completely closed, in the absence of any relief valves.

4- In the system shown below. Calculate the missing operational parameters and the total system efficiency.



f = 2000Ns/m v = 0.1 m/s
F = 9000 N
Piston dia. = 65 mm Rod dia. = 25 mm
No internal leakage
P 1= ?, P2 = ?, Q1= ?, Q2 = ?

Q = 6X 10^{-7} $(\Delta P)^{1/2}$
P3 = ?
power losses in DCV = ?

Pp = ?
Power loss in FCV = ?

Cracking pressur =6 MPa

Vp = 25 cm3/rev
n = 1000 rpm
Volumetric efficiency = 0.95
Mechanical efficiency = 0.93
Pump flow rate = ? motor power = ?

Good Luck

Prof. Dr. Khaled M. Saadeldin

Tanta University

Department: Mech. Power Engineering
Total Marks: 9? Marks

Faculty of Engineering

Course Title: Hydraulic Power Circuits Date: Jun 2012	Co..se Code: Allowed time: 3	Year: 4th year No. of Pages: (2)

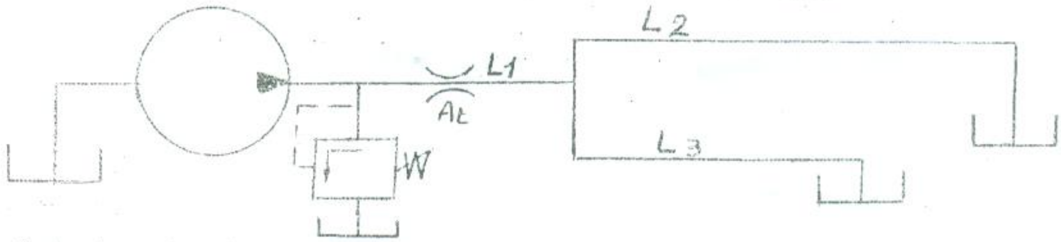
Remarks: (answer the following questions... assume any missing data... answers should be supported by sketches...etc)

Question no. 1:

1- Compare between three different types of spool lands (over , zero and under lapping) with respect to effective stroke, area, power loss, response, characteristics and sealing.

2- Discus briefly the effect of the saturated vapor pressure on the function of hydraulic systems.

3- Calculate the pressure at outlet of the pump of the following system, given: Pump flow Q = 20 L/min, oil density $\rho = 850\ kg/m^3$, dynamic viscosity μ = 0.0085 Pas, area of the throttling valve $A_t = 25\ mm^2$, discharge coefficient = 0.611, dimension of lines : D1=15 mm D2= 10 mm D3 = 12 mm
L1= 1.5 m L2= 3 m L3 = 2 m



4- Calculate the size of accumulator necessary to deliver 5 liters of oil between pressures of 200 and 100 bar (gauge pressure), charging pressure is 90 bars.

Question no. 2

1- Discus in detail the modeling of the hydraulic transmission lines assuming lumped parameters. Derive the transfer function matrix relating the input and output pressures and flow rates.

2- Explain the mechanical locking in hydraulic cylinders.

3- Discuss the different mounting methods of hydraulic cylinders.

4- Calculate: the displacement volume, delivery pulsation coefficient, the max. speed of rotation, leakage flow rate, resistance to internal leakage, input power and driving torque of a gear pump of the following parameters: n= 1450 rpm, Number of teeth = 12, module =3.5 mm, tooth width = 20 mm, Pressure angle = 20 deg., Inlet pressure = 0.2 MPa, Exit

Question 3 [20 Marks]

A. Discuss how to draw the rotor and stator blade shape in an axial flow compressor.

B. Define the free vortex condition in an axial flow compressor.

C. Air at 101.3 kPa and 288 K enters an axial flow compressor stage with a velocity of 150 m/s. There are no inlet guide vanes. The rotor has a tip diameter of 61 cm, a hub diameter of 50.8 cm and rotates at 6000 rpm. The air enters the rotor and leaves the stator in the axial direction with no change in velocity and radius. The air is turned through 30° as it passes through the rotor.

(i) Construct the velocity diagrams at the mean diameter for this stage.

(ii) Draw the shape of the rotor and stator blades.

(iii) Calculate the mass flow rate.

(iv) Calculate the required power.

(v) Calculate the pressure ratio of this stage.

Question 4 [15 Marks]

A. What are the differences between turbojet, turbofan, and turboprop engine? Why some turbojets are equipped with an afterburner?

B. A turbo-jet engine travels at 216 m/s in air at 0.78 bar and – 7.2°C. Air first enters diffuser in which it is brought to rest relative to the unit and it is then compressed in a compressor through a pressure ratio of 5.8 and fed to a turbine at 1110°C. The gases expand through the turbine and then through the nozzle to atmospheric pressure (i.e., 0.78 bar). The efficiencies of diffuser, nozzle and compressor are each 90%. The efficiency of turbine is 80%. Pressure drop in the combustion chamber is 0.168 bar. Assume calorific value of fuel as 44150 kJ /kg of fuel. Determine:

i) Air/fuel ratio.

ii) Specific thrust of the unit.

iii) Total thrust, if the inlet cross-section of diffuser is $0.12 m^2$.

Best Wishes.

Tanta University

Department: Mechanical Power Engineering
Total Marks: 75 Marks

Faculty of Engineering

Course Title: Gas Turbine Engines
Date: /6/2012 (Second term)

Course Code: MEP4232
Allowed time: 3 hours min

Year: 4th
No. of Pages: (2)

Remarks: (Answer as much as you can ....Assume any missing data......All questions carry equal marks)

Question 1: (25 Marks)

A. In an axial flow gas turbine, obtain all the gas angles in terms of degree of reaction, flow coefficient and blade loading coefficient.

B. Draw h-s diagram for impulse turbine and reaction turbine with degree of reaction 0%, 50% and 100%. Show the difference between the rotor blade shape of impulse and reaction turbine.

C. Show by a neat sketch the variation of pressure and velocity through an impulse turbine and reaction turbine.

D. In a single-stage axial flow gas turbine gas enters at stagnation temperature of 1100 K and stagnation pressure of 5 bar. Axial velocity is constant through the stage and equal to 250 m/s. Mean blade speed is 350 m/s. Mass flow rate of gas is 15 kg/s and assume equal inlet and outlet velocities. Nozzle efflux angle is 63°, stage exit swirl angle equal to 9°.Determine the rotor-blade gas angles, degree of reaction, and power output.

Question 2: (15 Marks)

A. Consider a two-stage turbine operating at steady state with reheat at constant pressure between the stages. Show that the maximum work is developed when the pressure ratio is the same across each stage. Assume that the inlet state and the exit pressure are specified, each expansion process is isentropic, and the temperature at the inlet to each turbine stage is the same.

B. Air is taken in a gas turbine plant at 1.1 bar 20°C. The plant comprises of L.P. and H.P. compressors and L.P. and H.P. turbines. The compression in L.P. stage is up to 3.3 bar followed by intercooling to 2.7°C. The pressure of air after H.P. compressor is 9.45 bar. Loss in pressure during intercooling is 0.15 bar. Air from H.P. compressor is transferred to heat exchanger of effectiveness 0.65 where it is heated by the gases from L.P. turbine. After heat exchanger the Air passes through combustion chamber. The temperature of gases supplied to H.P. turbine is 700°c. The gases expand in H.P. turbine to 3.62 bar and air then reheated to 670°C before expanding in L.P. turbine. The loss of pressure in reheater is 0.12bar. Assume: Isentropic efficiency of compression in both stages= 0.82. Isentropic efficiency of expansion in turbines=0.85. For air: c_p= 1.005 kJ/kg K, γ=1.4. For gases: c_p = 1.15 kJ/kg K, γ=1.33. Neglect the mass of fuel. Determine:

i) The overall efficiency

ii) The back work ratio

iii) Mass flow rate when the power generated is 6000kW.

Please Turn Over

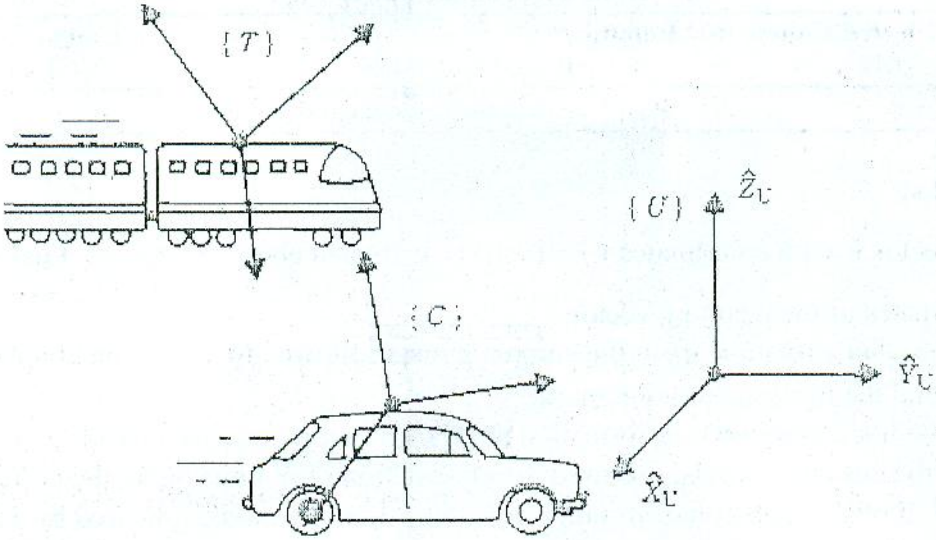


Fig. 3

Q4: (21 marks)

For the spherical manipulator shown in Fig. 4:

a) Given x_c, y_c, z_c and d_1, solve the inverse position kinematics to find θ_1, θ_2, and d_3.

b) What would be the value of θ_1 if x_c and y_c are zero?

c) If the wrist center does not intersect z_0, how many solutions to the inverse position kinematics are available?

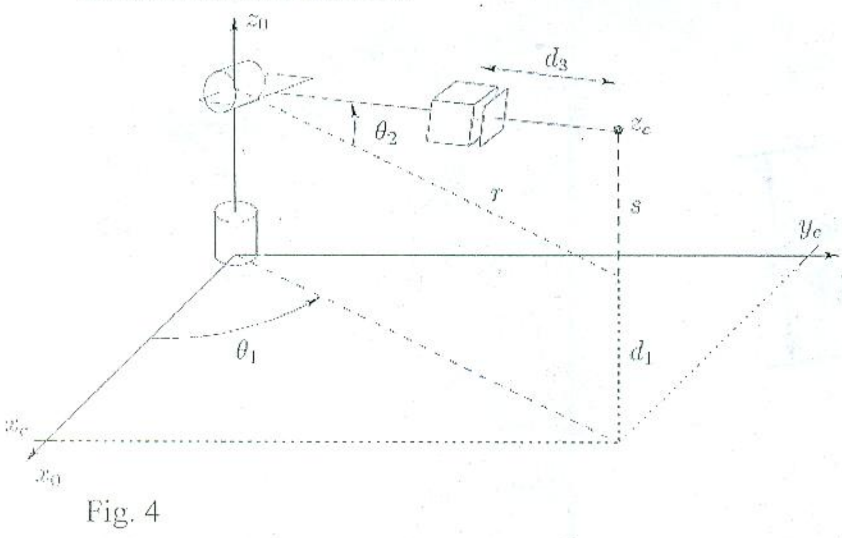


Fig. 4

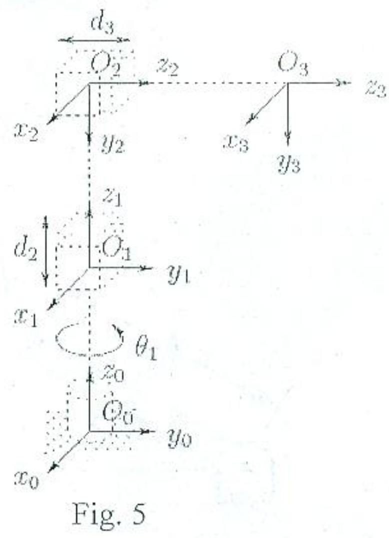


Fig. 5

Q5: (21 marks)

Consider the three-link cylindrical robot represented symbolically by Fig. 5. The frames are attached as shown. Find:

a) The table of links' parameters.

b) The homogeneous transformation matrices, A_1, A_2 and A_3.

c) The transformation matrix representing the kinematics T_3^0.

Best wishes, Dr. Zakarya ZYADA

Course Title: Selected Course (6) "Robotics" Course Code: MEP4235

Date: June 9th, 2012 Allowed time: 3hrs Total Marks: 85

Please answer the following questions

Q1: (12 marks)

a) The vector $\vec{v}$ with coordinates $v^0 = (0,1,1)^T$ is rotated about y_0 by $\frac{\pi}{2}$. Find the coordinates of the resulting vector.

b) Suppose that a rotation about the current z -axis followed by a rotation about the current y -axis, find the resulting rotation matrix.

c) Find the homogeneous transformation matrix H that represents a rotation of α degrees about the current x - axis, followed by a translation of b units along the current x - axis, followed by a translation of d units along the current z - axis, followed by a rotation of θ degrees about the current z - axis.

Q2: (10 marks)

a) Consider a three-link planar arm as shown in Fig. 2-a. Assign coordinate frames according to D-H convention.

b) Consider the two-link planar arm of Fig. 2-b, with coordinate frames assigned according to D-H convention. Find the link parameters and the forward kinematics Transformation matrix.

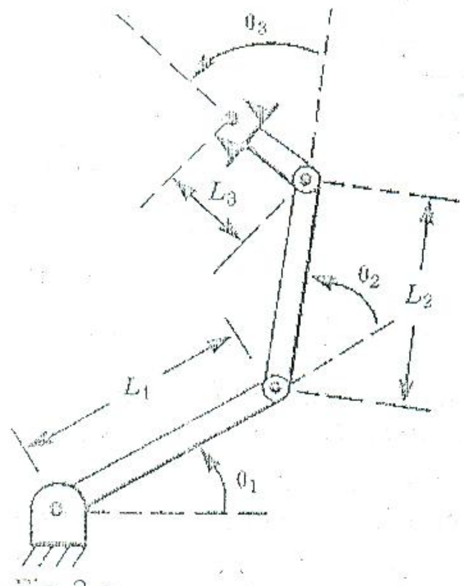


Fig. 2-a.

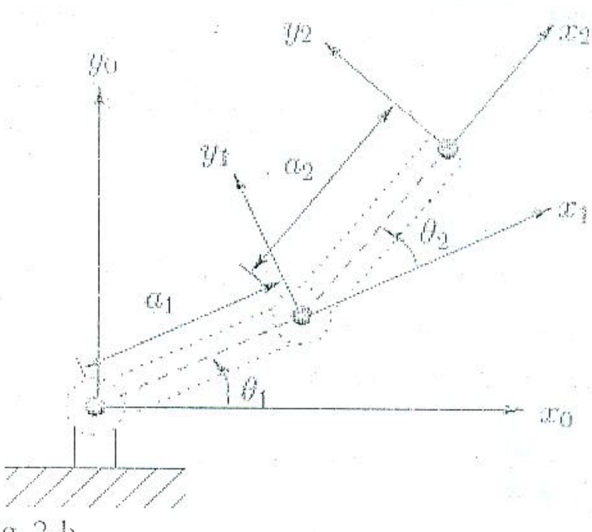


Fig. 2-b

Q3: (21 marks)

Figure 3 shows a fixed universe frame, $\{U\}$, a frame attached to a train travelling at 100 km/hr; $\{T\}$, and a frame attached to a car travelling at 30 km/hr $\{C\}$. Both vehicles are heading in the $\hat{X}$ direction of $\{U\}$. The rotation matrices ${}^U_T R$ and ${}^U_C R$ are known and constant. What is:

a) $\frac{{}^U d}{dt} {}^U R_{CORG}$

b) ${}^C\left({}^U V_{TORG}\right)$

c) ${}^C\left({}^T V_{CORG}\right)$

Tanta University
Faculty of Engineering
Department of Mechanical Engineering
Year: Four Subject: Sea water Desalination
Name: Talal Abouelmaaty

Date: June 2012
Time allowed: 3 Hr
Full mark: 85
Final Exam: 2 pages

- Brine blow down temperature = 35 °C
- Top brine temperature = 80 °C
- Terminal temperature difference in the condenser = 3 °C
- Thermodynamic losses = 2 °C
- The overall heat transfer coefficient for both the evaporator and condenser , U= 2 kw/m^2.°C

Where;

$$M_s \lambda_s = M_f Cp (\Delta T_{st} + \Delta T_{loss} + TTD_c)$$
$$M_d \lambda_v = M_f Cp \Delta T_{st} = (Mf+Mcw) Cp (T_o - \Delta T_{st} - \Delta T_{loss} - TTD_c - T_{cw})$$
$$(LMTD)_h = (\Delta T_{st} + \Delta T_{loss} + TTD_c)/\ln((TTD_h + \Delta T_{st} + \Delta T_{loss} + TTD_c)/(TTD_h))$$
$$(LMTD)c = (\Delta T_{st})/\ln((\Delta T_{st} + TTD_c)/(TTD_c))$$
$$PR = (\lambda_s)(\Delta T_{st})/((\Delta T_{st} + \Delta T_{loss} + TTD_c)(\lambda_v))$$

Appendix A Thermodynamic Properties 539

Table A.7: Variation in latent heat of water evaporation in (kJ/kg) as a function of temperature (°C)

T (°C)	Calculated Latent Heat (kJ/kg)	Latent Heat from Steam Tables (kJ/kg)	Percentage Error
5	2489.89	2489.56	0.013241
10	2477.93	2477.75	0.007259
15	2466.006	2465.93	0.003078
20	2454.106	2454.12	0.000577
25	2442.218	2442.3	0.003365
30	2430.33	2430.48	0.006175
35	2418.43	2418.62	0.007845
40	2406.507	2406.72	0.008854
45	2394.548	2394.77	0.009271
50	2382.542	2382.75	0.008746
55	2370.476	2370.66	0.007767
60	2358.339	2358.48	0.005984
65	2346.119	2346.21	0.00389
70	2333.804	2333.84	0.001563
75	2321.381	2321.37	0.000459
80	2308.84	2308.78	0.002614
85	2296.169	2296.05	0.005166
90	2283.354	2283.19	0.007192
95	2270.385	2270.19	0.008602
100	2257.25	2257.03	0.009743
105	2243.936	2243.7	0.010528
110	2230.432	2230.2	0.010415
115	2216.726	2216.5	0.010206
120	2202.806	2202.61	0.008904
125	2188.66	2188.5	0.007316
130	2174.276	2174.17	0.004888
135	2159.643	2159.59	0.002441
140	2144.748	2144.76	0.00058
145	2129.579	2129.65	0.00334
150	2114.125	2114.26	0.006395
155	2098.373	2098.57	0.009369
160	2082.313	2082.56	0.01187
165	2065.931	2066.21	0.013499
170	2049.216	2049.5	0.013838
175	2032.157	2032.42	0.01295
180	2014.74	2014.95	0.010402
185	1996.955	1997.07	0.005742
190	1978.79	1978.76	0.001499
195	1960.232	1960	0.011812
200	1941.269	1940.75	0.026741

Table B.1: Variation in seawater boiling point elevation (°C) as a function of temperature (°C) and salinity (wt%)

	Salinity (wt%)						
temperature °C	1	2	3	4	5	6	7
10	0.085	0.171	0.258	0.348	0.441	0.538	0.639
15	0.087	0.175	0.266	0.359	0.456	0.556	0.662
20	0.089	0.180	0.273	0.370	0.470	0.575	0.684
25	0.091	0.185	0.281	0.381	0.485	0.593	0.706
30	0.093	0.190	0.290	0.393	0.500	0.612	0.727
35	0.096	0.195	0.298	0.405	0.516	0.630	0.748
40	0.099	0.201	0.307	0.417	0.531	0.648	0.769
45	0.101	0.207	0.316	0.430	0.546	0.666	0.789
50	0.104	0.213	0.326	0.443	0.562	0.684	0.809
55	0.108	0.220	0.336	0.456	0.578	0.703	0.829
60	0.111	0.227	0.346	0.469	0.594	0.721	0.848
65	0.115	0.234	0.357	0.483	0.610	0.739	0.866
70	0.118	0.241	0.368	0.497	0.627	0.756	0.885
75	0.122	0.249	0.379	0.511	0.643	0.774	0.903
80	0.126	0.257	0.391	0.525	0.660	0.792	0.921
85	0.130	0.265	0.402	0.540	0.677	0.810	0.938
90	0.135	0.274	0.415	0.555	0.694	0.828	0.955
95	0.139	0.283	0.427	0.571	0.711	0.845	0.971
100	0.144	0.292	0.440	0.587	0.728	0.863	0.987
105	0.149	0.301	0.453	0.603	0.746	0.880	1.003
110	0.154	0.311	0.467	0.619	0.764	0.898	1.018

Good luck
TALAL

Tanta University
Faculty of Engineering
Department of Mechanical Engineering
Year: Four Subject: Sea water Desalination
Name: Talal Abouelmaaty

Date: June 2012
Time allowed: 3 Hr
Full mark: 85
Final Exam: 2 pages

Assume any missing or necessary data; answer all ..estions- غير مسموح بالخرائط أو الجداول

1- a) For desalination by reverse osmotic (RO) define the following terms; Osmotic pressure, Operating pressure, Salt rejection (SR) and permeate recovery.

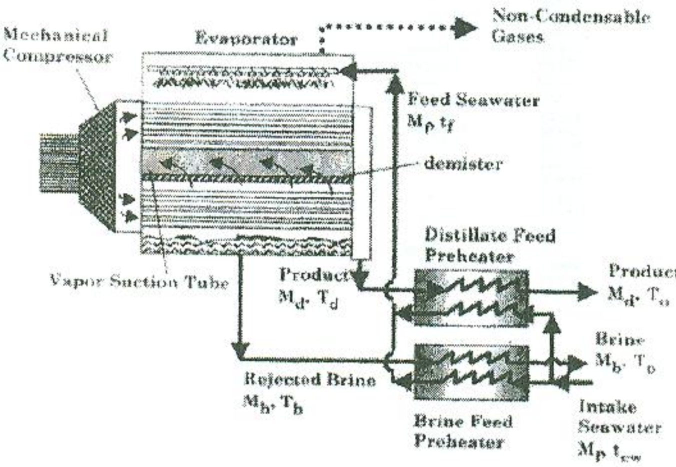
b) Design a single stage RO desalination system by calculating the permeate salinity, the brine salinity, the brine flow rate and the membrane area;
Water permeability is 2.05×10^{-6} $m^3/m^2.s.Kpa$, salt permeability is 2.03×10^{-5} $m^3/m^2.s.Kpa.$, feed salinity is 34000 ppm, feed water rate = 2.5 kg/s, permeate flow rate = 1kg/s, feed pressure = 5000kpa, reject pressure = 4800 kpa and permeate pressure = 101kpa.

2- For a single effect evaporator, prove that

$$PR = \frac{\lambda_s}{\lambda_v + cp(T_v - T_f)\frac{X_f}{X_b - X_f} + \frac{X_f}{X_b - X_f}.cp.\ BPE}$$

A single-effect evaporator generates a distillate product at a flow rate of 1kg/s. The system operating temperatures are as follows: The boiling temperature, T_b, is 90 °C, The feed temperature, T_f, is 85 °C and The steam temperature, T_s, is 102 °C . Determine the heat transfer areas in the evaporator and the condenser, the thermal performance ratio, the flow rates of feed seawater and reject brine, and the flow rate of cooling seawater. Assume that the specific heat of seawater is constant and equal to 4.2 kJ/kg °C. Assume that, the overall heat transfer coefficient for both the evaporator and condenser , 2.55 and 2 kw/m^2.°C respectively.

3- For a single effect Mechanical vapour compression, describe the operation procedure, write the mass balance equations, evaporator thermal balance, heat exchangers energy balance, specific power consumption and draw the temperature profiles in evaporator and feed heaters



4- Calculate the performance ratio, specific heat transfer area, specific flow rate of cooling water, conversion ratio, and salinity of brine blow down for a single stage flash desalination unit operating at the following conditions:
- Feed salinity = 45000 ppm
- Feed temperature = 25 °C
- Heating steam temperature = 90 °C
- Production capacity = 1 kg/s

Q3: (20 marks)

a) Explain and sketched the open and closed cycle of cooling water used in condenser.

b) Load curve can be supplied either by hydro station or steam station. The following data is available:

	Hydro	Steam
Capital cost_kW	Rs 2100	Rs 1200
Running cost_kWh	Rs 0.032	Rs 0.05
Interest and depreciation	7·5%	9%
Reserve capacity	33%	25%

Find:

(a) **At what load factor would the overall cost be the same in both cases?**

(b) **What would be the cost of generating 40×10^6 kWh at this load factor?**

Q4: (25 marks)

a) Explain and sketched the forced and induced-draft systems, why the balanced draft system is preferred over the forced and induced-draft systems.

b) A power plant supplies the loads as tabulated below:

Time hr	6-8	8-9	9-12	12-2	2-6	6-9	9-1	1-6
Load kW	1000	2000	3000	2000	2500	2000	1000	500

a) **Draw the load curve and find the load, capacity and use factors for power plant**

If the load curve is supplied by numbers of power plant are available capacity 1000 kW and 500 kW.

a) **Choose the number and capacity of the plants to supply this load**

b) **Find the operating time and use factor of the plants selected and show the results in table**

Best wishes, Dr. elsayed elagouz

Try all the following questions

Allow to use the table and chart of steam

Q1: (20 marks)

a) What the sources of air leakage into condenser, briefly state the effects the air leakage on the performance of a condenser.

b) A steam power plant operates regenerative Rankine cycle with two open feed water heaters. Steam enters the high-pressure turbine at 10 MPa and 400°C and the low-pressure turbine at 5 MPa. The condenser pressure is 5 kPa. The efficiency of the high-pressure turbine is 90 % and the efficiency of the low-pressure turbine is 85 %. Feed water leaves both heaters as a saturated liquid.

Show the cycle-on a T-s diagram with respect to saturation lines and find the condition of heaters

Q2: (20 marks)

The following data is available from a trial of a steam boiler.

Feed water temperature = 70°C

Feed water supplied = 4150 kg/hr

Steam pressure = 12 bar, dryness fraction of steam = 0.98

Coal fired = 460 kg/hr

C.V. of dry coal = 42000 kJ/kg

Moisture in coal = 4%.

Temperature of the flue gases = 2850°C.

Temperature of boiler house = 25°C.

Barometric pressure = 1 bar.

The ultimate analysis of coal is C = 86%, H_2 = 4%, Ash = 5% and other mailer = 5%.

The analysis of dry flue gas is, CO_2 = 10.4%, CO= 1.2%, O2 = 9.1% and N_2 = 79.3%.

Determiner:

(a) **The capacity of the f-d fan, in kg/m if atmospheric conditions are 25C, 1.01 bar, and a relative humidity of 60 percent**

(b) **The capacity of the i-d fan, in kg/m, if the exhaust gas is at 290 °C and 0.912 bar**

(c) **Draw the heat balance sheet on 1 kg of coal used basis dry.**