Tanta University
Second Term Exam
Time Allowed: 3hrs

Hydraulic and Pneumatic Circuits
Course Code: MEP4229
Total Assessment Marks: 90
4th Year Mechanical Power Engineering

Faculty of Engineering
Mech. Power Eng. Dept
June 1, 2022

***Please, answer the following questions:***

## Question (1) (35Marks)

1. Discuss with the help of free sketch the working principle of the single vane oscillatory motor.
2. What is the purpose of cushion devices in hydraulic cylinders? Discuss the principle of operation.
3. A pump delivers oil at a rate of 1.15L/s into the blank end of the 76.2mm diameter hydraulic cylinder. The piston contains a 25.4mm diameter cushion plunger that is 19.05mm long. The cylinder drives a 6672N weight which slides on a flat horizontal surface having a coefficient of friction (μ) equal to 0.12, see Fig. 1. The pressure relief valve setting equals 51.7bar. Find the maximum pressure developed by the cushion.
4. Figure 2 shows a main spindle on an automatic lathe is driven by a hydraulic motor, while a hydraulic cylinder is used to execute a feed movement of the workpiece slide.
   a) Draw a circuit that can be used to study the pump characteristic curve.
   b) Identify each item in the circuit.
   c) Mention the usage of each item in the circuit.

## Question (2) (30Marks)

1. What is the purpose of a pressure relief valve? What are its types? Discuss the working principle of each type with the help of free sketch drawing.
2. Discuss with the help of free sketch the working principle of the pressure reducing valve. Mention an example of its function in hydraulic systems.
3. For the fluid power system of Fig. 3, the total pressure drop in the line from the pump discharge port to the blank end of the cylinder is 517050Pa. The total pressure drop in the return line from the rod end of the cylinder is 344700Pa. Determine the:
   a) Volumetric displacement of the pump
   b) Input power required to drive the pump
   c) Input torque required to drive the pump
   d) Percentage of pump input power delivered to the load

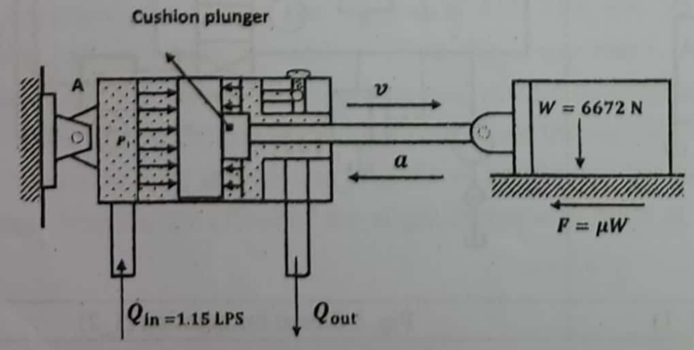

Fig. 1 Cylinder with cushioning device

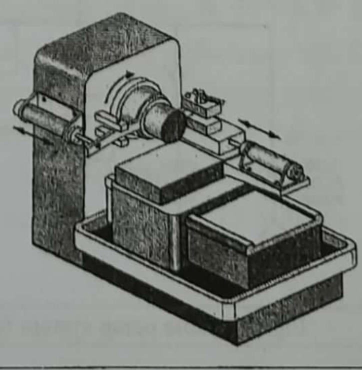
Fig. 2 Automatic lathe machine

Table-1 System data

| | |
|---|---|
| Cylinder piston diameter | 20.32cm |
| Cylinder rod diameter | 10.16cm |
| Cylinder extending speed | 7.62cm/s |
| External load on cylinder | 177920N |
| Pump volumetric efficiency | 92% |
| Pump mechanical efficiency | 90% |
| Pump speed | 1800rpm |
| Pump inlet pressure | -27576Pa |

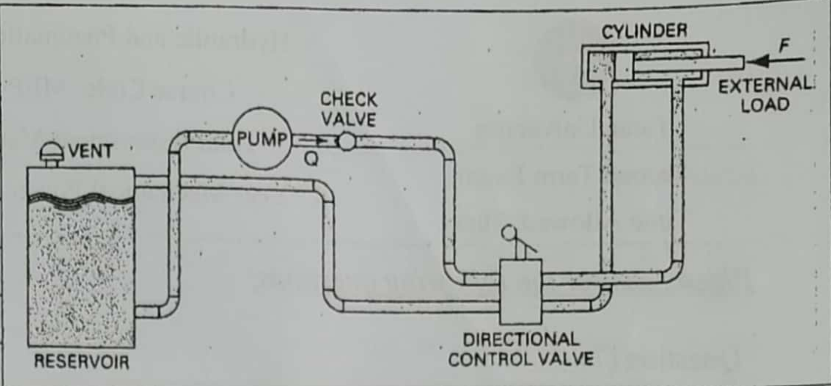


Fig. 3 System for question (2_3)

Question (3) (25Marks)

1. For the double pump system shown in Fig. 4 for the application of a sheet metal punch press, <u>what should be the pressure settings of the unloading valve and pressure relief valve</u> under the following conditions:
   - Sheet metal punching operation requires a force of 2000lb
   - Hydraulic cylinder has a 1.5-in piston diameter and 0.5-in rod diameter
   - During rapid extension of the cylinder, a frictional pressure loss of 100psi occurs in the line from the high flow pump to the blank end of the cylinder. During the same time a 50psi pressure loss occurs in the return line from the rod end of the cylinder to the oil tank. Frictional pressure losses in these lines are negligible small during the punching operation.

Assume the unloading valve and pressure relief valve pressure settings (for their full pump flow requirements) should be 50% higher than the pressure required to overcome frictional pressure losses and the cylinder punching load respectively

2. Figure 5 shows a fail-safe circuit with overload protection. The purpose of the circuit is to prevent the cylinder from accidentally falling on an operator as well as prevent overloading of the system.
   a) Identify marked valves in the circuit
   b) How could the cylinder be extended? re-draw the circuit in this case
   c) What is the purpose of using valve (5) in the given circuit?
   d) Throughout the cylinder extension, the cylinder is over-loaded. Discuss and illustrate by re-drawing the circuit how could the system be protected against overloading.

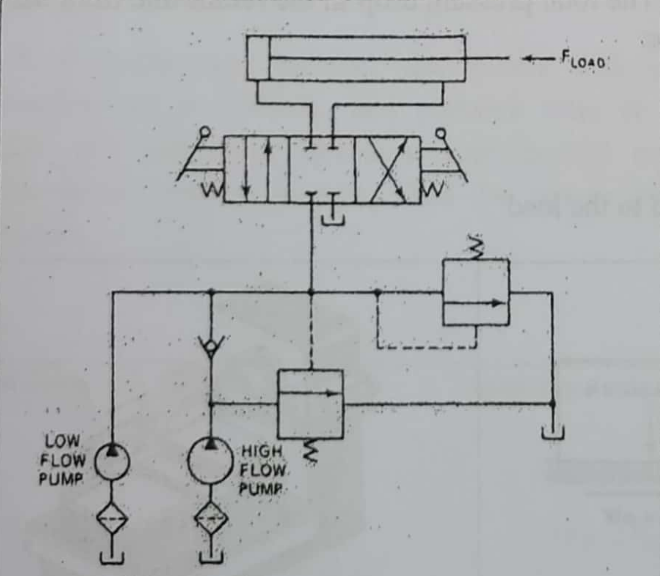


Fig. 4 Double pump system for question (3_1)

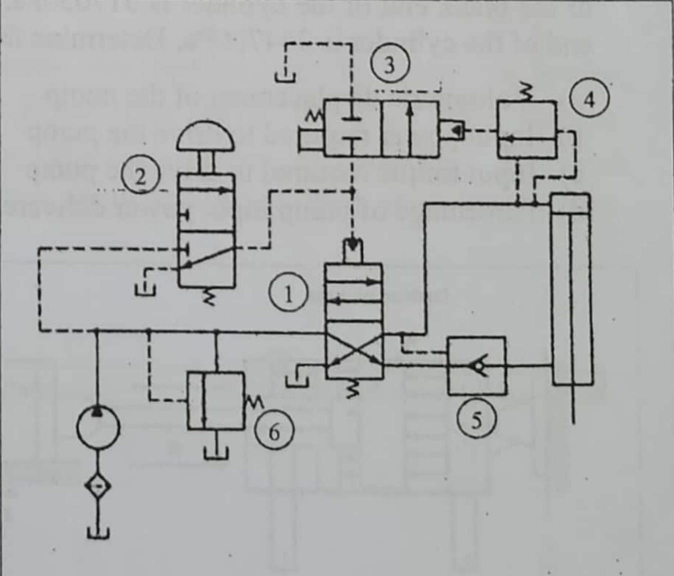


Fig. 5 Circuit for question (3_2)

Tanta University

Mechanical Power Engineering Dept.
Total Marks: 75 marks

Faculty of Engineering

**Course Title: Elective Course (5)**
**''Turbo-Jet Engines''** محركات توربينية غازية
**Date:** 5th June 2022 (Final Exam)

**Course Code: MEP4232**
**Allowed Time:** 3 hrs.

**Final Written Exam**
**No. of Pages:** 2 pages

**ANSWER ALL THE FOLLOWING QUESTIONS**

**Question (1)** **(20 Marks)**

**A)** If the inlet state and the exit pressure are specified for a two-stage turbine operating at steady state, **show that the maximum total work output is required when the pressure ratio is the same across each stage.** Use a cold air-standard analysis assuming that each expansion process is isentropic, there is no pressure drop through the reheat, and the temperature at the inlet to each turbine stage is the same. (5 Marks)

**B)** If the inlet state and the exit pressure are specified for a two-stage compressor operating at a steady state, **show that the minimum total work input is required when the pressure ratio is the same across each stage.** Use a cold air-standard analysis assuming that each compression process is isentropic, there is no pressure drop through the intercooler, and the temperature at the inlet to each compressor stage is the same. (5 Marks)

**C)** A gas-turbine plant operates on the regenerative Brayton cycle with two stages of compression and two stages of expansion between the pressure limits of 100 and 1200 kPa. The working fluid is air. The air enters the first and the second stages of the compressor at 300 K and 350 K, respectively, and the first and the second stages of the turbine at 1400 K and 1300 K, respectively. Assuming both the compressor and the turbine have an isentropic efficiency of 80 percent and the regenerator has an effectiveness of 75 percent, determine (a) the back work ratio and the net -work output, (b) the thermal efficiency. (10 Marks)

**Question (2)** **(15 Marks)**

**A)** Explain briefly with sketches the different types of jet engine and how it generates thrust. (6 Marks)

**B)** A turbojet aircraft flies with a velocity of 900 km/h at an altitude where the air temperature and pressure are 35°C and 40 kPa. Air leaves the diffuser at 50 kPa with a velocity of 15 m/s, and combustion gases enter the turbine at 450 kPa and 950°C. The turbine produces 500 kW of power, all of which is used to drive the compressor. Assuming an isentropic efficiency of 83 percent for the compressor, turbine and nozzle determine (a) the pressure of combustion gases at the turbine exit, (b) the mass flow rate of air through the compressor, (c) the velocity of the gases at the nozzle exit, and (d) the propulsive power and the propulsive efficiency for this engine.
**Hint:** Neglect the effect of the slight increase in mass at the engine exit. (9 Marks)

**Question (3)** **(15 Marks**

**A)** An axial flow compressor has the following data: - Blade velocity at root is 140 m/s. Blade velocity at mean radius is about 185 m/s. Blade velocity at tip is 240 m/s. Stagnation temperature rise in this stage is 15K. Axial velocity is constant from root to tip and equals 140 m/s. Work done factor is 0.85. Degree of reaction at mean radius is 50%. For a free vortex design, determine the stage air angles at the root, mean, and tip. Then, calculate the degree of reaction at the blade root and tip.

**B)** A 10-stage axial flow compressor is designed for stagnation pressure ratio of **4.5:1**. The overall isentropic efficiency of the compressor is 88% and stagnation temperature at inlet is 290K. Assume equal temperature rise in all stages, and work done factor is 0.87. Determine the air angles of a stage at the design radius where the blade speed is 218 m/s. Assume a constant axial velocity of 165 m/s, and the degree of reaction is 76%.

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**Question (4)** **(25 Marks)**

**A)** Define the following terms of single stage axial flow turbine, **(I)** degree of reaction **(II)** total to total efficiency **(III)** Blade loading coefficient and **(IV)** flow coefficient. Support your answer with simply clear sketches

**B)** Briefly explain the difference points between compressor and gas turbine in terms of **(I)** definitions, main components and working principles, **(II)** Classifications and **(III)** Design criteria. Support your answer with simply clear sketches.

**C)** Compare between industrial gas turbine (power station) and aircraft gas turbine engines.

**D)** In a single-stage turbine, gas enters and leaves the turbine axially. Inlet stagnation temperature is 1000 K, and pressure ratio is 1.8 bar. Gas leaves the stage with velocity 270 m/s and blade speed at root is 290 m/s. Stage isentropic efficiency is 0.85 and degree of reaction is zero. Find the nozzle efflux angle and blade inlet angle at the root radius.

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**End of Questions** **With my Best Wishes...** *Dr. Ayman Refaat & Dr. Ahmed Abdo*

ميكا قوى

كلية الهندسة

قسم هندسه القوى الميكانيكيه

جامعة طنطا

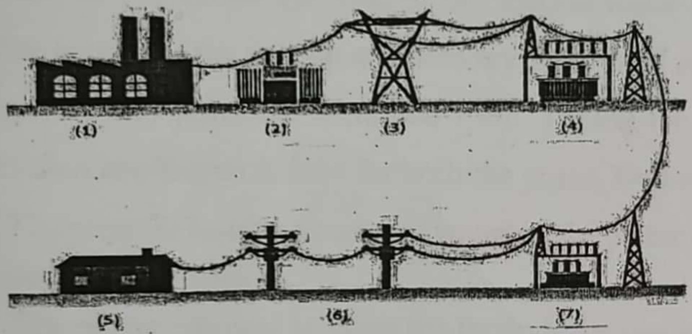
| | | | | |
|---|---|---|---|---|
| اسم المقرر | منشآت الطاقة | امتحان دور سبتمبر للعام الجامعي ٢٠٢٢/٢٠٢١ | كود المقرر | MEP4230 |
| | | | الفرقة | الرابعة |
| زمن الامتحان | ٣ ساعات | عدد صفحات الامتحان (١) | تاريخ الامتحان | 2022/06/08م |
| الاجابه بترتيب الأسئلة. | | | درجه الامتحان: ٨٥ درجه | |

**السؤال الاول:**

ا- الشكل يوضح مراحل نقل الكهرباء من محطة التوليد حتى المنزل.

اذكر المراحل الموضحة بالأرقام بالترتيب.

ب- ما هو الفرق بين النقل والتوزيع؟




**السؤال الثاني:**

ا- اذكر انواع محطات توليد الطاقة في مصر.

ب- عرف كلا من: محطات الطاقة المائية – محطات الطاقة الشمسية.

ج- ما هي مكونات شبكة توزيع الكهرباء الاساسية والثانوية؟

**السؤال الثالث:**

ا- عرف مع ذكر أنواع ومميزات وعيوب كل من:

الطاقة المتجددة – الطاقة الغير متجددة.

ب- اذكر نبذة عن شركات توزيع الكهرباء في مصر.

ج- ما هي اهم ادوات تحويل الطاقة المستدامة، مع الشرح.

**السؤال الرابع:**

ا- ماهي منحنيات الحمل Load Curve؟

ب- اذكر ما تعلمت من مادة منشئات الطاقة.

*Best wishes*
*Dr. M.I.Elhadary*

**انتهت الاسئلة ............**

**لجنة الممتحنين: د/ محمد إبراهيم الحضري & د/ فريد حماد**

رسمة توربينا

| Tanta University<br>Faculty of Engineering<br>Mech., Power Engineering Dept.<br>4th Year Power Mechanics,<br>2nd Term | Course: Hydraulic Machines (B)<br>Code: MEP 4121<br>Final Exam, Full Marks: 75.0 marks<br>Time allowed: 3.0 hrs No of pages: 2.0<br>Date: 12-06-2022 |
|---|---|

**Question (1) ( 15 Marks)**

1. **Derive** a relations for calculating the inertia heads of the suction and delivery pipes of the piston pump, then clearly **drawing** the indicator diagram of the piston pump considering only the inertia effect. **(5.0 Marks)**

2. A double-acting piston pump of 15 cm bore and 30 cm stroke runs at 35 rpm. The center of the pump is 5 m above the level of the suction water level and 30 m below the delivery water level. The lengths of the suction and delivery pipes are 7 m and 36 m, whereas the diameters of the suction and delivery pipes are 6 cm and 7 cm. Taking the atmospheric pressure head is 10.3 m and the friction coefficient is 0.04 for both the pipes; **Determine** **(8.0 Marks)**

(a) The pressure head in a meter of water on the piston at the beginning, middle, and end of the suction and delivery strokes.

(b) The power required to drive the pump if the mechanical efficiency is 75 %.

(c) The maximum head at any instant against which the pump has to work and its corresponding duty.

3. **Define** the following expressions:

(a) Spillway (b) Deflector plate **(2.0 Marks)**

**Question (2) ( 15 Marks)**

1. **Deduce** the relations for the turbine head calculations of a Pelton wheel turbine, then **derive and determine** the maximum head conditions of the Pelton turbine. **(6.0 Marks)**

2. Francis turbine has a runner 0.60 m diameter and 75 mm wide at the inlet. The runner outlet diameter is 0.35 m. The effective area of flow is 93% of the gross area and the flow velocity is constant. The guide vane angle is 23°, the inlet vane angle is 93°, and the outlet vane angle is 30°. Assume the hydraulic efficiency is 90% and mechanical efficiency of 94%, **Determine**

(a) The turbine speed so that the water enters the runner without shock

(b) The shaft output power when the effective supply head is 100 m. **(9.0 Marks)**

**Question (3) ( 15 Marks)**

1. **Draw** clearly the energy distribution diagram of Francis turbine to convert the hydraulic head into useful turbine head with showing the total energy line of the turbine? **(3.0 Marks)**

2. Pelton turbine running at 720 rpm uses a water discharge of 0.30 $m^3/s$. If the total available head is 400 m and the buckets deflect the jet by 165°. Assume $C_v$= 0.97, jet speed ratio is 0.46 and the relative velocity coefficient is 0.90, **Determine**

(a) The hydraulic efficiency
(b) The diameters of the runner wheel and jet.
(c) The overall efficiency
(d) The dimensionless specific speed **(8.0 Marks)**

**3. Write** a brief short note about:

(a) Gravity dams (b) Arch dams (c) Types of draft tubes **(4.0 Marks)**

**Question (4) ( 15 Marks)**

**1.** ***Prove that*** the percentage of frictional work done saved by air vessel for single acting piston pump is 84.80 % **(4.0 Marks)**

**2.** In a single acting piston pump with a piston diameter of 12 cm and stroke of 18 cm running at 60 rpm. An air vessel is fixed at the delivery side at a distance of 3 m from the level of the pump. The length and diameter of the delivery pipe are 25 m and 10 cm, respectively. Taking the atmospheric pressure head is 10.3 m and the friction coefficient is 0.04, **Calculate**

(a) The reduction percentage in the delivery inertia head due to the fitting of the air vessel.
(b) The reduction percentage in the delivery frictional head due to the fitting of the air vessel.
(c) Maximum speed of the pump **(8.0 Marks)**

**3. Writes down with** simple sketches **five of the technical considerations** that should be taken into account for designing Pelton wheel turbines. **(3.0 Marks)**

**Question (5) ( 15 Marks)**

**1.** A propeller turbine runner has an outer diameter of 4.5 m and an inner diameter of 2.5 m and develops 3000 kW when running at 140 rpm under a total supply head of 25 m. The hydraulic efficiency is 94% and the overall efficiency is 82%, **Find**

(a) The discharge through the turbine
(b) The guide blade angle at the inlet. **(7.0 Marks)**

**2.** A draft tube of 5 m in length has a diameter of 2 m at its top. Water discharge with a flow rate of 30 $m^3/s$ and a velocity of 1.2 m/s at the outlet. The pressure head at the top is 5.8 m (vacuum) and the atmospheric head is 10.3. Neglect friction losses through the draft tube and turbine blades; **Find**

(a) The length of the draft tube immersed in the tail race
(b) The draft tube efficiency.
(c)The pressure head at the inlet of turbine blades if the velocity at blades inlet is 9 m/s. **(8.0 Marks)**

**With My Best Wishes** **Dr. Mohamed E. Zayed**

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|---|---|---|---|---|---|
| Tanta University | | Department: Mechanical Power Engineering | | | Faculty of Engineering |
| Course Title: Desalination | | | Course Code: MEP | $4^{rd}$ : years | |
| Date: 15 – 6 – 2022 | | Allowed time: 3 hr Full Marks: (85) | | No of Pages: 4 | |
| Name: Prof. Dr. Mohamed Abdelgaied Ahmed | | | | Final Exam | |

**Answer the following questions: Assume any necessary assumptions.** **Marks**

**Question No. 1** (20)

A single-effect thermal vapor system generates a distillate product at a flow rate of 1kg/s. The system operating temperatures are as follows:

- Intake seawater temperature, $T_{cw} = 25\ ^{\circ}C$.
- The boiling temperature, $T_b$, is 90 °C.
- The feed temperature, $T_f$, is 85 °C.
- The compressed vapor temperature, $T_s$, is 102 °C.
- The motive steam pressure, $P_m$, is 15 bar.

**Determine** the heat transfer are as 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 the specific heat of seawater and brine streams is constant and equal to 4.2 kJ/kg °C.

**Question No. 2** (20)

A single-effect mechanical vapor-compression system is to be designed at the following conditions:

-The distillate flow rate, $M_d = 1$ kg/s.

-The heat capacity of the vapor is constant, $C_{p,v} = 1.884$ kJ/kg°C.

-The heat capacity of all liquid streams is constant, $C_p = 4.2$ kJ/kg°C.

-The overall heat transfer coefficient in the evaporator, $U_e = 2.4$ kJ/s m$^2$ °C.

-The overall heat transfer coefficient in the brine preheater, $U_b = 1.5$ kJ/s m$^2$ °C.

-The overall heat transfer coefficient in the product preheater, $U_d = 1.8$ kJ/s m$^2$ °C.

-The intake seawater temperature, $T_{cw} = 25$ °C.

-The condensed vapor temperature, $T_d = 62$ °C.

-The compressed vapor temperature, $T_s = T_d + 3 = 65$ °C.

-The evaporation temperature, $T_b = T_d - 2 = 60$ °C.

-The feed seawater salinity, $X_f = 42000$ ppm.

-The salinity of the rejected brine, $X_b = 70000$ ppm.

-Compressor efficiency, $\eta = 58.9$ %

**Calculate** the specific power consumption, the heat transfer areas for the evaporator and preheaters, and the specific heat transfer area.

**Question No. 3**

An MSF once through process plant has the following design data: (22)

- Seawater temperature: 34 °C.
- Seawater salinity: 42000 ppm.
- Top brine temperature: 100 °C .
- Temperature in the last stage: 40 °C.
- Temperature of heating steam: 110 °C.
- Specific flow rate of brine circulation: 8.478
- Heat transfer area in the brine heater: 80 $m^2$.
- Overall heat transfer coefficient in brine heater: 1.5 $kW/m^{2}{}^{o}C$.

**Calculate the following:**

- The plant performance ratio.
- The specific heat transfer area.

**Question No. 4** (23)

a) Discuss with drawing the types of membrane.

b) Design a single stage RO desalination system by calculating the permeate salinity, the brine salinity, the brine flow rate, and the membrane area.

Data

- Water permeability is 2.05 x 10-6 kg /$m^2$ s kPa.
- Salt permeability is 2.03 x 10-5 kg/$m^2$ s.
- Feed salinity is 42,000 ppm.
- Feed flow rate: 2.5 kg/s.
- Permeate flow rate: 1 kg/s.