كلية الهندسة ــ جامعة طنطا	المادة : محركات حرارية (أ)
الفرقة : الثالثة قوى ميكانيكية	*الدرجة النهائية : ٨٥ درجة*
امتحان الفصل الدراسى الأول 2022-2023	زمن الإمتحان : 3 ساعات
كود المادة : MEP3109	التاريخ : 2023-1-15

أجب عن الأسئلة الآتية : **(استخدم الرسم كلما أمكن)**

السؤال الأول : (٢٣ درجة)

أ) **علل لما يأتى :-**

١ ـ قدرة المحرك ثنائى الأشواط نظريا ضعف قدرة المحرك الرباعى الاشواط لنفس ظروف التشغيل ؟

٢ ـ عدم إنتشار إستخدام الوقود الصلب فى محركات الإحتراق الداخلى ؟

٣ ـ نسبة الإنضغاط فى محرك الديزل أكبر من نسبة الإنضغاط فى محرك البنزين ؟

٤ ـ التبريد فى محركات الإحتراق الداخلى شر لابد منه ؟

٥ ـ التشحين فى محرك الديزل يزيد الكفاءة الحجمية ؟

٦ ـ تستخدم القدرة النوعية للمقارنة بين محركات الإحتراق الداخلى ؟

٧ ـ رفع رقم الأوكتان يعطى فرصة لزيادة نسبة الإنضغاط فى محرك البنزين ؟

٨ ـ الدق يؤدى إلى إنخفاض الجودة الحرارية , وكذلك إلى تفحم زيت التزييت ؟

٩ ـ زيادة عطلة الإشتعال فى محرك الديزل تزيد فرصة حدوث الدق ؟

١٠ ـ تلعب التصميمات المختلفة لغرف الإحتراق لمحركات الديزل أهمية أكبر منها لمحركات البنزين ؟

ب) **اشرح مع الرسم كلا من :**

ـ اختبار مورس ـ خط ويلانز

السؤال الثانى :- (١٦ درجة)

أ) اشرح طريقة معملية لقياس الكفاءة الميكانيكية لمحرك إشعال بالشرارة أسطوانة واحدة ؟

ب) إشرح مع الرسم إختبار ضغط الإنضغاط فى محرك بنزين رباعى الأشواط ذو ست إسطوانات ؟

ج) إرسم التوقيت الدائرى لفتح وغلق كل من صمامات السحب والعادم فى محركات الإحتراق الداخلى مع ذكر قيم نمطية لكل توقيت ؟ ثم وضح كيفية تحديد النقطة الميتة العليا للمحرك فى المعمل؟

السؤال الثالث :- (٢٣ درجة)

أ) أشرح مع الرسم مسار سائل التبريد عند غلق وفتح الترموستات من وإلى المحرك من المشع ؟

ب) عرف ما يلى :

ـ فترة التراكب ـ الضغط المتوسط البيانى ـ رقم إنجلر ـ الصفع

ج) اشرح كيفية قياس القدرة الفرملية وكمية الحرارة الناتجة من الوقود فى حساب الموازنة الحرارية ؟

د) اشرح كيف تؤثر العوامل الآتية على أداء محركات الإحتراق الداخلى :

ـ نوع الوقود ـ ظروف المدخل ـ نسبة الخليط

← انظر خلفه

السؤال الرابع :- (٢٣ درجة)

أ) محرك إحتراق بالشرارة ذو غرفة إحتراق مسطحة وشمعة الشرر فى وضع جانبى وقطر إسطوانته الداخلى ١٠٠ مم . إحسب زاوية تقديم الشرارة المناسب عند دوران المحرك بسرعة ٣٠٠٠ لفة / دقيقة علما بأن عطلة الإشعال ٠,٠٠٢ ثانية وسرعة إنتشار اللهب ٣٦ م / ث ؟

ب) محرك احتراق داخلى اشتعال بالضغط ثنائى الأشواط قطراسطوانته ١٢٠ مم, وطول شوط مكبسه ١٢٥ مم , وعدد اسطواناته ٤ اسطوانات , أجريت له تجربة معملية عند سرعة ٢٤٠٠ لفة فى الدقيقة , وأخذت له القراءات الآتية :

- إستهلاك الوقود ١,٦٦ لتر فى زمن ١٢٠ ثانية .
- كثافة الوقود المستخدم ٨٣٠ كجم/م٣
- الصيغة الكيميائية للوقود المستخدم $C_{16}H_{34}$
- ثابت الفرملة ١٠٠٠ لحساب القدرة للمحرك بوحدات كيلووات
- تصرف ماء التبريد للمحرك ١١٢,٦ لتر فى زمن ٣٠ ثانية
- الإرتفاع فى درجة حرارة ماء التبريد عبر المحرك ١٠ ° م
- هبوط الضغط عبر فوهة صندوق الهواء ٥ سم ماء .
- قطر فوهة صندوق الهواء ١١,٥ سم .
- ضغط ودرجة حرارة الهواء الجوى *1* بار و ٣٠ ° م
- معامل تصرف الهواء عبر فوهة صندوق الهواء ٠,٦١ .
- درجة حرارة غازات العادم ٦٠٠ ° م
- الحمل على الفرملة ٦٥,٨ كجم
- القيمة الحرارية للوقود المستخدم ٤٤٠٠٠ كجول/ كجم
- عند قطع الحريق عن أحد الأسطوانات كان الحمل على الفرملة (عند نفس السرعة المذكورة) ٥٤,٢ كجم

المطلوب : أ- حساب الموازنة الحرارية للمحرك بوحدات كيلووات

ب- الكفاءة الحجمية للمحرك

ج- رسم العلاقة بين القدرة الفعالة للمحرك وكلا من الكفاءة الحرارية الفعالة ومعامل الهواء الزائد

مع أطيب الأمنيات بالنجاح والتوفيق

أ.د/ الشناوى عبد الحميد الشناوى

Tanta University
Faculty of Engineering
Mech., Power Engineering Dept.
3rd Year Power 1st term 2022/2023
Examiner: Dr. Mohamed E. Zayed

Course: Fluid Mechanics (2)
Code: MEP 311
Final Exam, Full Marks: 75.0 marks
Time allowed: 3.0 hrs No of pages: 2.0
Date: 17-01-2022

Question (1) (15 Marks)

1. **Derive** the discharge formula for flow through a By-pass over the main pipe. **(5.0 Marks)**
2. One end of a horizontal pipe 50 cm in diameter, and 200 m long is connected to a water tank in which the water level height is 25 m. The other end of the pipe is discharging water freely into the atmosphere. There is a gate valve in the middle of the pipe with a loss coefficient of 0.20 and two 90^{o} elbows with a loss coefficient of 0.30, and $f = 0.04$, **determine**

(a) The discharge through the pipe;

(b) The power transmitted through the pipe;

(c) The maximum power transmitted through the pipe;

(d) The efficiency of power transmission;

(e) If a 25 cm diameter jet nozzle is fitted at the end of the pipe, determine the jet power and efficiency of the jet nozzle. **(8.0 Marks)**

3. **Define** the physical and mathematical of the following expressions:

(a) Hydraulic diameter (b) Jet efficiency **(2.0 Marks)**

Question (2) (15 Marks)

1. **Deduce** a relation for calculating the time of emptying from one reservoir into another reservoir through a long pipe. **(7.0 Marks)**
2. Water is being discharged from a reservoir through a pipe 4 km long and 50 cm diameter to another reservoir having a water level 12.5 m below the first reservoir. It is required to feed a third reservoir, whose water level is 15 m below the first reservoir, through a pipe 1.5 km long to be connected to the main pipe at a distance of 1 km from its entrance. Find the diameter of the new pipe, so that the flow into both reservoirs is the same. Assume friction coefficient for all pipes as 0.032. **(8.0 Marks)**

Question (3) (15 Marks)

1. **Derive Chezy** formula for loss of head due to friction in pipelines? **(4.0 Marks)**
2. A compound pipe system is to carry water from a reservoir (8 m diameter) to another reservoir (5 m diameter). The difference between the water levels in the reservoirs is 35 m. The compound system consists of three pipes as; the first pipe is 40 cm diameter and 400 m long, the second pipe is 30 cm diameter and 300 m long, and the third pipe is 20 cm diameter and 500 m long. Assume the friction coefficient for all pipes as 0.024 and neglect all minor losses; **determine**

(a) The discharge through the compound system in L/s

(b) The diameter of the equivalent pipe that can be replaced by the compound pipe system

(c) The time is taken to empty the first reservoir completely. **(7.0 Marks)**

3. **Derive** a relation for calculating the discharge with a triangular notch (V-notch) **(4.0 Marks)**

Question (4) (15 Marks)

1. **Prove** *that* the conditions for maximum discharge through a water open channel of the trapezoidal section are $\frac{b+2nd}{2} = d\sqrt{n^2+1}$ and $m = d/2$? **(5.0 Marks)**

2. A trapezoidal channel with 2500 m length and 1:1 side slope has to be designed to convey 10 m^3/s and at a velocity of 2 m/s, so that the amount of discharge is maximum and the concrete lining is minimum. **Calculate:**

(a) The hydraulic mean depth

(b) The depth and width of the channel

(c) The total cost of the channel if the cost of 1 m^2 of the wetted area of lining is 150 EGP.

(d) If 15% of the water channel discharge flows over a triangular 90° V notch, find the depth of water over the V-Notch. (Take $C_d = 0.62$) **(7.0 Marks)**

3. **Draw clearly** the hydraulic gradient line and total energy line of a horizontal pipe connected to a water tank in which the water level height **H** and the end of the pipe is fitted with a **jet nozzle**, indicating the velocity and pressure heads of its elements. **(3.0 Marks)**

Question (5) (15 Marks)

1. **Write down four of** the methods that are used to avoid water hammer problem in pipelines. **(3.0 Marks)**

2. **Derive** an expression for estimating the pressure rise due to the water hammer if the valve at the end of a rigid pipe is closed suddenly. **(5.0 Marks)**

3. Water is flowing through a 2 km long pipe of 20 cm diameter and 8 mm wall thickness with a velocity of 2 m/s. If the Bulk modulus of elasticity of water is 2.1 x 10^9 Pa, and Young modulus of elasticity of the pipe material is 21 x 10^{10} Pa. Calculate;

(a) The pressure rise due to the water hammer if the valve at the end of the pipe is closed suddenly.

(b) The time taken by the pressure wave to return at the valve after the valve is closed **(7.0 Marks)**

With My Best Wishes

Dr. Mohamed Elsheshtawy Zayed

Tanta University	Advanced Fluid Mechanics	Faculty of Engineering
First Term Exam	3rd Year Mechanical Power Engineering Course Code: MEP3113	Mechanical Power Eng. Dept.
Time Allowed: 3hrs	Total Assessment Marks: 85	January 25, 2023

Please, answer the following questions: support your answer with clear sketches.

Question (1)

(15Marks)

1. **Science studies the accelerations and velocities of moving fluid particles regardless of external forces.**

   a- Fluid kinetic   b-Fluid static
   c- Fluid dynamic   d- fluid kinematic

2. **The total of the forces influencing the fluid flow in a specific direction is equal to the rate change of momentum.**

   a- Mass conservation   b-Momentum conservation
   c- Energy conservation   d- None of the above

3. **................ studies the viscous laminar flow through a circular pipe.**

   a- Navier model   b-Hagen -Poiseuille Model
   c- Couette Model   d- None of the above

4. **................ studies the viscous laminar flow between two plates; one of them is fixed and the other moving with a uniform velocity.**

   a- Navier model   b- Hagen-Poiseuille Model
   c- Couette Model   d- None of the above

5. **The viscous laminar flow between two concentric cylinders is called...........**

   a- Concentric flow   b- Cross flow
   c- Co-axial flow   d- Eccentric flow

6. **Navier-Stokes differential equations is applicable to**

   a- Laminar boundary layer flow only   b- turbulent boundary layer flow only
   c- Transient flow only   d- Laminar, transient, and turbulent boundary layer

7. **Layer foil separates the horizontal rotating shaft and prevents it from contact with the stationary surface.**

   a- Journal Bearing   b- Foot step Bearing.
   c- Collar Bearing   d- Conical thrust bearing.

8. **Layer foils rests down the bottom of vertical rotating shaft.**

   a- Journal Bearing   b- Foot step Bearing.
   c- Collar Bearing   d- Conical thrust bearing.

9. **Give a clear definition of uniform flow, non-uniform flow, pathline, streakline, the material derivative, linear deformation, and angular deformation.**

Question (2)

(20Marks)

1. Consider a two-dimensional, incompressible flow field in which an initially square fluid particle moves and deforms. The fluid particle dimension is a at time t and is aligned with the x- and y-axes. At some later time, the particle is still aligned with the x- and y-axes but has deformed into a rectangle of horizontal length $2a$. What is the vertical length of the rectangular fluid particle at this later time?

2. Consider steady, incompressible, two-dimensional flow through a converging duct, see **Fig. 1**. A simple approximate velocity field for this flow is: $\boldsymbol{V} = (U_0 + bx)\hat{\imath} - by\hat{\jmath}$

   where U_0 is the horizontal speed at $x = 0$.

   a) Calculate the material acceleration for fluid particles passing through this duct.

   A fluid particle (A) is located at $x = x_A$ and $y = y_A$ at time $t = 0$, see **Fig. 2**. At some later time t, the fluid particle has moved downstream with the flow to some new locations $x = x_{A'}$ and $y = y_{A'}$.

   b) Generate analytical expressions for both the x- and y-locations of the fluid particle at arbitrary time t in terms of its initial x- and y-locations (x_A and y_A) and constants U_0 and b (in other words: develop expressions for $x_{A'}$ and $y_{A'}$)

Question (3)

(25Marks)

1. Give a clear definition of bearings. Then classify them based on their working principles, advantages, limitations, and applications, respectively.

2. Drive an expression for the power required to overcome the viscous resistance in journals for the rotating shaft. The shaft has a diameter D (m) and a rotating speed N (rpm). The bearing width is L (m) and the oil film thickness is h (m). the oil has a dynamic viscosity of μ (Ns/m^2).

3. Determine the oil film thickness **h** between the plates of a collar bearing of (**Di** =0.2 m) inner diameter and (Do = 0.3 m) outer diameter transmitting power, if 50 watts was required to overcome viscous friction while running at N=700 rpm. The oil used has a viscosity of μ =30 centi-Poise (0.03 Ns/m^2). Look at **Fig. 3**

Question (4)

(25Marks)

1. Consider the steady, two-dimensional velocity field: $\boldsymbol{V} = (0.5 + 0.8x)\hat{\imath} + (1.5 - 0.8y)\hat{\jmath}$

   where lengths are in units of m, time in s, and velocities in m/s. There is a stagnation point at (0.625, 1.875) as shown in **Fig.4**. Streamlines of the flow are also plotted in **Fig.4**. Calculate the various kinematic properties, namely, the rate of translation, rate of rotation, linear strain rate, shear strain rate, and volumetric strain rate. Verify that this flow is incompressible.

2. Consider the fully developed two-dimensional planar Poiseuille flow (flow between two infinite fixed parallel plates), see **Fig. 5**. The velocity distribution is given by:

$$u = \frac{1}{2\mu}\frac{dP}{dx}(y^2 - hy)$$

   a) Is this flow rotational or irrotational? If it is rotational, calculate the vorticity component in the z-direction.
   b) Calculate the linear strain rates in the x- and y-directions and calculate the shear strain rate.

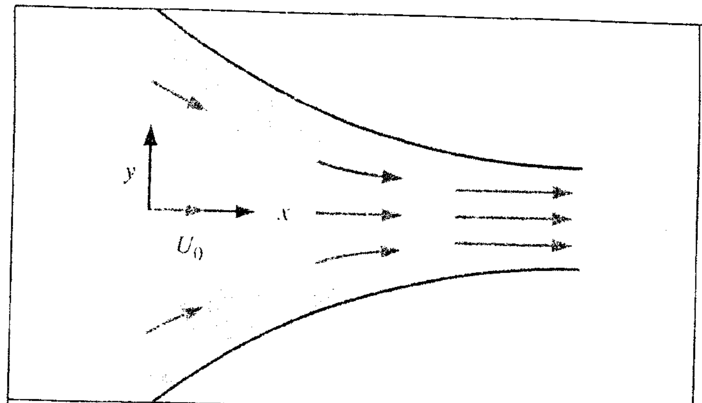


Fig. 1: Flow through convergent duct, Q2

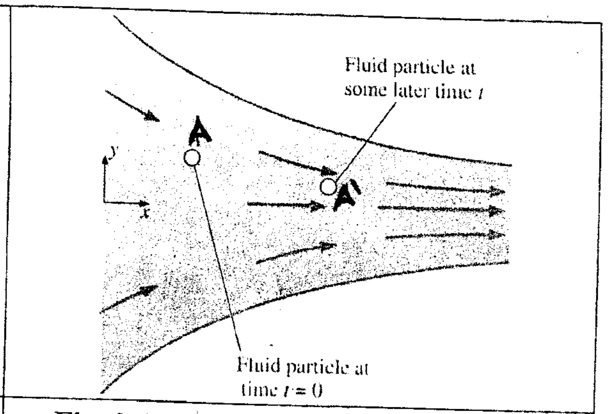


Fig. 2: Flow of a fluid particle (*A*), Q2

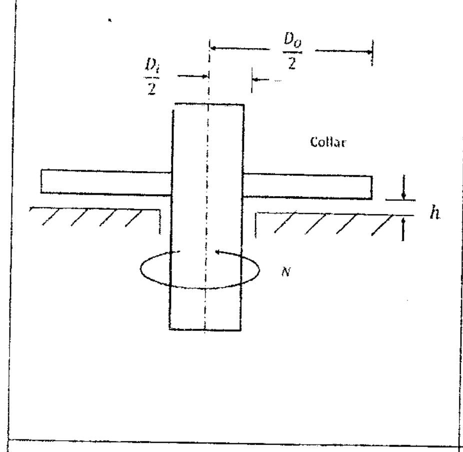


Fig. 3: Rotating shaft in a bearing Q3

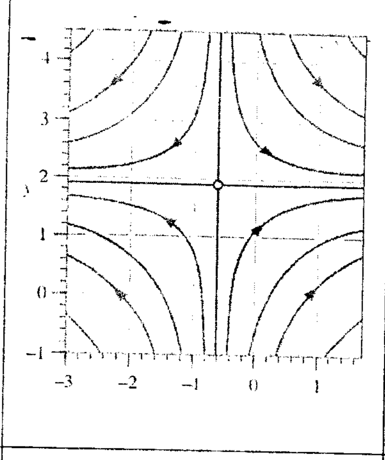


Fig. 4 Fluid element for Q.4

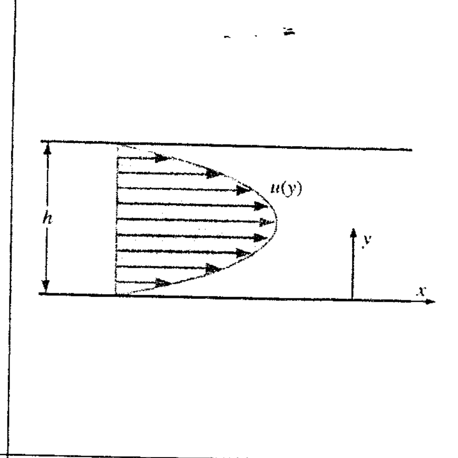


Fig. 5: 2D planar Poiseuille flow Q4

Navier – Stokes equations in Cartesian coordinates.

In x direction
$$\rho\frac{Du}{Dt} = -\frac{\partial P}{\partial x} + \rho g_x + \mu\nabla^2 u$$

In y direction
$$\rho\frac{Dv}{Dt} = -\frac{\partial P}{\partial y} + \rho g_y + \mu\nabla^2 v$$

In z direction
$$\rho\frac{Dw}{Dt} = -\frac{\partial P}{\partial z} + \rho g_z + \mu\nabla^2 w$$

Best of Luck — *Dr. Ahmed Abdo*

Course Title	Refrigeration and Air-Conditioning (a)	Academic Year 2022/2023 **First** Semester Exam	Course Code	MEP3107
Year/ Level	3rd Year Mechanical Power			
Date	22-January-2023	No. of Pages (4)	Allowed time	3 hrs
			Total Assessment Marks: 85	

Remarks: Request from the Exam Committee:
Kindly allow students to use their Refrigeration and Air-Conditioning Tables and Charts, however students are not allowed to write in or exchange these materials.

Notes for Students: Neat and clear answers will be appreciated. State the assumptions used.

Question Number (1) [17 points]

a) List the **main different applications** of refrigerant? [05 points]

b) In brief, **classify** the different types of **refrigerants** used in refrigeration systems. [04 points]

c) A combined aircraft cooling cycle is illustrated as follow: Ambient air passes through ram diffuser, main compressor, first heat exchanger, secondary compressor, second heat exchanger, evaporative cooler heat exchanger, third heat exchanger, regenerator heat exchanger, cooling turbine and then passes through the cabin before exiting to atmosphere. 40% of cabin mass flowrate is extracted after ram diffuser and used to cool the primary air in the first and second heat exchanger (20% for each one). 10% of cabin mass flowrate is extracted after ram diffuser and expanded in secondary turbine, which is combined with the cooling turbine, this air is used to cool the primary air in the third heat exchanger. 10% of cabin mass flowrate is extracted after the cooling turbine and used to cool the primary air in the regenerator heat exchanger. The combined cycle has the following data: Load 30 TR. Ambient temperature and pressure are -55°C and 0.15 bar. Ram efficiency is 90% and Mach number is 1.2. Main compressor pressure ratio is 4 with 90% isentropic efficiency, while secondary compressor pressure ratio is 1.25 with 80% isentropic efficiency. Cooling turbine isentropic efficiency is 90%, while secondary turbine is 95%. Cabin pressure and temperature are 1 bar and 25°C. Temperature of primary air leaving the first heat exchanger is 60K lower than the temperature of air leaving the main compressor. Temperature of primary air leaving the second heat exchanger is 100K lower than the temperature of air leaving the secondary compressor. Primary air temperature drops through evaporative cooler heat exchanger, third heat exchanger and regenerator heat exchanger are 40K, 25K and 8K, respectively. Pressure drops in the first and second heat exchanger is 0.2 bar each one, while pressure drop in evaporative cooler heat exchanger, third

heat exchanger and regenerator heat exchanger is 0.05 bar each one. Refer to cabin mass flow rate by $\dot{m}$ in system mass balance. **Required only**: Schematic diagram and T-S diagram showing all points. [08 points]

Question Number (2) [17 points]

a) In brief, classify the compressors used in vapor compression refrigeration systems. [04 points]

b) Expansion valves serve two purposes. Explain? What are the main types of expansion valves? [04 points]

c) Compare the COP of the vapor compression cycle that uses wet compression (so that gas leaving compressor is dry saturated), dry saturated compression and superheated compression with gas entering compressor having 15 K superheat. In all cases R-134a is the refrigerant, condensing temperature is 313 K and evaporating temperature is 253 K. Assume simple ideal vapor compression cycle. [09 points].

Question Number (3) [17 points]

a) Illustrate **using sketches** the flow diagram and P-h chart of the **cascade** vapor compression cycle. Discuss the **applications** where it can be used. [06 points]

b) An ammonia refrigeration system, Fig. (1), consists of two compressors, two evaporators, flash intercooler & subcooler heat exchanger and a condenser. Ammonia vapour condenses in the condenser at 40 °C. the amount of liquid refrigerant, which goes to the low temperature evaporator, is subcooled 10 °C in the liquid subcooler and another 10 °C in the liquid vapour heat exchanger. Vapour leaves the L.P. evaporator saturated at -30 °C, then it is superheated in the heat exchanger at the same pressure. All vapour comes out the flash intercooler and H.P. evaporator saturated at 4 bar. The cooling capacities of the L.P. and H.P. evaporators are 10 T.R. and 25 T.R. respectively. **Draw** the P-h chart and **calculate:** (i) Refrigerant mass flow rate through each evaporator, (ii) Refrigerant mass flow rate through each evaporator compressor, (iii) Power required for each compressor, (iv) Heat rejected from the condenser, (v) COP. [11 points]

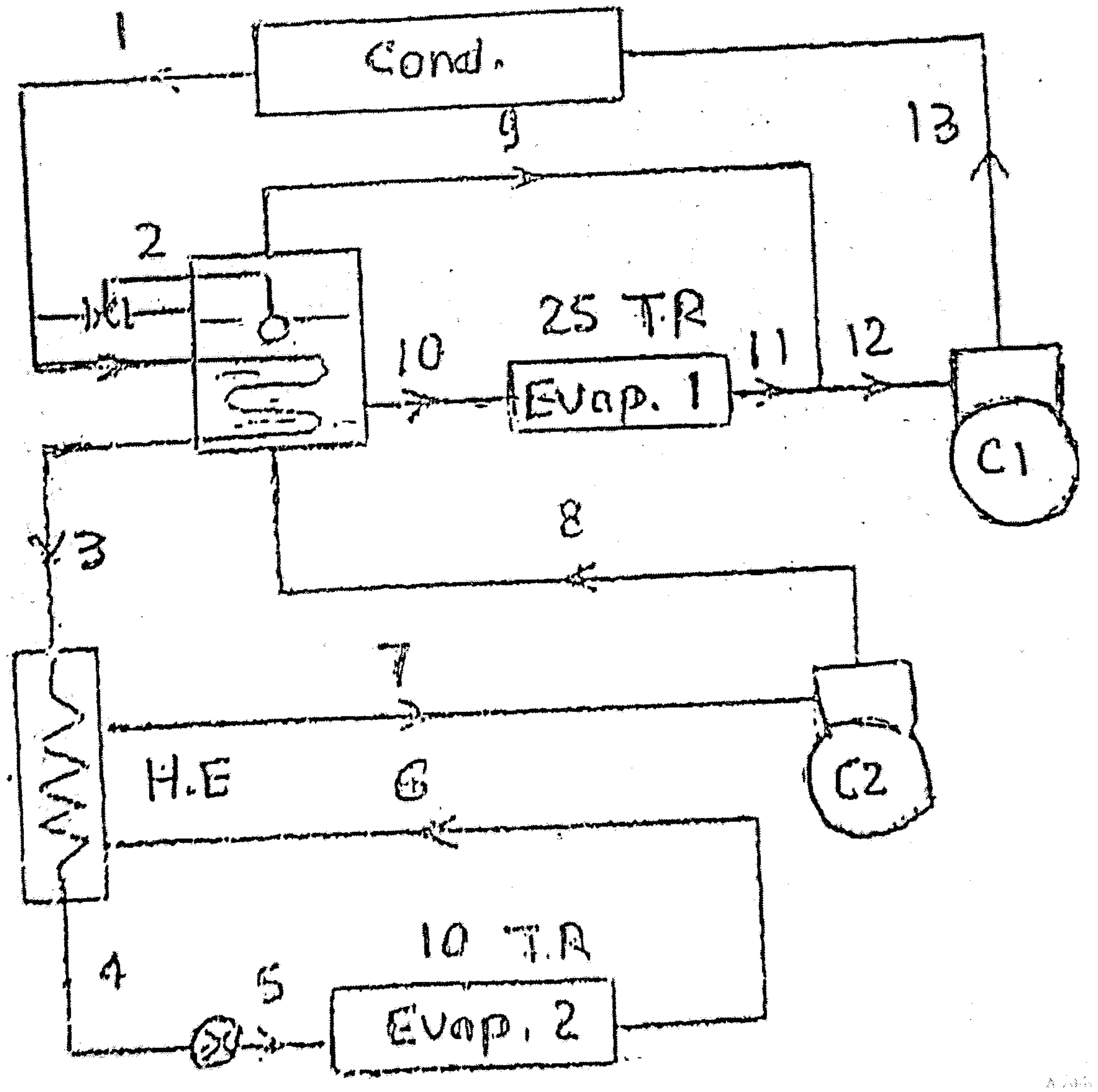


Fig. (1)

Question Number (4) **[18 points]**

a) **Deduce** the relation of the **COP_{max}** of the simple **absorption** refrigeration cycle. **Explain** briefly. [05 points]

b) Compare between the aqua-ammonia and lithium bromide-water absorption cycles. [04 points]

c) For a Lithium bromide-water system Fig. (2), fitted with a heat exchanger between the generator and the absorber, if: the condensing temperature is 38 °C, the evaporating temperature is 4 °C, temperature of weak solution leaving the absorber is 38 °C, temperature of weak solution entering the generator is 82 °C, the generator temperature is 93 °C, the

steam temperature is 104 °C, the ambient temperature is 38 °C, the store temperature is 7 °C, and system refrigeration capacity is 10 T. R.. Neglect the pressure drop on the lines and in the components; and assuming states 3, 4, 8 and 10 are saturated, determine: (i) Coefficient of performance of the system, (ii) Steam consumption, (iii) Relative efficiency. [09 points]

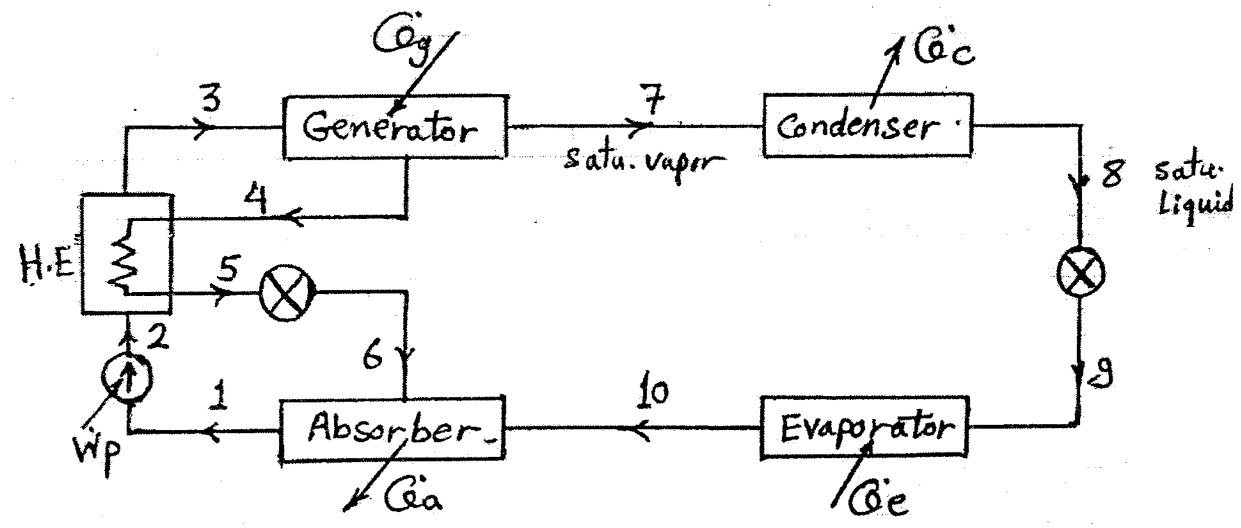


Fig. (2)

Question Number (5) **[16 points]**

a) Illustrate using **sketch** the complete flow diagram of the steam jet refrigeration system. Explain the steam jet refrigeration **principles**. [06 points]

b) In a steam jet refrigeration unit receives dry and saturated steam with a pressure of 5 bar at the nozzle and operates with a chilled water temperature of 8 °C. The efficiency of the nozzle is 84 % and that of the diffuser is 80 %. The ratio of motive steam flow to vapour flow from the evaporator is 8.4 to 1. Flashed vapour velocity is 60 m/s. Calculate the condenser pressure to which the jet compressor can discharge and the coefficient of performance of the refrigeration unit. [10 points]

End of questions.............

Best of Luck *Dr. Ahmed Mostafa Khaira*

Tanta University

Mechanical Engineering Department
Academic Year 2022/2023
First Semester - Final Exam

Faculty of Engineering

Third Year Mechanical Power Engineering				
Course Title	Heat Transfer - 2	No. of Pages (3)	Date	Saturday (12/01/2023)
Course Code	MEP 3108		Allowed time	3 hrs

Request from the Exam Committee:
Kindly allow students to use their personnel **Heat Transfer Tables and Formula Sheet**.

يسمح للطالب باستخدام الجداول و المعادلات الخاصة بانتقال الحرارة

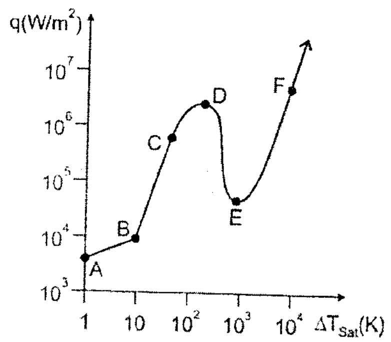
Notes for Students: Assume any missing data and please state all your assumption clearly

Answer **all** following **Five** questions. The **maximum total mark** of this exam paper is **75**.

Question No. 01: (Total mark is 11)

a) Select the correct answer?

1. Which of the following is/are example/s of pool boiling?
   - A. boiling of liquid in a kettle placed on stove
   - B. completely submerged electrically heated coil in pool of liquid
   - C. both a. and b.
   - D. none of the above
2. Which type of boiling occurs in steam boilers employing natural convection?
   - A. Pool
   - B. Local
   - C. Saturated
   - D. Forced convection
3. Dropwise condensation usually occurs on
   - A. oil surface
   - B. coated surface
   - C. glazed surface
   - D. smooth surfac
4. In the following boiling curve, curve C-D represents ....
   - A. pure convection with liquid rising to surface for evaporation
   - B. Nucleate boiling with bubbles condensing in liquid
   - C. Nucleate boiling with bubbles rising to surface.
   - D. Partial Nucleate boiling



b) In a fire tube boiler, the hot flue gases is flowing through 50 m long, 5 cm outer diameter mechanically stainless steel pipes which are polished and submerged in water. The water is required to be boiled at 150°C while the outer surface temperature of the heating pipes is 165°C, determine: (a) the rate of heat transfer from the hot gases to water, (b) the rate of evaporation.

Question No. 02: (Maximum mark is 16)

A room is arranged on the side of a building. The wall of the room is 13 m long and 3.5 m high. wall is 0.25 m thick and have an effective thermal conductivity of 1.5 W/m. °C. Consider conditions for which the ambient air is in parallel flow over the outer surface of the wall with 7 m/s and 40 °C. the inside air quiescent and is maintained at 20 °C. °C. Estimate: (a) outer heat transfer coefficient, (b) inner heat transfer coefficient and (C) the rate at which heat is lost through the room.

الأسئلة مستمرة بالصفحات 3/2 & 3/3

Question No. 03: (Maximum mark is 16)

The exhausted gases from a combustion process are conveyed to an industrial application through a thin-walled metallic pipe of diameter with D_p = 1 m and length L_p = 100 m. The gases enter the duct at atmospheric pressure 1 atm, mean temperature $T_{m,i}$ = = 1600 K and velocity of and $V_{m,i}$ = 10 m/s. the gases must exit the duct at a temperature that is no less than $T_{m,o}$ = 1400 K.

Determine the minimum thickness of an alumina-silica insulation (k_{ins} = 0.125 W/m K) needed to meet the outlet requirement under worst case conditions for which the duct is subjected to ambient air at T_∞ = 250 K and a cross-flow velocity of V_∞ = 10 m/s.

Hints:

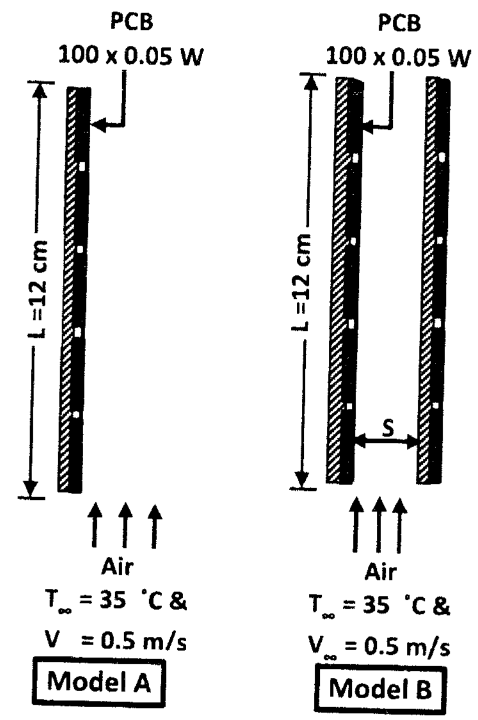
- Consider that the properties of the gases may be approximated as those of air,
- Consider that the outer convection coefficient or the outer convection resistance of the configuration is approximately the same whether the pipe is covered with insulation or not.

Question No. 04: (Maximum mark is 16)

A 12-cm-high and 20-cm-wide circuit board houses 100 closely spaced logic chips on its surface, each dissipating 0.05 W. The board which can be thought of as a more or less flat plate is cooled by a fan that blows air upwards along the 12-cm-long side hot surface of the board at inlet condition 35°C at a velocity of 0.5 m/s. The heat transfer from the back surface of the board is negligible. For each of the two given models (Model A is a single board and Model B is an array of boards with spacing S equal S_{opt}), determine the average temperature on the hot surface of the circuit board for each of the followings cases:

a) The natural convection is ignored
b) The natural convection is not ignored and a mixed convection should be considered.

Disregard any heat transfer by radiation for both cases.



(**Hint:** As a first guess you might assume the average surface temperature is 58°C, this is to get the thermophysical properties, however, after you determine a new value for the average temperature, you can repeat the solution, if necessary. Acceptable tolerance can be considered as ±5°C).

الأسئلة مستمرة بالصفحة التالية 3/3

Question No. 05: (Maximum mark is 16)

For specific industrial operation, it is required to heat a 2.5 kg/s flow rate of water from 15 to 85 °C. The heating may be accomplished by available hot engine oil at 160 °C which can be cooled down to 100°C. To perform this process a shell-and-tube heat exchanger has to be designed such that the water passes inside the tubes while the engine oil passes through the shell side of the exchanger. It is proposed to use ten thin walled tubes of diameter D = 25 mm, and each tube makes eight passes through the shell. The oil is known to provide an average convection coefficient of h_o = 400 W/m^2 K on the outside of the tubes. For these given parameters, determine the followings:

a) required flow rate for the oil,
b) effectiveness of the heat exchanger
c) NTU of the heat exchanger,
d) overall heat transfer coefficient
e) required length of the tubes.

End of Exam, Best Wishes نهاية الأسئلة صفحة 3/3

Prof. Yasser Elsamadony and Dr. Khaled Khodary

الفرقة الثالثة ميكانيكا (انتاج وقوى)

TANTA UNIVERSITY
FACULTY OF ENGINEERING
PRODUCTION ENG. & MECH. DESIGN DEPT.
MECHANICAL POWER ENG. DEPT.

3rd YEAR 2022-2023
DATE: 10/1/2023 TIME: 3 HOURS
MPD 3115:THEORY OF VIBRATIONS
MPD 3153:THEORY OF VIBRATIONS

FINAL TERM EXAM

Question 1 (20% Marks)

An electric motor of mass M, mounted on an elastic foundation, is found to vibrate with a deflection of 0.15 m ***at resonance***. It is known that the unbalanced mass of the motor is 8% of the mass of the rotor due to manufacturing tolerances used, and the damping ratio of the foundation is ζ=0.025. Determine the following:

a) The eccentricity or radial location of the unbalanced mass (e).
b) The peak deflection of the motor when the frequency ratio varies from resonance.
c) The additional mass to be added uniformly to the motor if the deflection of the motor at resonance is to be reduced to 0.1 m.

Question 2 (25% Marks)

A shaft, carrying a mid-way rotor of weight 100 N and eccentricity 0.1 cm, rotates at 1200 rpm. Assume the stiffness of the shaft as 0.2 MN/m and the external damping ratio as 0.1. Determine the following:

a) The steady-state whirl amplitude and the force transmitted to each bearing.
b) The maximum whirl amplitude.
c) The shaft diameter, if the shaft length is 200 mm and the allowable bending strength is 70 MPa.
d) What is the critical speed and what will be the change in this critical speed if elastic bearings are added instead of the rigid bearings.

Question 3 (20% Marks)

A rotating machine having a mass of 2000 kg rests on springs with a static deflection of 0.007 m. When the machine runs at 1000 rpm, the unbalance rotating force is 3300N. The ratio of two consecutive amplitudes in free vibration is 1 to 0.83, determine the following:

a) The dynamic amplitude, the transmitted force and the transmissibility at this speed.
b) What will happen to the amplitude and the transmitted force if the speed of the machine is reduced?

Prof. Samy Assal

Question 4 (25% Marks)

The basic principle of vibration control in most practical cases is to keep the natural frequencies low. One of the approaches to achieve this principle is to study the effect of the coupling between coordinates on the natural frequencies. For the simple model of an automobile shown in **Fig. 1**, the *position* of the suspension has an effect on the *coupling* between coordinates and thus on the *natural frequencies*.

a) Derive the equations of motion using Lagrange's method, and then derive the condition for decoupling the coordinates.
b) Compare between the two cases (coupled and decoupled); which is better according to the principle mentioned above. Take I_G=2Ma^2 and for the coupled case a =0.25 L.

Question 5 (25% Marks)

A machine of mass 150 kg with a rotating unbalance of 0.5 kg.m is placed at the mid span of a 2 m long simply supported beam. The machine operates at a speed of 1200 rpm. The beam has an elastic modulus of 210×10^9 N/m^2 and a cross section moment of inertia of 2.1×10^{-6} m^4 with an assumed damping factor of 0.3.

a) Determine the steady state response.
b) In the *absence of damping*, design a dynamic vibration absorber such that when attached to the mid span of the beam, the vibration of the beam will be ceased and the absorber amplitude will be 20 mm.
c) The two natural frequencies of the new system.
d) The force transmitted to each of the support of the beam for the new system.

For simple supported beam $k=\frac{48EI}{L^3}$.

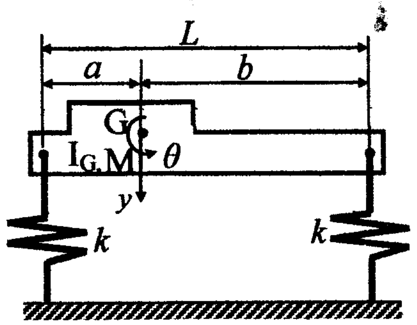


Fig. 1

Best Wishes for all