Tanta University	Production Engineering and Mechanical Design Department **Total marks: 85 Marks**	Faculty of Engineering

Course Title: Theory of Vibrations **Course Code:** MPD3153 **Year:** 3rd year Mech. Power. Eng.	**Final exam**	**Date:** 29 / 1 / 2022 **Allowed time:** 3 Hours **No. of pages:** 2 pages

Solve the following questions **(Total marks 85)**

Q1- Find the equation of motion and the natural frequency for the mechanical system shown in Fig. 1, motion in terms of $\boldsymbol{x}$ using the **energy method**. The disk A rolls without slipping and the pulley B rotates around the fixed center O.

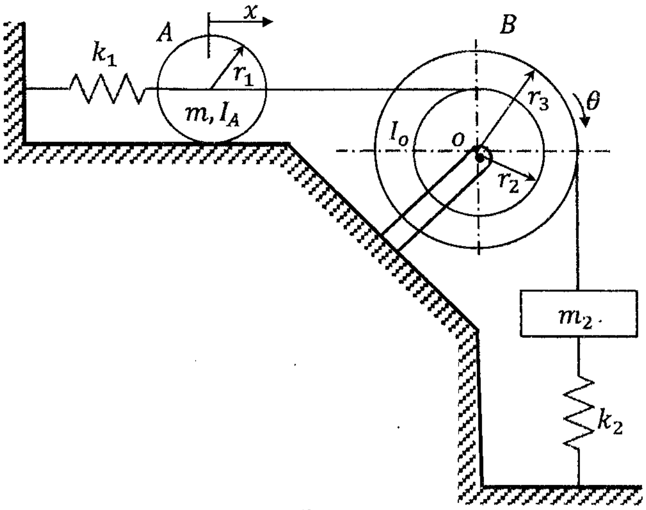


Fig. 1.

Q2- For the mechanical system shown in Fig. 2, the uniform bar has mass moment of inertia $\boldsymbol{I}$ and pinned at point $\boldsymbol{O}$. Find the equation of motion in terms of $\boldsymbol{\theta}$ using **Lagrange's formula**. Also, find the damping ratio and natural frequency.

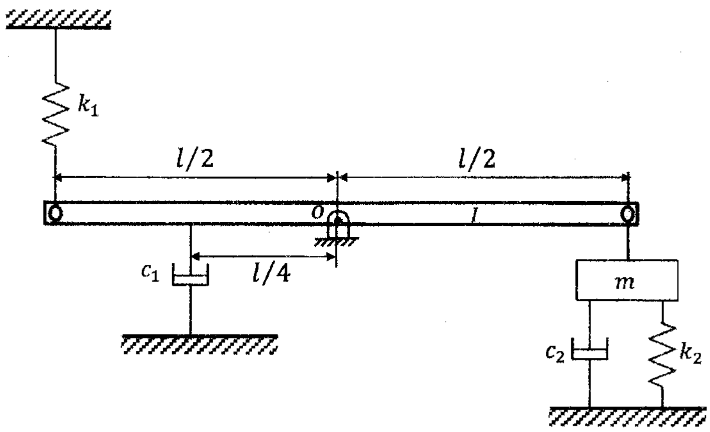


Fig. 2.

Q3- In a spring mass system, the mass is $10\ Kg$, the spring stiffness is $16\ KN/m$ and the damping constant is $1600\ N.s/m$. the mass is displaced by 0.01 m and released with a velocity $2\ m/s$ in the direction of return motion. Find

(a) Circular frequency.

(b) Damping ratio.
(c) Displacement after 0.01 s.

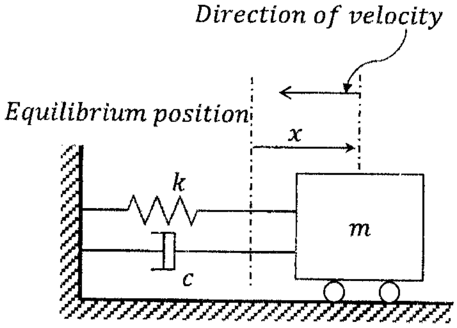


Fig. 3.

Q4- A vibrating system having 50 Kg mass and spring stiffness of 500 N/m is having dry friction damping with limiting frictional force equal to 6 N. If the mass is given initial displacement of 300 mm, find:

(a) Reduction of amplitude per cycle.
(b) Number of cycles before stopping.
(c) Time elapsed before stopping.
(d) Distance at which the mass stops from the mean position.

Q5- A machine of 100 Kg mass is supported on springs of total stiffness 700 KN/m and has an unbalanced rotating element, which results in a disturbing force of 300 N at a speed of 2500 rpm. Assuming a damping ratio of 0.25, determine:

(a) Amplitude of vibration.
(b) Transmissibility.
(c) Transmitted force.

Q6- Consider a viscously damped two-degree-of-freedom spring-mass system shown in Fig. 4. The motion of the system is completely described by the coordinates $x_1(t)$ and $x_2(t)$ which define the positions of the masses m_1 and m_2 at any time t from the respective equilibrium positions. The external forces $f_1(t)$ and $f_2(t)$ act on the masses m_1 and m_2, respectively. Find:

a) the equations of motions in matrix form;
b) the natural frequencies, the normal modes and mode shapes when $k_1 = 30\ N/m$, $k_2 = 5\ N/m$, $k_3 = 0\ N/m$, $m_1 = 10\ Kg$, $m_2 = 1\ Kg$, $c_1 = c_2 = c_3 = 0\ N.s/m$.

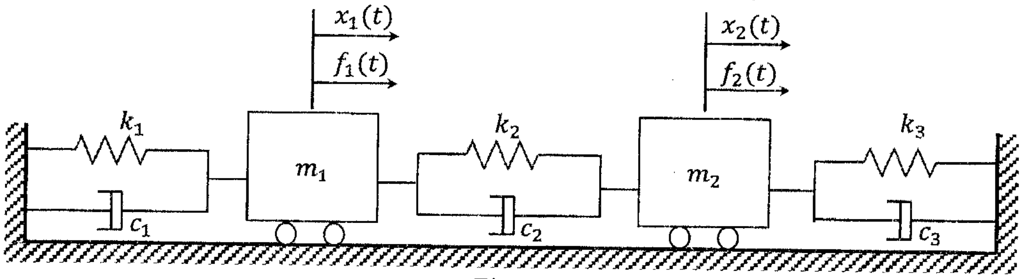


Fig. 4.

With best wishes
Dr. Abdelhameed Zayed

Tanta University Faculty of Engineering Mech., Power Engineering Dept. 3rd Year Power Mechanics, 1st term Examiner: Dr. Ayman Refaat	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: 25-01-2022

Question (1) (15 Marks)

1. **Derive Darcy** formula for loss of head due to friction in pipelines? **(5.0 Marks)**

2. One end of a horizontal pipe 40 cm in diameter, 100 m long, and 0.80 cm wall thickness is connected to a water tank in which the water level height is 10 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. Taking the minor losses into account, 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) The pressure rise if the valve of the pipeline is suddenly closed with the transmission of water at maximum power. Take the Bulk's modulus of elasticity of water is $2.1*10^9$ Pa, and Young's modulus of elasticity of the pipe material is $21*10^{10}$ Pa. **(8.0 Marks)**

3. **Define** the following expressions:

(a) Hydraulic mean depth (b) Hydraulic inertia **(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. A pipe 50 cm diameter and 5000 m long connects two reservoirs **A** and **B.** The difference between their water levels is 25 m. Half way along the pipe there is a branch, which is connected to a third reservoir **C.** Neglecting the minor losses, and $f = \mathbf{0.024}$. **Determine** the water discharge supplied to the reservoir **B**, if

(a) No water is supplied to reservoir **C**,

(b) The water discharge supplied to reservoir **C** is 0.12 m^3/s. **(8.0 Marks)**

Question (3) (15 Marks)

1. **Derive** the discharge formula for flow through a By-pass over the main pipe? **(4.0 Marks)**

2. A pipeline *ABC* 180 m long is laid on an upward slope of 1:50. The length of portion *AB* is 90 m and its diameter is 15 cm. At section *B*, the pipe suddenly enlarged to 30 cm diameter so up to section

C for a length of 90 m. The water flow rate is 55 L/s and the pressure head at section *A* is 14.28 m. Assume (f =0.02). **Determine** the pressure head at section *C* and clearly **draw the hydraulic gradient and total energy lines.** **(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 1500 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 total cost of the channel if the cost of 1 m^2 of the wetted area of lining is 125.0 L.E.
   (c) If 10% 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. **Writes down** the methods that are used to avoid water hammer problem in pipe lines. **(3.0 Marks)**

Question (5) (15 Marks)

1. **Draw clearly** the circuit of simple hydraulic system, indicating the names of its hydraulic elements. **(3.0 Marks)**
2. **Derive** an expression for hydraulic resistance of **turbulent flow** through hydraulic transmission line and expresses the power loss in the transmission line. **(5.0 Marks)**
3. Hydraulic pump 10 L/s discharge if the hydraulic tank is open and the suction transmission line has 2 m length and 80 mm diameter. While the delivery transmission line has 12 m length and 60 mm diameter. Given that the oil kinematics viscosity is $1*10^{-4}$ m^2/s and the oil density is 900 kg/m^3. **Calculate;**
   (a) Hydraulic resistance of each line of the pump;
   (b) Pump head if the static head is 6 m;
   (c) Hydraulic output power **(7.0 Marks)**

With My Best Wishes

Tanta University	Mechanical Engineering Department Academic Year 2021/2022 First Semester - Final Exam	Faculty of Engineering

Third Year Mechanical Power Engineering

Course Title	Heat Transfer - 2	No. of Pages (2)	Date	Saturday (22/01/2022)
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**.

Notes for Students:

- Assume any missing data and please clearly demonstrate all of your assumption
- Answer **all** following questions. The **maximum total mark** of this exam paper is **75**.

Question No. 01: (Total mark is 10)

a) Compare between filmwise condensation and dropwise condensation with respect to its shape and heat transfer coefficient value (explain why they are equal or one is higher than the other)?

b) Discuss all main factors that may have an influence on the boiling process?

c) Draw the pool boiling curve for a fluid (surface heat flux as a function of excess temperature (Ts-Tsat)? On this curve:

- Show and named all different pool boiling regimes? Then explain the mechanism of each regimes and explain why surface heat flux value increases or decreases in each regimes as excess temperature (Ts-Tsat) increases?

Question No. 02: (Maximum mark is 20)

Air at 3.5 MPa and 38 °C flows across a tube bank consisting of 400 tubes of 1.25 cm outer diameter arranged in a staggered manner 20 rows high, SL = 3.75 cm and ST= 2.5 cm. The incoming flow velocity is 9 m/s, and the tube wall temperatures are maintained constant at 200 °C by a condensing vapour on the inner side of the tubes. The length of tubes is 1.5 m. Estimate the exit air temperature, total heat transfer rate and air side pressure drop

Question No. 03: (Maximum mark is 15)

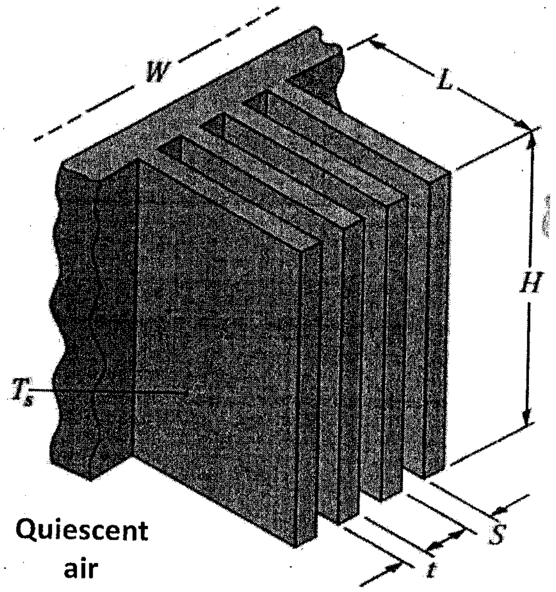
A thin-walled, uninsulated 0.3-m-diameter duct is used to route chilled air at 0.05 kg/s through the attic of a large commercial building. The attic air is at 37°C, and natural circulation provides a convection coefficient of 2 W/m^2 K at the outer surface of the duct. If chilled air enters a 15-m-long duct at 7°C, what is its exit temperature and the rate of heat gain? Properties of the chilled air may be evaluated at an assumed average temperature of 300 K.

Question No. 04: (Maximum mark is 15)

Consider a vertical array heat sink of equally spaced fins of rectangular profile, which is to be used to cool an electronic device mounted in quiescent, atmospheric air at T_∞ = 27°C. Each fin has L = 20 mm and H = 150 mm and operates at an approximately uniform temperature of T_s = 77°C.

a) Determine the optimum value of fin spacing S for the prescribed conditions.

b) For the optimum value of S and a fin thickness of t = 1.5 mm, determine the rate of heat transfer from the fins for an array of width W = 355 mm.



Question No. 05: (Maximum mark is 15)

In a design process of a shell and tube heat exchanger, flow of 2.5 kg/s of water must be heated from 15 to 85 °C. The heating processes is to be achieved by passing hot engine oil, which is available at 160 °C, through the shell side of the heat exchanger. The oil is known to provide an average convection coefficient of h_o = 400 W/m^2·K on the outside of the tubes. Ten tubes pass the water through the shell, and each tube makes eight passes through the shell. The tubes are thin walled highly conducting material of diameter D = 25 mm. Determine the oil mass flow rate, if it should leave the exchanger at 100 °C. How long must the tubes be to accomplish the desired heating?

End of Exam, Best Wishes

Prof. Yasser Elsamadony and Dr. Khaled Khodary

Tanta University	Advanced Fluid Mechanics 3rd Year Mechanical Power Engineering	Faculty of Engineering
First Term Exam	Course Code: MEP3113	Mechanical Power Eng. Dept.
Time Allowed: 3hrs	Total Assessment Marks: 85	February 1, 2022

Please, answer the following questions:

Question (1) (15Marks)

Water flowing from the oscillating slit shown in **Fig. 1** produces a velocity field given by:

$$\mathbf{V} = u_0 \sin[\omega(t - y/v_0)]\hat{\imath} + v_0\hat{\jmath}$$

where u_0, v_0 and ω are constants. Thus, the y component of velocity remains constant ($v = v_0$) and the x component of velocity at $y = 0$ coincides with the velocity of the oscillating sprinkler head [$u = u_0\sin(\omega t)$ at $y = 0$].

a) Determine the function of streamline that passes through the origin at ($t = 0$)
b) Plot the streamline at ($t = 0$) for different y values given in Table 1

Table 1 Given y Values:

0	$\pi v_0/\omega$	$2\pi v_0/\omega$	$3\pi v_0/\omega$	$4\pi v_0/\omega$

Question (2) (20Marks)

1. A particle moves around the circular path $x^2 + y^2 = 9$ m^2 at a uniform speed of 4 m/s. Express the u and v components as functions of **time**, assuming $\theta = 0$ at $t = 0$. See Fig. 2.

2. As a valve is opened, water flows through the diffuser shown in **Fig. 3**. At an increasing flowrate so that the velocity along the centerline is given by:

$$\mathbf{V} = u\hat{\imath} = V_0(1 - e^{-ct})(1 - x/l)\hat{\imath}$$

where V_0, c and l are constants.

a) Determine the acceleration as a function of x and t
b) If $V_0 = 10$ ft/s and $l = 5$ ft. What value of c (other than zero) is needed to make the acceleration zero for any x at $t = 1$ s?. Explain how the acceleration can be zero if the flowrate is increasing with time.

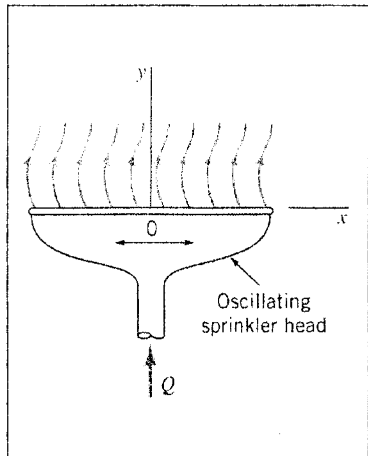


Fig. 1 Oscillating slit

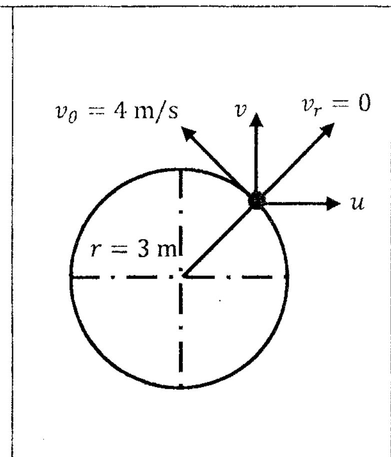


Fig. 2 Particle circular motion

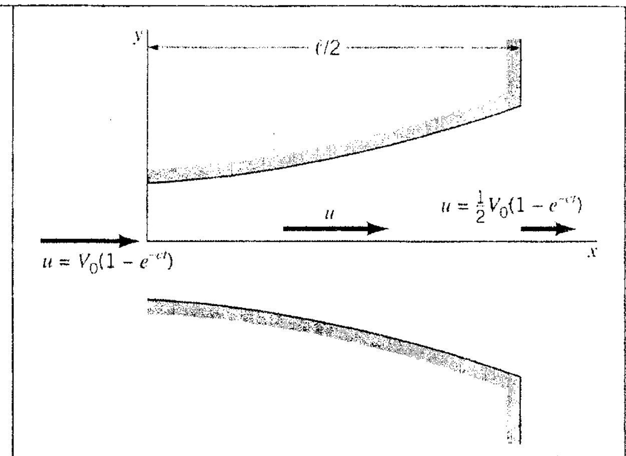


Fig. 3 Flow through a diffuser

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 a collar bearing for the rotating shaft given in Fig. 4. The outer and inner diameters of the collar are Do (m) and Di (m) respectively and the rotating speed is N (rpm). The oil film thickness is h (m) and the oil has a dynamic viscosity of μ (Ns/m^2).

3. Determine the oil film thickness between the plates of a collar bearing of 0.25 m inner diameter and 0.40 m outer diameter transmitting power, if 60 watts was required to overcome viscous friction while running at 600 rpm. The oil used has a viscosity of 30 centi-Poise (0.03 Ns/m^2).

Question (4) (25Marks)

1. A wide moving belt passes through a container of a viscous liquid. The belt moves vertically upward with a constant velocity W_0, as illustrated in **Fig. 5**. Because of viscous forces the belt picks up a film of fluid of thickness h. Gravity tends to make the fluid drain down the belt. Use the Navier–Stokes's equations to determine an expression for the followings:
a) The velocity distribution of the fluid film as it is dragged up by the belt
b) The volume flow rate per unit width

Assume that the flow is laminar, steady, and fully developed. Also, the shearing stress at the free surface is zero

2. Consider the fully developed two-dimensional planar Poiseuille flow (flow between two infinite fixed parallel plates), see **Fig. 6**. 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

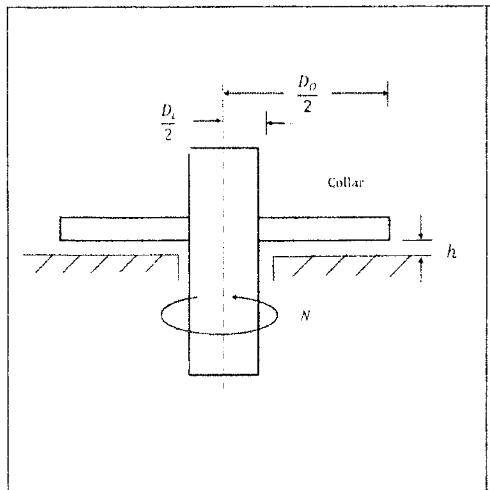


Fig. 4 Rotating shaft in a bearing

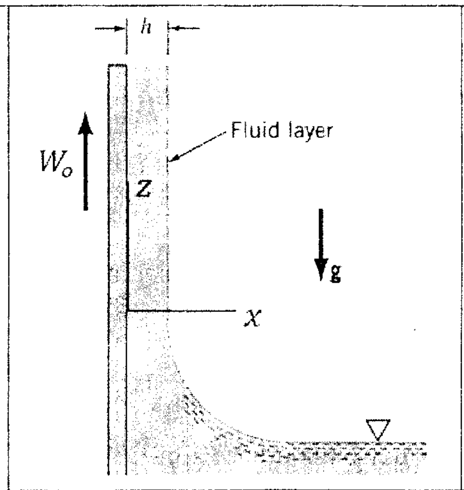


Fig. 5 Dragged fluid by a belt

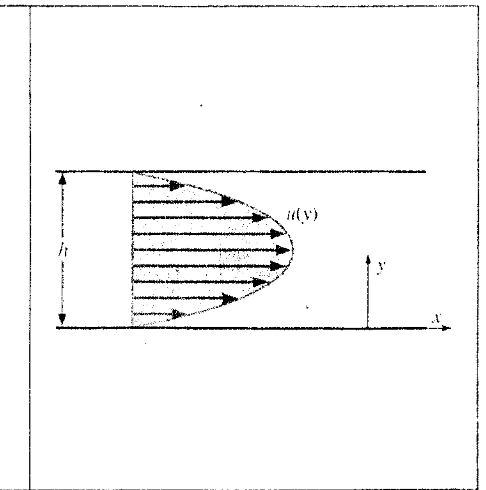


Fig. 6 2D planar Poiseuille flow

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 2021/2022	Course Code	MEP3107
Year/ Level	3rd Year Mechanical Power	First Semester Exam		
Date	15-January- 2022	No. of Pages (2)	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) [16 points]

a) List the most important **desirable properties** for a **refrigerant**? [4 points]

b) List the **main advantages** and **disadvantages** of the **capillary tubes**? [4 points]

c) Even though the COP of air refrigeration systems is very low compared to vapour compression refrigeration systems, it is still found to be most suitable for aircraft refrigeration systems. **Explain**? [4 points]

d) Draw flow diagram and T-S chart for **Regenerative** air-cooling system. [4 points]

Question Number (2) [18 points]

a) A simple vapour compression cycle works between fixed pressure limits. List three methods to improve its coefficient of performance. [4 points]

b) In brief, classify the compressors used in vapor compression refrigeration systems. [4 points]

c) A R-12 refrigerator works between the temperature limits – 10°C and 30°C. The compressor employed is single cylinders single-acting compressor having a stroke of 20 cm, bore diameter of 15 cm, and volumetric efficiency of 85%. The compressor runs at 500 r.p.m. The refrigerant is sub-cooled, and it enters at 22°C in the expansion valve. The vapour is superheated and enters the compressor at – 2°C. Work out the following: 1) Show the process on p-h diagrams. 2) The amount of refrigerant circulated per minute. 3) The refrigeration capacity in T.R. 4) The C.O.P. of the system. [10 points]

Question Number (3) [16 points]

a) Discuss the **applications of flash chamber** with the help of P-h chart and schematic diagrams. [4 points]

b) A refrigeration system uses **R22** contains one compressor and two evaporators with individual expansion valves and back-pressure valve as shown in figure (Fig. Q-3). The low temperature evaporator has a refrigerating capacity of 5 tons and operates at T_{ev1}= – 20°C. The higher temperature evaporator has a capacity of 3 tons and operates at T_{ev2} = – 5°C. The cycle is ideal, and the condenser pressure is 16 bars. **Work out the following:**

(i) Show the cycle on p-h diagrams.

(ii) Refrigerant mass flow rate through each evaporator and compressor ($\dot{m}_{R1}$, $\dot{m}_{R2}$, $\dot{m}_c$).

(iii) The compressor power input.

(iv) The condenser capacity.

[12 points]

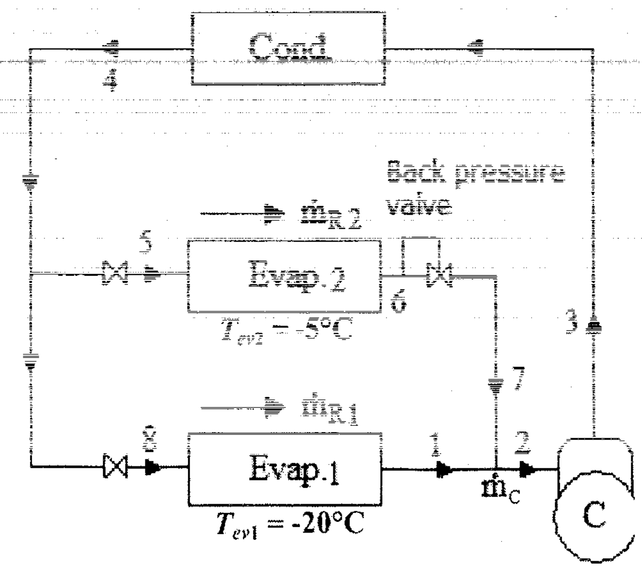


Fig. Q-3

Question Number (4) [20 points]

a) List the main advantages and disadvantages of the absorption refrigeration unit? [5 points]

b) A 1000 TR capacity absorption system uses lithium-bromide water solution with a heat exchanger that heats the weak solution from the absorber by the strong solution returning from the generator to the absorber. Assume saturated conditions for states: entering generator, strong solution leaving generator, leaving condenser, and leaving evaporator. Draw the flow diagram of the cycle and use the following data:

Temperature:		**Entering condenser**	105 °C
In evaporator	5 °C	**Leaving condenser**	45 °C
Leaving absorber	40 °C	**Entering generator**	80 °C
Strong solution leaving generator	100 °C	**Strong solution leaving H.E.**	60 °C

Determine the properties of all state points and find COP of the cycle. [15 points]

Question Number (5) [15 points]

a) List the main advantages and disadvantages of the steam jet refrigeration system? [5 points]

b) A steam jet refrigerator unit is supplied with dry and saturated steam at 5.5 bar. The evaporator pressure is 0.016 bar and steam to vapour ratio is 1.7 to 1. All processes in the nozzle and diffuser are reversible adiabatic. Calculate the pressure to which the jet compressor can discharge. [10 points]

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

Best of Luck | *Dr. Ahmed Mostafa Khaira*