B12

Tanta University

Production Engineering and Mechanical Design Department

Total marks: 85 Marks

Faculty of Engineering

Course Title: Theory of Machines
Course Code: MPD2109+MPD2150
Year: 2nd year Mech. Eng.

Final exam

Date: 14 / 01 / 2023
Allowed time: 3 Hour
No. of pages: 2 page

Solve the following questions

Q1- (17 Marks)

The crank AE of the mechanism shown in Fig. 1 has angular velocity of 60 *rpm* clockwise. Draw the space, velocity and acceleration diagrams. Find the accelerations of points B and C and the angular accelerations of links BC and CD. The lengths of the links are as follows:
AE = 150 *mm*, OB = 400 *mm*, BC = 600 *mm*, and CD = 200 *mm*.

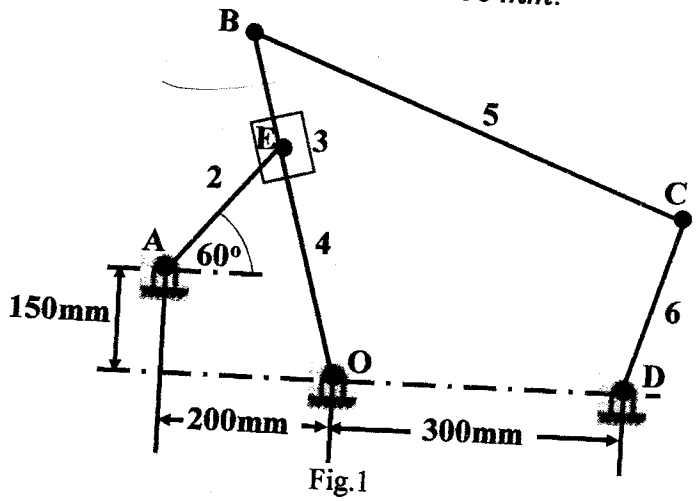


Fig.1

Q2- (17 Marks)

Determine the torque T_2 required to be applied for the static equilibrium of the mechanism shown in Fig. 2. The force P acting on the slider is 5000 *N* and the dimensions of the mechanism are as follows:
OA = 240 *mm*, AB = 1000 *mm*, BC = 620 *mm*, CD = 400 *mm* and DE = 600 *mm*.

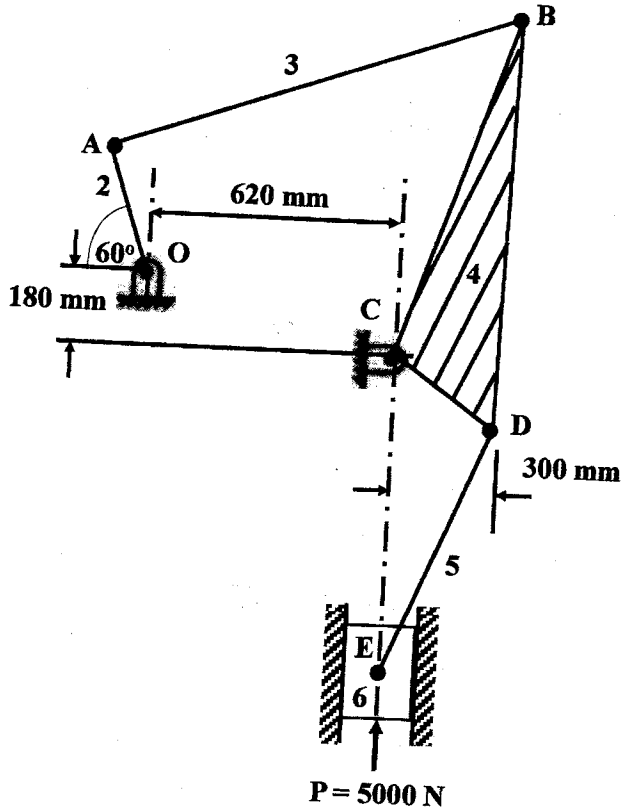


Fig.2

Q3- (17 Marks)

Draw the profile of a cam operating a reciprocating roller follower and with the following data:
Minimum radius of cam = 25 mm, lift = 30 mm and roller diameter = 15 mm.
The cam lifts the follower for 120^o with simple harmonic motion followed by a dwell period of 30^o. Then the follower lowers down during 150^o of the cam rotation with uniform acceleration and retardation followed by a dwell period.
If the cam rotates at a uniform speed of 150 rpm, calculate the maximum velocity and acceleration of the follower during the descent period.

Q4- (17 Marks)

In the epicyclic gear train shown in Fig.3, an arm carries two gears C and E. The shaft S_1 carries two gears A and B. If the arm rotates at 150 rpm in the clockwise direction about the center of the gear F. Using the tabular method, determine the speed of gear D on the output shaft S_2 when

(a) Gear F is fixed.
(b) Gear F rotates at 15 rpm in the clockwise direction.

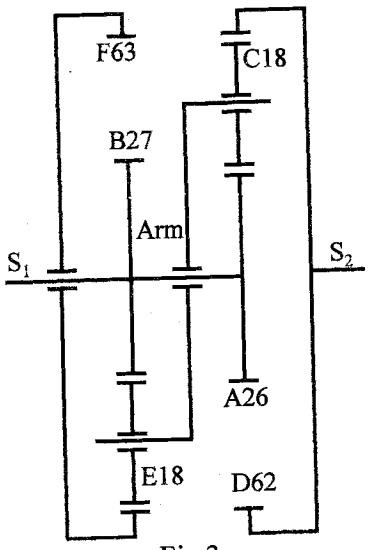


Fig.3

Q5- (17 Marks)

The equation of the turning moment curve of a three crank engine is $(8000 + 180\ sin3\theta)\ N.m$, where θ is the crank angle in radians. The flywheel and other rotating parts have a mass of 350 Kg and radius of gyration 220 mm and the mean speed is 400 rpm. Calculate:

1. power of the engine, and
2. the maximum fluctuation of the speed of the flywheel in percentage when
   (a) the resisting torque is constant, and
   (b) the resisting torque is $(800 + 80\ sin\theta)\ N.m$.

End of exam

With best wishes
Dr. Abdelhameed Zayed

Physics and Engineering Mathematics Department

Tanta University	Year: **2nd Year Mechanical Power Engineering Department**	Faculty of Engineering
Date: **Jan 18th, 2023** (1st term)	Course Title: **Engineering Mathematics (3)**	Total Marks: **85**
Allowed time: **3 hours**	Course Code: **PME2113**	No. of pages: **2**
	FINAL EXAM	

Please answer the following questions: B1)

Question (1) **(45Marks)**

(a) Sketch the image of the following regions

(a-1) the unit circle in the first quadrant by the mapping $w = (1+i)z + (3+2i)$.

(a-2) the triangle with the vertices $(0,0)$, $(0,1)$, $(1,0)$ by the mapping $w = (-1+i)z + (4+5i)$.

(b) Evaluate $\int \frac{J_6(x)}{x}\, dx$. Try to express your answer in terms of $J_5(x)$ and $J_3(x)$. (**Hint**: $\int x^k J_{k-1}\, dx = x^k J_k + c$, $\int x^{-k} J_{k+1}\, dx = -x^{-k} J_k + c$)

(c) The general equation for the unidirectional steady state non-Newtonian flow through a longed horizontal and unit vertical rectangular channel with viscosity dependent domain might be casted in the following differential form

$$\frac{d}{dy}\left(2\nu \frac{dU}{dy}\right) + \frac{dp}{dx} = f, \quad 0 \le y \le 1,$$

where U is the required velocity, $dp/dx \approx 0$ is the pressure gradient (assume its value here is neglected), $\nu = \mu + yU_\infty$ is the viscosity with $\mu = 1$, $U_\infty = 1.5$, $f = 2(k^2 - y^2)U$ is the external force with $k = 0.5$ is a non-integer constant value. Here, x refers to the horizontal direction of the channel and y refers to the vertical direction.

(c-1) Using the method of power series, predict the distribution of velocity along the vertical direction of the channel for the boundary conditions $U_{y=0} = 1$ and $\frac{dU}{dy}|_{y=0} = 0$.

(c-2) Give a sketch for $U(y)$ across the channel.

(d) Evaluate the following integral $\int_0^\infty \sqrt{x}\, e^{-x^3}\, dx$.

(e) Put in the form of $u + iv$ the following: $(4+4i)^5(-2+2\sqrt{3}i)$.

(f) Show that $(1+i)^i = e^{-\left(\frac{\pi}{4}+2n\pi\right)} e^{\frac{i}{2}\ln 2}$, where $n = 0, \pm 1, \pm 2, \ldots$

Please, consider page 2/2

e the following integral $I = \int_{-\infty}^{\infty} \frac{\cos 2x}{x^2+1} dx$.

e that everywhere in a medium the components of the heat flux density are $Q_x = 3$ and Q_y =

$allories/(cm^2 s)$).

-1) Find the temperature $\phi(x, y)$. Assume that $\phi(0,0) = 0$ and the thermal conductivity of the medium is $k = 0.1$ $(callories/(cm^{\circ}C\ s))$.

o-2) Find the stream function $\psi(x, y)$. Assume $\psi(0,0) = 0$.

o-3) Sketch the isothermals on which $\phi(x, y)$ equals $0, 40, -40$.

b-4) Sketch the streamlines on which $\psi(x, y)$ equals $0, 40, -40$.

ow that $\lim_{z\to 0} f(z) = 0$ if z approaches $zero$ along any straight line passes through the origin, where

$$f(z) = \begin{cases} \dfrac{xy^3}{x^2+2y^6} + i\dfrac{x^3y}{5x^6+y^2} & z \neq 0 \\ 0 & z = 0 \end{cases}$$

Given that $\frac{d}{dx}(x^k J_k) = x^k J_{k-1}$ and $\frac{d}{dx}(x^{-k} J_k) = -x^{-k} J_{k+1}$, prove that $J'_k = \frac{1}{2}(J_{k-1} - J_{k+1})$ and $\frac{k}{x} J_k = J_{k-1} + J_{k+1}$.

$\oint_C \frac{z-1}{z(z-2)(z+4)} dz$ inside $C: |z| = \frac{5}{2}$. (**Hint**: the indicated direction is the counterclockwise direction).

) Show that

f-1) $\int_{C_1} z\ dz = \int_{C_2} z\ dz = 4 + 2i$,

where C_1 is the line segment from $-1 - i$ to $3 + i$ and C_2 is the portion of the parabola $x = y^2 + 2y$ joining $-1 - i$ to $3 + i$, as indicated in Figure 1.

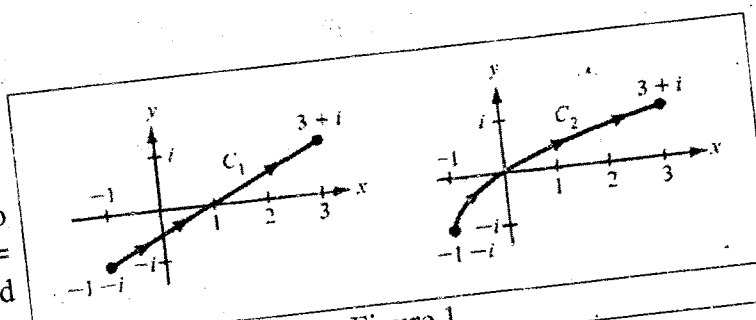


Figure 1

(f-2) $\int_{C_1} \bar{z}\ dz = -\pi i$, $\int_{C_2} \bar{z}\ dz = -4i$,

where C_1 is the semicircular path from -1 to 1 $(z(\theta) = \cos\theta + i\sin\theta)$ and C_2 is the polygonal path from -1 to 1, as indicated in Figure 2.

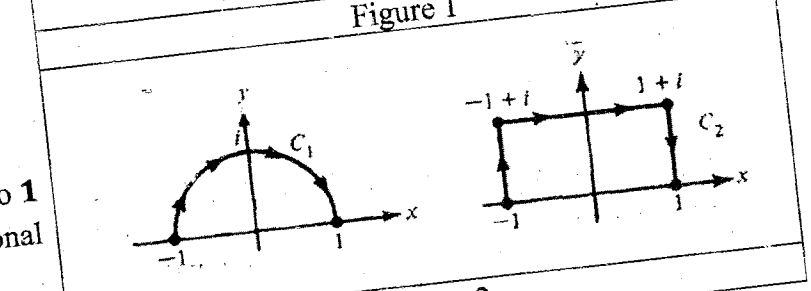


Figure 2

Dr. Ali Mehrez

Best of Luck

Course Title: Machine Design **Course Code:** MPD2150 **Year:** 2nd year Mech. Power. Eng.	**Final exam**	**Date:** 21 / 1 / 2023 **Allowed time:** 3 Hours **No. of pages:** 2 pages

Solve the following questions

Q1- A force P of 1780 N is acting vertically at D to a gear attached to the solid 25 mm diameter shaft AB as shown in Fig. 1. Determine the principal stresses and the maximum shearing stress at point H located as shown on top of the shaft (analytically and graphically using Mohr's circle). **(20 Marks)**

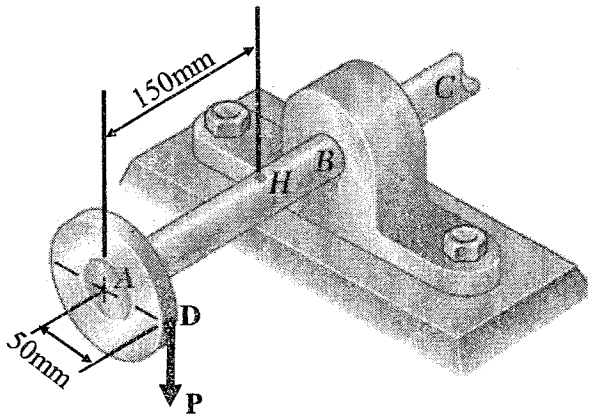


Fig. 1.

Q2- The shaft of an overhang crank subjected to a force P of 1 kN is shown in Fig. 2. The shaft is made of plain carbon steel 45C8 and the tensile yield strength is 380 N/mm^2. The factor of safety is 2 and Poisson's ratio, μ, is 0.3. Determine the diameter of the shaft using the **(20 Marks)**

1. Maximum principal stress theory;
2. Maximum shear stress theory;
3. Maximum principal strain theory;
4. Maximum strain energy theory; and
5. Maximum distortion energy theory.

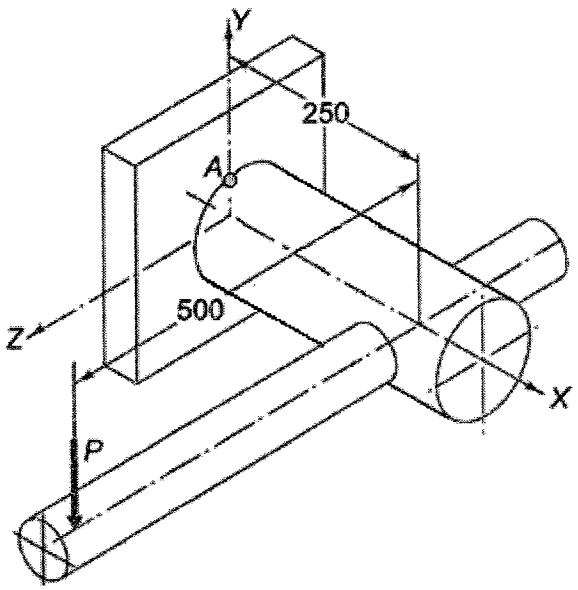


Fig. 2.

Q3- Determine the equations of the elastic curve for the beam shown in Fig. 3. Specify the slope at A and the maximum displacement of the beam. EI is constant. **(20 Marks)**

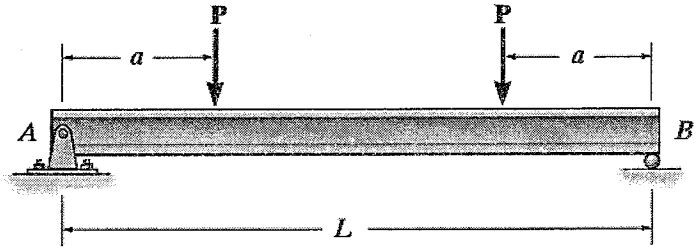
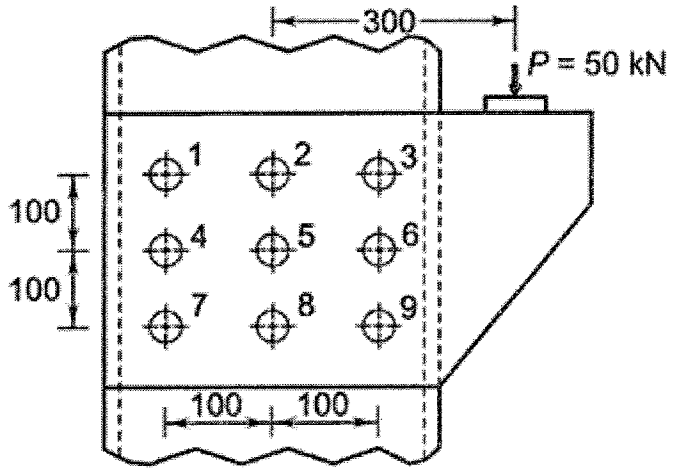


Fig. 3.

Q4- A bracket carrying a load P is attached to a steel channel by means of nine identical rivets as shown in Fig. 4. Determine the diameter of rivets, if the permissible shear stress is 60 N/mm^2. **(20 Marks)**

Q5- A cast iron bracket, supporting the transmission shaft and the belt pulley, is fixed to the steel structure by means of four bolts as shown in Fig.4. There are two bolts at A and two bolts at B. The total tension P is 15 kN. The belt tension act in a vertically downward direction.
The distances are $L_1 = 50\ mm$, $L_2 = 150\ mm$ and $L = 200\ mm$
The maximum permissible tensile stress in any bolt is 60 N/mm^2. Determine the size of the bolts.
(20 Marks)



All dimensions are in mm

Fig. 4.

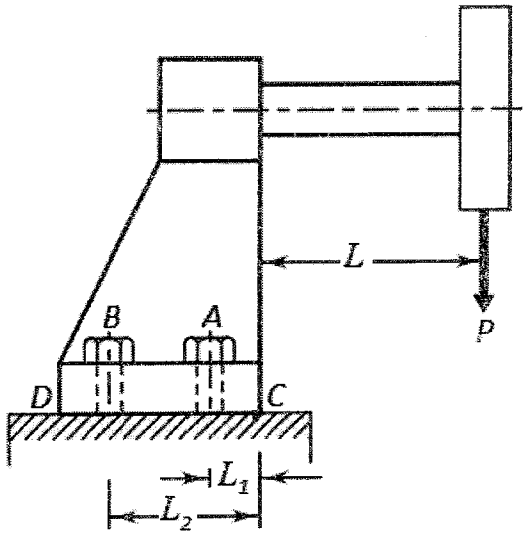


Fig. 5.

End of exam

With best wishes
Dr. Abdelhameed Zayed

B16

Tanta University

Mechanical Power Department

Faculty of Engineering

Course Title	Thermodynamics (2)	Academic Year 2022/2023 First Semester Exam	Course Code	MEP2104
Year	Second			
Date	9-1- 2023	No. of Pages (2)	Allowed time	3 hrs

Remarks: (Answer the following **questions**; **Support** your answers with **drawing** whenever possible; **Assume** any missing data; Steam tables and charts are allowed)

Question Number (1)

(20 Points)

a) What are the two statements of the second law of thermodynamics? **(3 points)**

b) What are the Carnot principles? **(3 points)**

c) What three different mechanisms can cause the entropy of a control volume to change? **(2 points)**

d) During a heat transfer process, the entropy of a system (always, sometimes, never) increases. **(2 points)**

e) A geothermal power plant uses geothermal water extracted at 160 °C at a rate of 440 kg/s as the heat source and produces 22 MW of net power. If the environment temperature is 25 °C, determine (*a*) the actual thermal efficiency, (*b*) the maximum possible thermal efficiency, and (*c*) the actual rate of heat rejection from this power plant. **(6 points)**

f) Air is expanded from 2000 kPa and 500 °C to 100 kPa and 50 °C. Assuming constant specific heats, determine the change in the specific entropy of air. **(4 points)**

Question Number (2)

(20 Points)

a) What is the Exergy? Is the exergy considered a property for the system? Why? **(2 points)**

b) A container filled with 45 kg of liquid water at 95 °C is placed in a 90-m^3 room that is initially at 12 °C. Thermal equilibrium is established after a while as a result of heat transfer between the water and the air in the room. Using constant specific heats, determine (*a*) the final equilibrium temperature, (*b*) the amount of heat transfer between the water and the air in the room, and (*c*) the entropy generation. Assume the room is well sealed and heavily insulated. **(8 points)**

c) Liquid water at 200 kPa and 20 °C is heated in a chamber by mixing it with superheated steam at 200 kPa and 300 °C. Liquid water enters the mixing chamber at the rate 2.5 kg/s and the chamber loses heat with a rate of 600 kJ/min to the surrounding air at 25 °C. If the mixture leaves at 200 kPa and 60 °C, determine (*a*) the mass flow rate of the steam, (*b*) the wasted work potential, and (*c*) the second law efficiency.

Question Number (3)

(10 points)

(15 Points)

a) What does the area enclosed by the cycle represent on a P-v diagram? How about on a T-s diagram? **(2 points)**

b) For a specified pressure ratio, why does multistage compression with intercooling decrease the compressor work, and multistage expansion with reheating increase the turbine work? **(2 points)**

c) Consider an engine operating on the ideal Otto cycle with a compression ratio of 8. At the beginning of the compression process, air is at 100 kPa and 17 °C. During the constant-volume heat-addition process, 800 kJ/kg of heat is transferred to air from a source at 1700 K and waste heat is rejected to the surroundings at 300 K. determine (*a*) the exergy destruction associated with each of the four processes and the cycle and (*b*) the second-law efficiency of this cycle. **(7 points)**

d) In an ideal Brayton cycle with regeneration, air is compressed from 80 kPa and 10 °C to 400 kPa and 175 °C, is heated to 450 °C in the regenerator, and then further heated to 1000 °C before entering the turbine. Under cold-air-standard conditions, determine the effectiveness of the regenerator? **(4 points)**

Question Number (4)

(20 Points)

a) Why is the Carnot cycle not a realistic model for steam power plants? **(3 points)**

b) How do actual vapor power cycles differ from idealized ones? **(3 points)**

c) Why is the combined gas–steam cycle more efficient than either of the cycles operated alone? **(2 points)**

d) A textile plant requires 4 kg/s of saturated steam at 2 MPa, which is extracted from the turbine of a cogeneration plant. Steam enters the turbine at 8 MPa and 500°C at a rate of 11 kg/s and leaves at 20 kPa. The extracted steam leaves the process heater as a saturated liquid and mixes with the feedwater at constant pressure. The mixture is pumped to the boiler pressure. Assuming an isentropic efficiency of 88 percent for both the turbine and the pumps, determine (*a*) the rate of process heat supply, (*b*) the net power output, and (*c*) the utilization factor of the plant. **(6 points)**

e) How do we achieve very low temperatures with gas refrigeration cycles? **(2 points)**

f) In gas refrigeration cycles, can we replace the turbine by an expansion valve as we did in vapor-compression refrigeration cycles? Why? **(2 points)**

g) How does the COP of a cascade refrigeration system compare to the COP of a simple vapor-compression cycle operating between the same pressure limits? **(2 points)**

End of the Questions

With my best wishes

Dr. Elsayed Elsaid & Dr. Farid Hammad

B1S

Mechanical Power Engineering Department

Tanta University — Faculty of Engineering

Course: Fluid Mechanics (1-A)	Academic Year 2022/2023 First Semester Exam	Course Code: MEP2103
Year: 2nd, Power Mechanics		Full Marks: 90 points
Date: 11-1- 2023	No. of Pages (4)	Allowed time: 3 hrs
Assume any missing data, use schematic diagrams in your answers		

Question Number (1) (30 Points)

a) Choose the correct answer: (10 points)

1. Fluid is a substance which offers no resistance to change of.....
   (a) pressure (b) flow (c) shape (d) volume
2. Practical fluids .....
   (a) are viscous (b) possess surface tension
   (c) are compressible (d) possess all the above properties
3. In a static fluid
   (a) resistance to shear stress is small (b) fluid pressure is zero
   (c) linear deformation is small (d) only normal stresses can exist
4. A fluid is said to be ideal, if it is
   (a) incompressible (b) inviscid
   (c) viscous and incompressible (d) inviscid and incompressible.
5. An ideal flow of any fluid must fulfill the following
   (a) Newton's law of motion (b) Newton's law of viscosity
   (c) Pascal' law (d) Continuity equation
6. Which of the following is dimensionless?
   (a) specific weight (b) specific volume (c) specific speed (d) specific gravity
7. The normal stress in a fluid will be constant in all directions at a point only if
   (a) it is incompressible (b) it has uniform viscosity (c) it has zero viscosity (d) it is at rest.
8. The SI unit of kinematic viscosity is:
   (a) m^2/s (b) kg/m-s (c) m/s^2 (d) m^3/s^2
9. The dimension of surface tension is:
   (a) ML^{-1} (b) L^2T^{-1} (c) $ML^{-1}T^1$ (d) MT^{-2}
10. What is the unit of dynamic viscosity of a fluid termed 'poise' equivalent to?
    (a) $dyne/cm^2$ (b) gm.s/cm (c) $dyne\ s/cm^2$ (d) gm-cm/s
11. The vertical component of the hydrostatic force on a submerged curved surface is the
    (a) Mass of liquid vertically above it
    (b) Weight of the liquid vertically above it
    (c) Force on a vertical projection of the surface
    (d) Product of the pressure at the centroid and the surface area
12. Resultant pressure of liquid in case of an immersed body acts through which one of the following?
    (a) Centre of gravity (b) Centre of pressure (c) Metacentre (d) Centre of buoyancy
13. Bodies in flotation to be in stable equilibrium, the necessary and sufficient condition is that the centre of gravity is located below the.....
    (a) Metacentre (b) Centre of pressure (c) Centre of gravity (d) Centre of buoyancy
14. What are the forces that influence the problem of fluid static?
    (a) Gravity and viscous forces (b) Gravity and pressure forces
    (c) Viscous and surface tension forces (d) Gravity and surface tension forces
15. Streamlines, path lines and streak lines are virtually identical for
    (a) Uniform flow (b) Flow of ideal fluids (c) Steady flow (d) Non uniform flow

16. Circulation is defined as line integral of tangential component of velocity about a .....
    (a) Closed contour (path) in a fluid flow (b) Open contour (path) in a fluid flow
    (c) Closed or open contour (path) in a fluid flow (d) None the previous
17. A streamline is a line:
    (a) Which is along the path of the particle
    (b) Which is always parallel to the main direction of flow
    (c) Along which there is no flow
    (d) On which tangent drawn at any point given the direction of velocity
18. Bernoulli equation is applicable for
    (a) steady rotational flow
    (b) steady rotational compressible flow
    (c) steady irrotational incompressible flow
    (d) unsteady irrotational incompressible flow
19. In a flow along a varying flow cross section, as the area decreases
    (a) the energy line will slope up
    (b) the hydraulic gradient line will slope up
    (c) the hydraulic gradient line will slope down
    (d) the energy line will slope down.
20. In steady flow in a varying section pipe if the diameter is doubled the kinetic energy will
    (a) be doubled (b) increase 4 times (c) increase 8 times (d) decrease to one sixteenth.

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b) Indicate whether the statements are "True" or "False" and correct the False: (5 Points)

1. Viscosity of liquids increases with temperature.
2. The head indicated by a water manometer is lower than the actual value.
3. In fluids the shear force is proportional to the rate of deformation.
4. Newtonian fluid is one whose viscosity will increase directly with rate of deformation.
5. The pressure on the base of a liquid column will depend upon the shape of the column.
6. In a plane surface immersed in a liquid the centre of pressure will be above the centroid.
7. The vertical force on an immersed curved surface equal to the column of liquid above the surface.
8. A floating body will displace the same volume of liquid irrespective of the liquid in which it floats.
9. A streamline shows the path of a particle in any flow.
10. For ideal flows the energy line will slope upward along the flow.

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c) Classify and define the different types of fluid with drawing a schematic diagram. ..... (5 Points)

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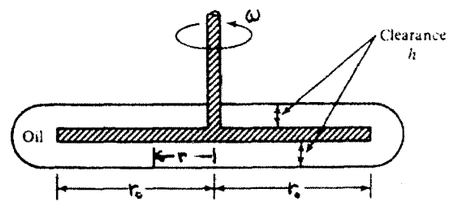
d) A disk of radius r_o rotates at angular velocity ω inside an oil bath of viscosity μ, as shown in Figure. Assuming a linear velocity profile and neglecting shear on the outer disk edges, derive an expression for the viscous torque on the disk ..... (10 Point)



Question Number (2) (20 Points)

a) Draw the pressure chart and indicate the relations between different types of pressure. (5 Points)

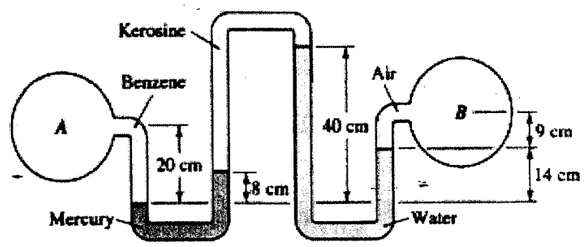
b) Prove that the pressure in a liquid is varying with vertical direction only. (5 Points)

c) State and explain with schematic diagrams, the law of buoyancy and the law of floating. (5 Points)

d) In Fig., all fluids are at 20°C. Determine the pressure difference (in Pa) between points A and B.

specific weights of used fluids

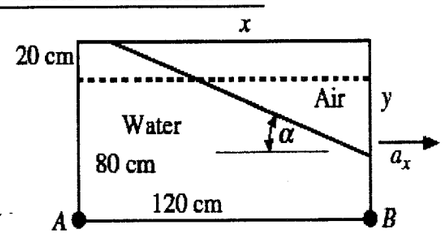
Benzine = 8640 N/m^3,
Mercury = 133100 N/m^3
Kerosene = 7885 N/m^3,
Water= 9790 N/m^3
Air =12 N/m^3..... (5 Points)



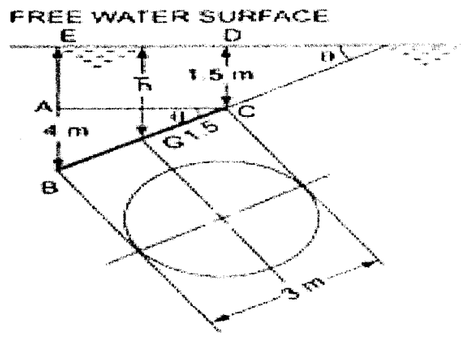
Question Number (3) (20 Points)

a) Deduce relations for calculating pressure force and its centre of pressure on a plane surface immersed in a liquid at an angle θ to the free surface. (5 Points)

b) In Fig., a 120-cm-long tank contains 80 cm of water and 20 cm of air maintained at 60 kPa above the water. The 60-cm-wide tank is accelerated at 10 m/s^2. After equilibrium is established, find the force acting on the bottom of the tank. (10 Points)



c) A circular plate 3.0 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of the center of pressure. (5 Points)



Question Number (4) (20 Points)

a)Derive the continuity equation in differential form and reduce it for a steady two-dimensional incompressible flow. (Cartesian Coordinates). (5 Points)

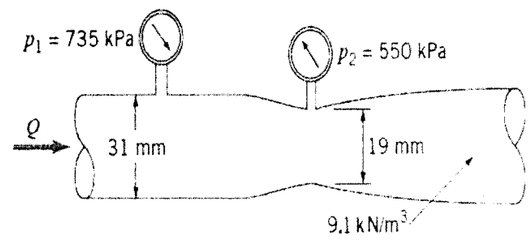
b) Derive from the first principles, the Euler's equation of motion for steady flow along a streamline. Obtain Bernoulli's equation by its integration. State the assumptions made. (10 Points)

c) Under ideal conditions show that the volume flow through a venturimeter is given by

$$Q = \frac{A_2}{\left[1-\left(\frac{A_2}{A_1}\right)^2\right]^{0.5}}\left[2g\left(\frac{P_1-P_2}{\gamma}\right)+(Z_1-Z_2)\right]^{0.5}$$

where suffix 1 and 2 refer to the inlet and the throat. (5 Points)

d) A liquid of 9.1 KN/m^3 specific weight and flows steadily through the variable area pipe shown in Fig. If viscous and compressibility effects and energy losses are negligible. Determine the air flow rate through the pipe? (5 Points)



End of questions.....

Dr. M. I. Amro and Committee