KUMARAGURU
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B.E. DEGREE EXAMINATIONS: APRIL / MAY 2023

(Regulation 2018)

Third Semester

MECHATRONICS ENGINEERING

U18MCT3104**:** Fluid Mechanics and Thermal Sciences

COURSE OUTCOMES

CO1: Describe the properties of fluids and its importance in selection of fluid for suitable application.

CO2: Apply the concept of fluid statics to determine the pressure and forces on plane and curved surfaces.

CO3: Differentiate the types of flow with its characteristics and also calculate the flow rate by applying concept of fluid kinematics and dynamics.

CO4: Identify the major and minor losses involved in the fluid flow through pipes.

CO5: Explain the concept of boundary layer and methods of preventing the boundary layer separation.

CO6: Summarize the laws of thermodynamics and concept of heat transfer mechanisms in energy interactions.

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. Matching type item with multiple choice code   CO1   [K_2]

List I	List II
A. Shock wave	i. Surface tension
B. Flow separation	ii. Vapour pressure
C. Capillary rise	iii. Compressibility
D. Cavitation	iv. Adverse pressure gradient

	A	B	C	D
a)	ii	i	iii	iv
b)	iii	iv	i	ii
c)	ii	iv	iii	i
d)	iii	i	ii	iv

2. The density of a fluid is sensitive to changes in pressure. The fluid will be known as   CO1   [K_1]

   a) Newtonian fluid   b) Perfect fluid

   c) Real fluid   d) Compressible fluid

3. Stability of a floating body can be improved by — CO2 [K₂]

   1. Making its width large
   2. Making the draft small
   3. Keeping the centre of mass small
   4. Reducing its density

   Select the correct answer using the code given below:
   a) 1,2,3 and 4
   b) 1,2 and 3
   c) 1 and 2
   d) 3 and 4

4. One dimensional flow means — CO3 [K₁]

   a) Uniform flow
   b) Steady flow
   c) Flow which neglects changes in traverse direction
   d) Straight line flow

5. Assertion (A): Bernoulli's equation is an energy equation. — CO3 [K₂]
   Reason (R): Starting from Euler's equation one can arrive at Bernoulli's equation.
   a) Both A and R are Individually true and R is the correct explanation of A
   b) Both A and R are Individually true but R is not the correct explanation of A
   c) A is true but R is false
   d) A is false but R is true

6. At the stagnation point in a flow field — CO3 [K₁]

   a) Pressure is zero
   b) Total energy is zero
   c) Velocity head gets dissipated into heat
   d) Velocity head gets converted into pressure head

7. Find out the correct order of minor energy losses for flow from left side tank to right side tank as shown in the given figure: — CO4 [K₂]

   1. Head loss at exit
   2. Head loss due to sudden enlargement
   3. Head loss due to entrance

   a) 3 – 2 – 1
   b) 1 – 2 – 3
   c) 2 – 1 – 3
   d) 2 – 3 – 1

8. At the point of boundary layer separation   CO5   [K₂]

   a) Shear stress is maximum   b) Shear stress is zero

   c) Velocity is negative   d) Density variation is maximum

9. Assertion (A): When a viscous fluid flows over a flat plate at zero angle attack, the thickness of boundary layer is an ever increasing one as its distance from the leading edge of the plate increases.   CO5   [K₂]
Reason (R): In practice 99 percent of the depth of the boundary layer is attained within a short distance of the leading edge.

   a) Both A and R are Individually true and R is the correct explanation of A   b) Both A and R are Individually true but R is not the correct explanation of A

   c) A is true but R is false   d) A is false but R is true

10. First law of thermodynamics refers to conservation of   CO6   [K₁]

   a) Mass   b) Momentum

   c) Energy   d) Force

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11. Define vapour pressure.   CO1   [K₁]

12. Differentiate between gauge pressure vacuum pressure.   CO2   [K₂]

13. Define centre of buoyancy.   CO2   [K₁]

14. Give differences between local acceleration and convective acceleration.   CO3   [K₂]

15. What are the assumptions made while deriving Bernoulli's equation?   CO3   [K₂]

16. Define hydraulic diameter.   CO4   [K₁]

17. What is meant by equivalent pipe? Write the Dupuit's equation.   CO4   [K₂]

18. Define displacement thickness.   CO5   [K₁]

19. State second law of thermodynamics.   CO6   [K₁]

20. What are the different modes of heat transfer?   CO6   [K₂]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 350 words)

21. a) If the velocity profile of a fluid over a plate is parabolic with the vertex 20 cm from the plate, where the velocity is 120 cm/sec. Calculate the velocity gradients and shear stresses at a distance of 0, 10 and 20 cm from the plate, if the viscosity of the fluid is 8.5 poise.   7   CO1   [K₃]

   b) A pressure gauge consists of two cylindrical bulbs B and C each of 10 sq.cm cross-sectional area, which are connected by a U-tube with vertical limbs each of 0.25 sq.cm cross-sectional area. A red liquid of specific gravity 0.9 is filled into C and clear water is filled into B, the surface of separation being in the limb is attached to C. Find the displacement of surface of separation when the pressure on the surface in C is greater than that in B by an amount equal to 1 cm head of water.   7   CO2   [K₃]

22. a) Derive an expression to find the capillary rise and capillary fall in a glass tube immersed in a vessel containing a liquid.　6　CO1　[K₃]

   b) Water flows through a pipe AB 1.2 m diameter at 3 m/s and then passes pipe BC 1.5 m diameter. At C, the pipe branches. Branch CD is 0.8 m in diameter and carries one third of the flow in AB. The flow velocity in branch CE is 2.5 m/s. Find the volume rate of flow in AB, the velocity in BC, the velocity in CD and the diameter of CE.　8　CO3　[K₃]

23. a) A block of wood of specific gravity 0.7 floats in water. Determine the metacentric height of the block if its size is 2 m × 1 m × 0.8 m.　6　CO2　[K₂]

   b) Derive an expression for Euler's equation of motion along a streamline. Obtain the Bernoulli's equation from the Euler's equation.　8　CO3　[K₃]

24. a) What is Hagen Poiseuille's equation? Derive an expression to determine the loss of head of viscous fluid flowing in a circular pipe.　8　CO4　[K₃]

   b) Explain the method of measuring temperature through constant volume gas thermometer.　6　CO6　[K₂]

25. a) Explain the concept of boundary layer separation? How the pressure gradient does affects it?　6　CO5　[K₂]

   b) Explain the different modes of heat transfer with suitable examples.　8　CO6　[K₂]

26. a) Three reservoirs A, B and C are connected by a pipe system as shown in figure. Determine piezometric head at junction at D. Take f = 0.005.　9　CO4　[K₃]
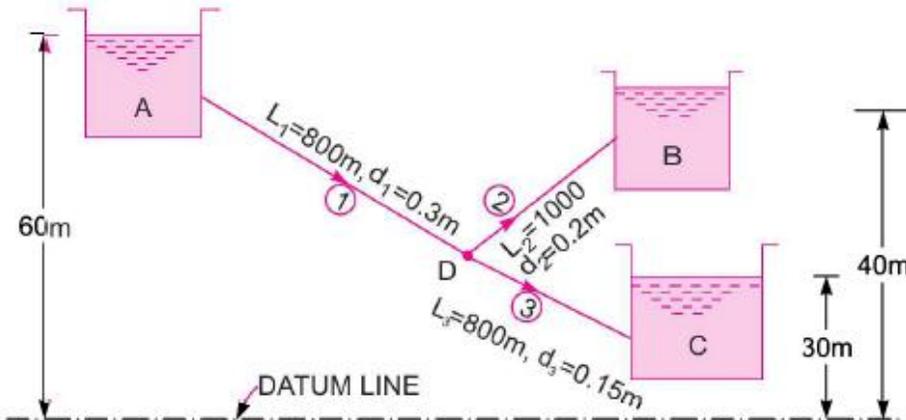
   b) State and derive the Kirchhoff's law related to thermal radiation.　5　CO6　[K₃]

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