# INSTITUTE OF AERONAUTICAL ENGINEERING 

(Autonomous)

Dundigal-500043, Hyderabad
B.Tech III SEMESTER END EXAMINATIONS (REGULAR / SUPPLEMENTARY) - FEBRUARY 2023

Regulation:UG20
FLUID DYNAMICS
Time: 3 Hours
AERONAUTICAL ENGINEERING
Max Marks: 70

Answer ALL questions in Module I and II<br>Answer ONE out of two questions in Modules III, IV and V<br>All Questions Carry Equal Marks<br>All parts of the question must be answered in one place only

## MODULE - I

1. (a) Explain briefly the following types of equilibrium of floating and submerged bodies:
i) Stable equilibrium ii) Unstable equilibrium iii) Neutral equilibrium
[BL: Understand| CO: 1|Marks: 7]
(b) A 1 m wide and 1.5 m deep rectangular plane surface lies in water in such a way that its plane makes an angle of $30^{\circ}$ with the free water surface. Determine the total pressure and position of centre of pressure when the upper edge is 0.75 m below the free water surface. [BL: Apply| CO: $1 \mid$ Marks: 7]

## MODULE - II

2. (a) The efficiency $\eta$ of a fan depends on density $\rho$, dynamic viscosity $\mu$ of the fluid, angular velocity $\omega$, diameter D of the rotor and the discharge Q . Express $\eta$ in terms of dimensional parameters.
[BL: Apply| CO: 2|Marks: 7]
(b) An oil of specific gravity 0.92 and viscosity 0.03 poise is to be transported at the rate of 2500 litres $/ \mathrm{sec}$. through a 1.2 m diameter pipe. Tests were conducted on a 12 cm diameter pipe using water at $20^{\circ} \mathrm{C}$. If the viscosity of water at $20^{\circ} \mathrm{C}$ is 0.01 poise. Find
i) Velocity of flow in the model
ii) Rate of flow in the model.
[BL: Apply| CO: 2|Marks: 7]

## MODULE - III

3. (a) State law of conservation of mass. Obtain the continuity equation in $r \theta$ and z directions of the cylindrical coordinate system.
[BL: Understand| CO: 3|Marks: 7]
(b) A horizontal venturimeter with inlet and throat diameters 30 cm and 15 cm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and throat is 20 cm of mercury. Determine the rate of flow. Take $C_{d}=0.98 \quad$ [BL: Apply| CO: $3 \mid$ Marks: 7]
4. (a) Determine Euler's equation of motion and obtain the Bernoulli's equation from Euler equation of motion. Explain the significance of each term in the equation. [BL: Understand| CO: 4|Marks: 7]
(b) A pitot tube is inserted in a pipe of 300 mm diameter. The static pressure in pipe is 100 mm of mercury (vaccum). The stagnation pressure at the centre of the pipe, recorded by the pitot-tube is $0.981 \mathrm{~N} / \mathrm{cm}^{2}$. Calculate the rate of flow of water through pipe, if the mean velocity of flow is 0.85 times the central velocity. Take $C_{v}=0.98$.
[BL: Apply| CO: 4|Marks: 7]

## MODULE - IV

5. (a) Explain the following: i) Laminar boundary layer ii) Turbulent boundary layer iii) Laminar sub-layer iv) Boundary layer thickness. [BL: Understand| CO: 5|Marks: 7]
(b) A jet plane which weighs 29.43 KN and having a wing area of $20 \mathrm{~m}^{2}$ flies at a velocity of 950 $\mathrm{km} /$ hour, when the engine delivers 7357.5 KW power. $65 \%$ of the power is used to overcome the drag resistance of the wing. Calculate coefficient of lift and drag of the wing. ( $\rho_{\text {air }}=1.21 \mathrm{~kg} / \mathrm{m}^{3}$ )
[BL: Apply| CO: 5|Marks: 7]
6. (a) Summarize about boundary layer separation. Outline the effect of pressure gradient on boundary layer separation?
[BL: Understand| CO: 5|Marks: 7]
(b) Experiments were conducted in a wind tunnel at 50 kmph on a flat plate of size $2 \mathrm{~m} \times 1 \mathrm{~m}$. The specific weight of air is $11.28 \mathrm{~N} / \mathrm{m}^{3}$. The plate is kept at such an angle that the coefficients of lift and drag are 0.75 and 0.15 , respectively. Determine lift force, drag force, resulting force and power exerted by air stream on the plate.
[BL: Apply| CO: 5|Marks: 7]

## MODULE - V

7. (a) Draw a schematic diagram of a Francis turbine and explain briefly its construction and working.
[BL: Understand| CO: 6|Marks: 7]
(b) A Pelton wheel of 1.1 m mean bucket diameter works under a head of 500 m . The deflection of jet is $165^{\circ}$ and its relative velocity is reduced over the bucket by 15 per cent due to friction. If the diameter of jet is 100 mm and the water is to leave the bucket without any whirl, determine:
i) Rotational speed of wheel ii) Ratio of bucket speed to jet velocity iii) Impulsive force and power developed by the wheel iv) Available power (water power) v) Power input to buckets vi) Efficiency of the wheel with power input to bucket as reference input. Take $C_{v}=0.97$.
[BL: Apply| CO: $6 \mid$ Marks: 7$]$
8. (a) Mention the differences between centrifugal pump and reciprocating pump. With neat sketch explain principle of operation and working of a centrifugal pump.
[BL: Understand| CO: 6|Marks: 7]
(b) A centrifugal pump is to discharge $0.118 \mathrm{~m}^{3} / \mathrm{s}$ at a speed of 1450 RPM against a head of 25 m . The impeller diameter is 250 mm , its width at outlet is 50 mm and manometric efficiency is 75 percent. Determine the vane angle at the outer periphery of the impeller.
[BL: Apply| CO: 6|Marks: 7]

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