Ref No:

# SRI KRISHNA INSTITUTE OF TECHNOLOGY, BANGALORE

## COURSE PLAN

Academic Year 2018-19

| | |
|---|---|
| Program: | B E – Mechanical Engineering |
| Semester : | 4 |
| Course Code: | 18ME43 |
| Course Title: | FLUID MECHANICS |
| Credit / L-T-P: | 03/3-0-0 |
| Total Contact Hours: | 44 |
| Course Plan Author: | Naveen Kumar Pattar |

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# A. COURSE INFORMATION

## 1. Course Overview

| | | | |
|---|---|---|---|
| Degree: | BE | Program: | ME |
| Semester: | IV | Academic Year: | 2019-2020 |
| Course Title: | FLUID MECHANICS | Course Code: | 18ME43 |
| Credit / L-T-P: | 03/3-0-0 | SEE Duration: | 180 min |
| Total Contact Hours: | 44 Hrs | SEE Marks: | 60 Marks |
| CIA Marks: | 40 | Assignment | 1 / Module |
| CoursePlan Author: | NAVEEN KUMAR PATTAR | Sign | Dt: |
| Checked By: | PRASANNA GOWDA | Sign | Dt: |
| CO Targets | | Program: | ME |

**Note:** Define CIA and SEE % targets based on previous performance.

## 2. Course Content

Content / Syllabus of the course as prescribed by University or designed by institute. Identify 2 concepts per module as in G.

| Module | Content | Teaching Hours | Identified Module Concepts | Blooms Learning Levels |
|---|---|---|---|---|
| 1 | **Basics:** Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc,pressure at a point in the static mass of fluid, variation of pressure, Pascal's law,Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges. **Fluid Statics:** Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. | 12 | Fluid properties | L3 |
| 2 | **Buoyancy:**center of buoyancy, meta center and meta centric height its application. **Fluid Kinematics:** Velocity of fluid particle, types of fluid flow, description of flow, continuity equation, Coordinate free form, acceleration of fluid particle, rotational & irrotational flow, Laplace's equation in velocity potential and Poisson's equation in stream function, flow net. | 08 | Fluid flow types | L3 |
| 3 | **Fluid Dynamics;** Introduction. Forces acting on fluid in motion. Euler's equation of motion along a streamline. Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's equation. Introduction to Navier-Stokes equation. Application of Bernoulli's theorem such as venturi- | 10 | Nature of flow | L3 |

| | | | | |
|---|---|---|---|---|
| | meter,orifice meter, rectangular and triangular notch, pitot tube. **Laminar and turbulent flow**: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation – velocity profile loss of head due to friction in viscous flow. Reynolds's experiment, frictional loss in pipe flow. Introduction to turbulence, characteristics of turbulent flow, laminar turbulent transition major and minor losses. | | | |
| 4 | **Flow over bodies**: Development of boundary layer, Prandtl‟s boundary layer equations, Blasius solution, integral momentum equation, drag on a flat plate, boundary layer separation and its control, streamlined and bluff bodies -flow around circular bodies and aero foils, calculation of lift and drag. **Dimensional analysis**: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude | 09 | Boundary layer | L3 |
| 5 | **Compressible Flows:** Introduction, thermodynamic relations of perfect gases, internal energy and enthalpy, speed of sound, pressure field due to a moving source, basic Equations for one-dimensional flow, stagnation and sonic Properties, normal and oblique shocks. **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, and applications. | 05 | 1)Thermodynamic properties<br>2)Computational Fluid Dynamics | L3 |
| **-** | **Total** | **44** | **-** | **-** |

## 3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).
1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

| Modules | Details | Chapters in book | Availability |
|---|---|---|---|
| **A** | **Text books (Title, Authors, Edition, Publisher, Year.)** | **-** | **-** |
| 1 | **Text books** | | |
| | Fluid Mechanics (SI Units), Yunus A. Cengel John M.Cimbala, 3rd Ed., Tata. McGraw Hill, 2014. | In Lib, In dept | Available |
| | Fluid Mechanics, F M White, McGraw Hill Publications Eighth edition. 2016 | In Lib, In dept | Available |
| | Mechanics of Fluids, Merle C. Potter, Devid C. Wiggerrt, Bassem H. Ramadan, Cengage learning, Fourth editions 2016. | In Lib, In dept | Available |
| 2 | **Reference books** | | |
| | Fundamentals of Fluid Mechanics by Munson, Young, Okiishi& Huebsch, John Wiley Publications.7 th edition. | In Lib | |
| | Fluid Mechanics, Pijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005. | In Lib | |
| | Fluid Mechanics, John F.Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006. | In Lib | |
| | Introduction to Fluid Mechanics by Fox, McDonald, John Wiley Publications,8 th edition. | In Lib | Available |

## 4. Course Prerequisites

Refer to GL01. If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.
Students must have learnt the following Courses / Topics with described Content . . .

| Modules | Course Code | Course Name | Topic / Description | Sem | Remarks | Blooms Level |
|---|---|---|---|---|---|---|
| 1-5 | 18PHY12 | Engineering Physics | Basic concepts of Archimedes principal, Pascals Law | I | | L2 |
| 4 | 18MAT21 | Engineering Mathematics | Engineering calculus | II | | L2 |
| 3 | 18ME33 | Basic thermodynamics | Basic thermodynamics | III | | L2 |

## 5. Content for Placement, Profession, HE and GATE

The content is not included in this course, but required to meet industry & profession requirements and help students for Placement, GATE, Higher Education, Entrepreneurship, etc. Identifying Area / Content requires experts consultation in the area.
Topics included are like, a. Advanced Topics, b. Recent Developments, c. Certificate Courses, d. Course Projects, e. New Software Tools, f. GATE Topics, g. NPTEL Videos, h. Swayam videos etc.

| Modules | Topic / Description | Area | Remarks | Blooms Level |
|---|---|---|---|---|
| 2 | Buoyancy, center of buoyancy | Industry and GATE | Seminar on Center of buoyancy | L3 |
| 3 | Laminar and Turbulent Flows | GATE | NPTEL Videos | L3 |

# B. OBE PARAMETERS

## 1. Course Outcomes

Expected learning outcomes of the course, which will be mapped to POs. Identify a max of 2 Concepts per Module. Write 1 CO per Concept.

| Modules | Course Code.# | Course Outcome **At the end of the course, student should be able to . . .** | Teach. Hours | Concept | Instr Method | Assessment Method | Blooms' Level |
|---|---|---|---|---|---|---|---|
| 1 | 18ME43.1 | Identify and calculate the fluid properties used in the analysis of fluid behaviour | 12 | Fluid properties | Lecture | Chalk and board | L3 Apply |
| 2 | 18ME43.2 | Explain the principles of buoyancy and fluid flow concept. | 08 | Fluid flow types | Lecture/ Tutorial | Chalk and board | L3 Apply |
| 3 | 18ME43.3 | Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical engineering. | 10 | Nature of flow | Lecture | Chalk and board | L3 Apply |
| 4 | 18ME43.4 | Explain the concept of boundary layer in fluid flow. | 09 | Boundary layer | Lecture | Chalk and board | L3 Apply |
| 5 | 18ME43.5 | Illustrate and explain the basic concept of compressible flow and CFD. | 05 | 1)Thermo dynamic properties 2)Computational | Lecture | Chalk and board | L3 Apply |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Fluid Dynamics | | | |
| **-** | **-** | **Total** | **44** | **-** | **-** | **-** | **L3** |

## 2. Course Applications

| Modules | Application Area<br>Compiled from Module Applications. | CO | Level |
|---|---|---|---|
| 1 | Pascal's law is applicable for designing Hydraulic jacks, Hydraulic press | 1 | L2 |
| 2 | Principle of buoyancy applicable for Submarines, Hydrometer, Ships & boats | 2 | L3 |
| 3 | To identify the type of fluid flow through various channels. | 2 | L2 |
| 3 | Application of Bernoulli's theorem for Flow measuring devices such as venturi meter,orifice meter,notches, pitot tube etc. | 3 | L3 |
| 4 | To identify type of flow in blood vessel,Grocery cooling,Settling tanks,Wind tunnels,designing sewage systems | 3 | L2 |
| 4 | Design of airfoils in airplanes,Design of automobile parts | 3 | L3 |
| 4 | We use dimensional analysis for three prominent reasons, they are:<br>Consistency of a dimensional equation<br>Derive relation between physical quantities in physical phenomena<br>To change units from one system to another | 4 | L3 |
| 5 | 1. Nozzles and Diffusers and converging diverging nozzles<br>2. Turbines, fans & pumps<br>3. Throttles – flow regulators,<br>4. One Dimensional Isentropic Flow – compressible pipe flow. | 4 | L3 |
| 5 | Some of the applications of CFD in Industries are -<br>1. Electronics- For design and analysis of cooling system.<br>2. Turbo machinery- For design and analysis pumps, compressors, fans, blowers, turbines nozzle and diffusers.<br>3. Power and Energy- For design and analysis of Thermal, nuclear and hydro power plants. It is also used for modelling of accident situations.<br>4. Construction- For design and analysis dams, spillways, canals, HVAC systems of buildings.<br>5. Hydraulics- Construction machinery like excavators, large<br>6. Automotive, Aerospace and Marine- Aerodynamic design of vehicles, combustion modelling, performance of components like turbochargers, propellers, and cooling fans etc.<br>7. Biomedical- Design of medical equipment like stents, blood flow through veins and arteries, pathology.<br>8. Sports- Evaluating performance of athletes, design of high performance gear like swimsuit and helmets. | 5 | L3 |

 

## 3. Mapping And Justification

CO – PO Mapping with mapping Level along with justification for each CO-PO pair.
To attain competency required (as defined in POs) in a specified area and the knowledge & ability required to accomplish it.

| Modules | Mapping | | Mapping Level | Justification for each CO-PO pair | Level |
|---|---|---|---|---|---|
| - | **CO** | **PO** | - | **'Area': 'Competency' and 'Knowledge' for specified 'Accomplishment'** | - |
| 1 | CO1 | PO1 | L2 | 'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the different Knowledge of Fluid properties is required in construction of machines like pumps in Mechanical Engineering. | L2 |
| 1 | CO1 | PO2 | L3 | 'Problem Analysis':Analyzing problems require knowledge of different Fluid flow systems requires the knowledge of fluid properties to complex engineering problems in Mechanical engineering. | L3 |
| 2 | CO2 | PO1 | L3 | 'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the buoyancy and flotation is required for deciding stability of floating bodies to accomplish solutions to complex engineering_problems in Mechanical Engineering. | L3 |
| 2 | CO2 | PO2 | L3 | 'Problem Analysis':Analyzing problems require knowledge Floating bodies requires of fluid pressure and metacentre to accomplish solutions to complex engineering problems in Mechanical engineering. | L3 |
| 3 | CO3 | PO1 | L2 | 'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the type of fluid flow in Mechanical Engineering. | L3 |
| 3 | CO3 | PO2 | L2 | 'Problem Analysis':Analyzing problems in fluid mechanics require the knowledge of fluid flow, to accomplish solutions to complex engineering problems in Mechanical engineering. | L3 |
| 4 | CO4 | PO1 | L3 | 'Engineering Knowledge:'Acquisition Knowledge on impact force is required to analyse various forces in fluid flow in Mechanical Engineering. | L3 |
| 4 | CO4 | PO2 | L3 | 'Problem Analysis':Analyzing problems require knowledge Principle of Bernoulli's theorem is applied for designing flow measuring devices to complex engineering problems in Mechanical engineering. | L3 |
| 5 | CO5 | PO1 | L3 | 'Engineering Knowledge:'Acquisition of Engineering_Knowledge is required to understand the thermodynamic relations of perfect gases, to accomplish solutions to complex engineering_problems in Mechanical Engineering. | L3 |
| 5 | CO5 | PO2 | L3 | 'Problem Analysis': Analyzing problems in an fluid flow concepts requires a knowledge of computational fluid dynamics, in Mechanical engineering. | L3 |

## 4. Articulation Matrix

CO – PO Mapping with mapping level for each CO-PO pair, with course average attainment.

| - | - | Course Outcomes | Program Outcomes | | | | | | | | | | | | | | | - |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Modules | CO.# | **At the end of the course student should be able to . . .** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | Level |
| 1 | 18ME43.1 | Identify and calculate the fluid properties used in the analysis of fluid behaviour | √ | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | L3 Apply |
| 2 | 18ME43.2 | Explain the principles of buoyancy and fluid flow concept. | √ | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | L3 Apply |
| 3 | 18ME43.3 | Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical engineering. | √ | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | L3 Apply |
| 4 | 18ME43.4 | Explain the concept of boundary layer in fluid flow. | √ | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | L3 Apply |
| 5 | 18ME43.5 | Illustrate and explain the basic concept of compressible flow and CFD. | √ | √ | - | - | - | - | - | - | - | - | - | - | - | - | - | L3 Apply |

## 5. Curricular Gap and Content

Topics & contents not covered (from A.4), but essential for the course to address POs and PSOs.

| Modules | Gap Topic | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|---|---|---|---|---|---|
| 2 | Buoyancy | NPTEL Videos | - | - | PO2 |
| 3 | Navier Stoke Equation | NPTEL Videos | - | - | PO2 |

## 6. Content Beyond Syllabus

Topics & contents required (from A.5) not addressed, but help students for Placement, GATE, Higher Education, Entrepreneurship, etc.

| Modules | Gap Topic | Area | Actions Planned | Schedule Planned | Resources Person | PO Mapping |
|---|---|---|---|---|---|---|
| 4 | Different types of boundary layer concepts | Placement, GATE, Higher Study, . | NPTEL video | 05/05/2020 | Self | PO1 |
| 5 | Overview of Computational fluid dynamics | Placement, GATE, Higher Study | Presentation | 29/05/2020 | Prasanna Gowda | PO5 |

# C. COURSE ASSESSMENT

## 1. Course Coverage

Assessment of learning outcomes for Internal and end semester evaluation. Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

| Modules | Title | Teach. Hours | No. of question in Exam | | | | | | CO | Levels |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | CIA-1 | CIA-2 | CIA-3 | Asg | Extra Asg | SEE | | |
| 1 | Basics: Fluid Statics: | 12 | 2 | - | - | 1 | 1 | 2 | CO1 | L2, L3 |
| 2 | Buoyancy: Fluid Kinematics: | 08 | 2 | - | - | 1 | 1 | 2 | CO2 | L2, L3 |
| 3 | Fluid Dynamics; Laminar and turbulent flow: | 10 | - | 2 | - | 1 | 1 | 2 | CO3 | L3 |
| 4 | Flow over bodies: Dimensional analysis: | 09 | - | 2 | - | 1 | 1 | 2 | CO4 | L3 |
| 5 | Compressible Flows: Introduction to CFD: | 05 | - | - | 4 | 1 | 1 | 2 | CO5 | L3 |
| **-** | **Total** | **44** | **4** | **4** | **4** | **5** | **5** | **10** | **-** | **-** |

## 2. Continuous Internal Assessment (CIA)

Assessment of learning outcomes for Internal exams. Blooms Level in last column shall match with A.2.

| Modules | Evaluation | Weightage in Marks | CO | Levels |
|---|---|---|---|---|
| 1, 2 | CIA Exam – 1 | 30 | CO1, CO2, | L2, L3 |
| 3, 4 | CIA Exam – 2 | 30 | CO3, CO4 | L2, L3 |
| 5 | CIA Exam – 3 | 30 | CO5 | L2,L3 |
| | | | | |
| 1, 2 | Assignment - 1 | 10 | CO1, CO2 | L2, L3 |
| 3, 4 | Assignment - 2 | 10 | CO3, CO4, | L2,L3 |
| 5 | Assignment - 3 | 10 | CO5 | L2, L3 |
| | | | | |
| 1, 2 | Seminar - 1 | 00 | | |
| 3, 4 | Seminar - 2 | 00 | | |
| 5 | Seminar - 3 | 00 | | |
| | - | | | |
| | **Final CIA Marks** | **40** | CO1 to Co5 | L2, L3 |

# D1. TEACHING PLAN - 1

## Module - 1

| Title: | Basics: Fluid Statics: | Appr Time: | 12hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | - | **Blooms** |
| - | The student should be able to: | - | **Level** |
| 1 | Identify and calculate the fluid properties used in the analysis of fluid behaviour | CO1 | L3 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Module Content Covered** | **CO** | **Level** |
| 1 | Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension | CO1 | L2 |
| 2 | capillarity, vapor pressure, comprehensibility and bulk modulus. | CO1 | L2 |
| 3 | Concept of continuum, types of fluids etc, pressure at a point in the static mass of fluid, | CO1 | L2 |
| 4 | variation of pressure, Pascal's law | CO1 | L2 |
| 5 | Absolute, gauge, atmospheric and vacuum pressures | CO1 | L2 |
| 6 | pressure measurement by simple Manometer | CO1 | L2 |
| 7 | Differential manometers and mechanical gauges | CO1 | L3 |
| 8 | Fluid Statics: Total pressure and center of pressure for horizontal plane, | CO1 | L3 |
| 9 | vertical plane surface | CO1 | L3 |
| 10 | Inclined plane surface submerged in static fluid. | CO1 | L3 |
| 11 | Numericals | CO1 | L3 |
| 12 | Numericals | CO1 | L3 |
| | | | |
| **c** | **Application Areas** | **CO** | **Level** |
| 1 | Pascal's law is applicable for designing Hydraulic jacks, Hydraulic press | CO1 | L3 |
| **d** | **Review Questions** | - | - |
| - | | - | - |
| 1 | Give reasons :<br>i) Viscosity of liquids varies with temperature.<br>ii) Thin objects float on free surface of static liquid.<br>iii) Metacentric height determines stability of floating body.<br>iv) Rise of water in a Calillary tube.<br>v) Mercury is used as Manometric liquid. | CO1 | L2 |
| 2 | Define following terms with their units.<br>i) Specific weight ; ii) Kinematic viscosity ; iii) Surface Tension<br>iv) Specific gravity ; v) Capillarity | CO1 | L3 |
| 3 | The space between two square flat parallel plates is filled with oil. Each side of the plates is 800 mm. Thickness of the oil film is 20 mm. The upper plate moves at a uniform velocity of 3.2 m/sec when a force of 50 N applied to upper plate.<br>Determine :<br>i) Shear stress<br>ii) Dynamic viscisity of oil in poise<br>iii) Power absorbed in moving the plate<br>iv) Kinematic viscosity of oil if specific gravity of oil is 0.90 | CO1 | L2 |
| 4 | state and prove Hydrostatic law. | CO1 | L2 |
| 5 | With neat sketch, explain working of differential u-Tube Manometer and derive relation for measuring pressure difference between two pipes. | CO1 | L3 |
| 6 | A wooden block of size 6m x 5m x 3m height floats in freshwater. Find the depth of immersion and determine the metacentric height. Specify gravity of wood is 0.70. Find the volume of concrete block placed on the wooden block, so as to completely submerge the wooden block in | CO1 | L3 |

| | | | |
|---|---|---|---|
| | water. Take specific gravity of concrete as 3.0 | | |
| 7 | Explain experimental procedure to determine the metacentric height of a floating vessel. | CO1 | L3 |
| 8 | Distinguish between :<br>i) Mass density and specific weight<br>ii) Newtonian and non-Newtonian fluid<br>iii) Absolute and Kinematic viscosity. | CO1 | L2 |
| 9 | An oil film of thickness 2mm is used for lubrication between a square plate of size 0.9m x 0.9m on an inclined plane having an angle of inclination 30 ° . The weight of the square plate is 350N and it slides down the plane with a uniform velocity of 0.3m/sec. Find the viscosity of the oil in poise. | CO1 | L2 |
| 10 | Establish a relationship among absolute, gauge and atmospheric pressures with a simple sketch. | CO1 | L3 |
| 11 | A U-tube manometer containing mercury is connected to a pipe in which water is flowing. Water lend in the limb connected to pipe is 0.5m below centre of the pipe and the free surface mercury in the other limb (open to atmosphere) is 0.8m below the centre of the pipe, Calculate the pressure of water in the pipe. | CO1 | L3 |
| 12 | Define the terms :<br>i) Total pressure<br>ii) Centre of pressure | CO1 | L2 |
| 13 | An annular plate 3m external diameter and 1.5m internal diameter is immersed in water with its greatest and least depths below water surface at 3.6m and 1.2m respectively. Determine the total pressure and the position of centre of pressure on one face of the plate. | CO1 | L3 |
| 14 | A solid cylinder 15cm diameter and 60cm long consists of two parts made of different materials. The first part at the base is 1.2cm long and of specific gravity 5. The other part of the cylinder is made of the material having specific gravity 0.6. State if it can float vertically in water. | CO1 | L3 |
| 15 | Derive the relation for pressure intensity and the surface tensile force, in case of soap bubble. | CO1 | L3 |
| 16 | A steel shaft of 30 mm diameter rotates at 240 rpm, in a bearing of diameter 32 mm. Lubricant oil of viscosity 5 poise is used for lubricant of shaft in the bearing. Determine the torque required at the shaft and power lost in maintaining the lubrication. Length of bearing is 90 mm. | CO1 | L3 |
| 17 | State and prove Pascal's law. | CO1 | L2 |
| 18 | Show that, for a submerged plane surface, the centre of pressure, lies below the centre of gravity of the submerged surface. | CO1 | L3 |
| 19 | A differential mercury manometer is used for measuring the pressure difference between two pipes A and B. Pipe A is 500 mm above the pipe B and deflection in Hg manometer is 200 mm. Pressure intensity in pipe A is greater than pipe B. Pipes carry oil of specific gravity 0.90. Find the pressure difference between the two pipes. Sp.gr. of mercury = 13.6. | CO1 | L3 |
| 20 | Differentiate between gauge pressure and absolute pressure. Represent positive and negative gauge pressures on a chart. | CO1 | L2 |
| 21 | Derive the relation for capillary rise of water in a glass tube. | CO1 | L3 |
| 22 | A liquid bubble of 2cm radius has an internal pressure of 12.95 Pascals. Determine the surface tension of the liquid film. | CO1 | L3 |
| 23 | A differential U-tube manometer is used to measure the pressure difference between two points in a horizontal water pipe line. If the manometer shows a difference in mercury levels as 25 cm, find the pressure difference between the points in bar. | CO1 | L3 |
| 24 | A wooden cylinder having specific gravity 0.7 is required to float in water. If the diameter of the cylinder is 'd' and the length '1'. Show that '1' cannot exceed 0.7715 d for the cylinder to float with its longitudinal axis vertical. | CO1 | L3 |
| 25 | Define compressibility. Derive an expression for the bulk modulus of elasticity for a perfect gas, undergoing the isothermal process. | CO1 | L2 |

| | | | |
|---|---|---|---|
| 26 | Calculate the capillary effect in mm in a glass tube of 3mm diameter, when, immersed in mercury. The value of the surface tension for mercury at 20°C in contact with air is 0.51 N/m. Contact angle for mercury = 130°. Also sketch the mercury surface inside and outside the tube indicating the angle of contact clearly. | CO1 | L3 |
| 27 | If the equation of velocity profile over a flat plate is V = 2y2/3 where 'v' is the velocity in m/s and 'y' is the distance in m, determine shear stress at<br>y = 75 mm. Take IA = 8.35 poise. | CO1 | L3 |

## Module – 2

| Title: | Buoyancy: Fluid Kinematics: | Appr Time: | 8hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| - | | - | **Level** |
| 1 | Explain the principles of buoyancy and fluid flow concept. | CO2 | L3 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Portion covered per hour** | - | - |
| 13 | **Module 2:**Buoyancy, center of buoyancy, and | CO2 | L2 |
| 14 | Meta center Meta centric height its application. | CO2 | L2 |
| 15 | Numericals | CO2 | L3 |
| 16 | Fluid Kinematics: Velocity of fluid particle, types of fluid flow | CO2 | L2 |
| 17 | Description of flow, continuity equation,<br>Coordinate free form. | CO2 | L3 |
| 18 | Acceleration of fluid particle, rotational & irrotational flow. | CO2 | L3 |
| 19 | Laplace's equation in<br>velocity potential and Poisson's equation in stream function, flow net. | CO2 | L3 |
| 20 | Numericals | CO2 | L3 |
| | | | |
| **c** | **Application Areas** | **CO** | **Level** |
| 2 | Principle of buoyancy applicable for Submarines, Hydrometer, Ships & boats | CO2 | L3 |
| | | | |
| **d** | **Review Questions** | - | - |
| - | | - | - |
| 1 | Define : i) Buoyancy and centre of buoyancy ; ii) Metacentre and metacentric height. | CO2 | L2 |
| 2 | Explain the method to find the metacentric height experimentally. | CO2 | L3 |
| 3 | Derive an expression for the depth of centre of pressure from free surface of, liquid of an inclined plane surface submerged in the liquid. | CO2 | L2 |
| 4 | A wooden cylinder of specific gravity 0.6 and circular in cross section is required to float in oil of specific gravity 0.9. Find the L/D ratio for the cylinder to float with its longitudinal axis vertical in oil; where L is the height of the cylinder and D is.its diameter. | CO2 | L3 |
| 5 | Explain the importance of metacentre with stability of floating bodies. | CO2 | L2 |
| 6 | A wooden block (barge) 6 mts in length, 4 mts in width and 3 mts deep, floats in fresh water with depth of immersion 1.5 mts. A concrete block is placed centrally on the surface of the wooden block, so that the depth of immersion with concrete is 2.8 mts. Find the volume of the concrete block placed centrally, if the specific gravity of concrete is 2.75. Find also thevolume of water displaced. | CO2 | L3 |
| 7 | Velocity potential function for a two dimensional fluid flow is given by (0= x(2y —1) . Check the existence of flow. Determine the velocity of flow at a P(2,3) and the stream function. | CO2 | L3 |
| 8 | Show that streamlines and equipotential lines are orthogonal to each | CO2 | L3 |

| | | | |
|---|---|---|---|
| | other. | | |
| 9 | Distinguish between :<br>i)Steady and un-steady flow<br>ii) Uniform and non-uniform flow<br>iii) Laminar and turbulent flow | CO2 | L2 |
| 10 | Explain velocity potential and streamline | CO2 | L3 |
| 11 | What is flow net state its uses,Enlist the methods of flow net? | CO2 | L2 |
| 12 | Explain the different types of fluid flows with examples | CO2 | L2 |

# E1. CIA EXAM – 1

## a. Model Question Paper - 1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME43 | Sem: | 4 | Marks: | 30 | Time: | 75 minutes |
| Course: | FLUID MECHANICS | | | | | | |

| - | - | **Note: Answer all questions, each carry equal marks. Module : 1, 2** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Give reasons :<br>i) Viscosity of liquids varies with temperature.<br>ii) Thin objects float on free surface of static liquid.<br>iii) Metacentric height determines stability of floating body.<br>iv) Rise of water in a Calillary tube.<br>v) Mercury is used as Manometric liquid. | 5 | 1 | L2 |
| | b | An oil film of thickness 2mm is used for lubrication between a square plate of size 0.9m x 0.9m on an inclined plane having an angle of inclination 30 ° . The weight of the square plate is 350N and it slides down the plane with a uniform velocity of 0.3m/sec. Find the viscosity of the oil in poise. | 10 | 1 | L3 |
| | c | Define following terms with their units.<br>i) Specific weight ii) Kinematic viscosity iii) Surface Tension<br>iv) Specific gravity v) Capillarity | 5 | 1 | L2 |
| | | | | | |
| | | **OR** | | | |
| 2 | a | Show that, for a submerged plane surface, the centre of pressure, lies below the centre of gravity of the submerged surface. | 10 | 2 | L2 |
| | b | An oil film of thickness 2mm is used for lubrication between a square plate of size 0.9m x 0.9m on an inclined plane having an angle of inclination 30 ° . The weight of the square plate is 350N and it slides down the plane with a uniform velocity of 0.3m/sec. Find the viscosity of the oil in poise. | 10 | 2 | L3 |
| | | | | | |
| 3 | a | Define : i) Buoyancy and centre of buoyancy ; ii) Metacentre and metacentric height. | 10 | 3 | L3 |
| | b | A wooden cylinder of specific gravity 0.6 and circular in cross section is required to float in oil of specific gravity 0.9. Find the L/D ratio for the cylinder to float with its longitudinal axis vertical in oil; where L is the height of the cylinder and D is.its diameter. | 10 | 3 | L3 |
| | | **OR** | | | |

## b. Assignment -1

Note: A distinct assignment to be assigned to each student.

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME43 | Sem: | IV | Marks: | 10 | Time: | 90 – 120 minutes |
| Course: | FLUID MECHANICS | | | | Module : 1, 2 | | |
| Note: Each student to answer 2-3 assignments. Each assignment carries equal mark. | | | | | | | |

| SNo | USN | Assignment Description | Marks | CO | Level |
|---|---|---|---|---|---|
| 1 | | Derive continuity equation for a three dimensional fluid flow in Cartesian co-ordinates. | 5 | CO1 | L2 |
| 2 | | Velocity potential function for a two dimensional fluid flow is given by (0= x(2y —1) . Check the existence of flow. Determine the velocity of flow at a P(2,3) and the stream function. | 5 | CO2 | L3 |
| 3 | | Show that streamlines and equi potential lines are orthogonal to each other. | 5 | CO2 | L3 |
| 4 | | State and prove Bernoulli's equation for a fluid flow. Mention assumptions made in derivation. | 5 | CO1 | L3 |
| 5 | | Water is flowing through a taper pipe of length 150m, having diameter 500 mm at the upper end and 250 mm at the lower end. Rate of flow is 70 liters per sec. The pipeline has a slope of 1 in 30. Find the pressure at the lower end if the pressure at higher level is 2.5 bar. | 5 | CO1 | L2 |
| 6 | | Explain with neat sketch, working of pitot-static tube. | 5 | CO2 | L3 |
| 7 | | Differentiate between Orificemeter and venturimeter with neat sketches. | 5 | CO2 | L3 |
| 8 | | A horizontal venturimeter with 50cm diameter at inlet and 20cm throat diameter is used for measuring rate of water flow, if the pressure at inlet is 1.8 Bar and vaccum pressure at the throat is 30cm of mercury, find the rate of flow. Assume 10% differential pressure head is lost between the inlet and throat section. Assume coefficient of discharge is 0.96 | 5 | CO2 | L3 |
| 9 | | Distinguish between :<br>i)Steady and un-steady flow<br>ii) Uniform and non-uniform flow<br>iii) Laminar and turbulent flow | 5 | CO2 | L2 |
| 10 | | If for a two dimensional potential flow, the velocity potential is given by<br>(I) = 4x(3y — 4),determine the velocity at the point (2, 3). Determine also the value of stream function xv at the point (2, 3). | 5 | CO2 | L3 |
| 11 | | Define Euler's equation of motion. Deduce Bernoulli's equation from the same. | 5 | CO2 | L3 |
| 12 | | A pipe line carrying oil of specific gravity 0.8 changes in diameter from 300mm at position A to 500mm diameter at position B which is 5m at a higher level. If the pressure at A and B are 20N/cm 2 and 15N/cm2 respectively and discharge is 150 litres/sec, determine the loss of head and direction of flow. | 5 | CO1 | L3 |
| 13 | | A horizontal venturimeter with inlet diameter 20cm and throat diameter 10cm is used to measure the flow of water. The pressure at the inlet is 17.658N/cm 2 and the vacuum pressure at the throat is 30cm of mercury. Find the discharge of water through the venturimeter. Take Cd = 0.98. | 5 | CO1 | L2 |
| 14 | | For a two dimensional fluid flow, velocity potential is 4) = y + x2 — y2. Find the stream function and velocity at a point P (2, 3). Check irrotationality of flow. | | CO2 | L3 |

# D2. TEACHING PLAN - 2

## Module – 3

| Title: | Fluid Dynamics; Laminar and turbulent flow: | Appr Time: | 8 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| - | At the end of the topic the student should be able to | - | **Level** |
| 1 | Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical engineering. | CO3 | L3 |
| **b** | ***Course Schedule*** | | |
| **Class No** | **Portion covered per hour** | - | - |
| 1 | **Fluid Dynamics;** Introduction. Forces acting on fluid in motion. Euler's equation of motion along a streamline. | CO3 | L2 |
| 2 | Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's equation. | CO3 | L3L3 |
| 3 | Introduction to Navier-Stokes equation. Application of Bernoulli's theorem such as venturi-meter | CO3 | L2 |
| 4 | Orifice meter, rectangular and triangular notch, pitot tube. | CO3 | L3 |
| 5 | **Laminar and turbulent flow**: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, | CO3 | L2 |
| 6 | Poiseuille equation – velocity profile loss of head due to friction in viscous flow. | CO3 | L3 |
| 7 | Reynolds's experiment, frictional loss in pipe flow. | CO3 | L3 |
| 8 | Introduction to turbulence, characteristics of turbulent flow, | CO3 | L3 |
| 9 | laminar turbulent transition major and minor losses. | CO3 | L3 |
| 10 | Numericals | CO3 | L3 |
| | | | |
| **c** | **Application Areas** | - | - |
| - | Students should be able employ / apply the Module learnings to . . . | - | - |
| 1 | Application of Bernoulli's theorem for Flow measuring devices such as venturi meter, orifice meter, notches, pitot tube etc. | CO3 | L3 |
| 2 | To identify type of flow in blood vessel,Grocery cooling,Settling tanks,Wind tunnels,designing sewage systems | CO3 | L3 |
| | | | |
| **d** | **Review Questions** | - | - |
| - | The attainment of the module learning assessed through following questions | - | - |
| 1 | Explain with neat sketch, working of pitot-static tube. | CO3 | L3 |
| 2 | Differentiate between Orificemeter and venturimeter with neat sketches. | CO3 | L3 |
| 3 | A horizontal venturimeter with 50cm diameter at inlet and 20cm throat diameter is used for measuring rate of water flow, if the pressure at inlet is 1.8 Bar and vaccum pressure at the throat is 30cm of mercury, find the rate of flow. Assume 10% differential pressure head is lost between the inlet and throat section. Assume coefficient of discharge is 0.96 | CO3 | L3 |
| 4 | Define Euler's equation of motion. Deduce Bernoulli's equation from the same. | CO3 | L3 |
| 5 | Sketch and derive the relation for actual discharge through an orifice meter. | CO3 | L3 |
| 6 | Derive an expression for discharge through V — notch. | CO3 | L3 |
| 7 | A horizontal venturimeter with inlet diameter 20cm and throat diameter 10cm is used to measure the flow of water. The pressure at inlet is 147 kPa and vacuum pressure at the throat is 40cm of mercury. Find the discharge of water through venturimeter. Take Cd = 0.98. | CO3 | L3 |
| 8 | Derive an expression for discharge through a rectangular notch. | CO3 | L3 |

| | | | |
|---|---|---|---|
| 9 | Derive an expression for discharge through a venturi-meter. | CO3 | L3 |
| 10 | When do you prefer orifice meter over a venturimeter? Why? | CO3 | L2 |
| | A rectangular channel 2 m wide has a discharge of 0.25 m3/s, which is measured by a right-angled V-notch weir. Find the position of the apex of the notch from the bed of the channel if maximum depth of water is not to exceed 1.3 m. Take Cd = 0.62. | CO3 | L3 |
| 11 | Derive Hagen-poiseulle's equation for viscous flow through a circular pipe | CO3 | L3 |
| 12 | Rate of water flow through a horizontal pipe is 0.030 m 3/sec. Length of pipe is 1000 meters. Diameter of pipe for first half of length is 200mm and suddenly changes to 400mm for remaining length. Find the elevation difference between the two reservoirs connected by the horizontal pipeline. Take f=0.01 for material of pipeline. | CO3 | L3 |
| 13 | What are the energy losses that occur in pipes? Derive an expression for loss of head due to friction in pipes. | CO3 | L3 |
| 14 | A pipe of dia 30cm and length 1000m connects two reservoirs having difference of water levels as 15m. Determine the discharge through the pipe. If an additional pipe of diameter 30cm and length 600m is attached to the last 600m length, find the increase in discharge. Take f = 0.02 and neglect minor losses. | CO3 | L3 |
| 15 | Sketch the velocity and shear stress distribution across the section of the pipe for viscous flow through it. | CO3 | L3 |
| 16 | An oil of viscosity 0.1Ns/m 2 and relative density 0.9 is flowing through a circular pipe of diameter 50mm and length 300m. The rate of flow of fluid through the pipe is 3.5 litres/sec. Find the pressure drop in a length of 300m and also the shear stress at the pipe wall. | CO3 | L3 |
| 17 | A pipeline 50 m long, connects two reservoirs, having water level difference of 10m. Diameter of the pipe is 300 mm. Find rate of water flow, considering all the losses. Coefficient of friction for pipe material is 0.01. | CO3 | L3 |
| 18 | List the types of losses, with a neat sketch and equations for head losses. | CO3 | L2 |
| 19 | Derive a relation for the discharge through a circular pipe of diameter D, for the viscous flow. | CO3 | L3 |
| 20 | Fuel is pumped up in a 30 cm diameter and 15 km long pipeline at the rate of 750 kg/min. The pipe is laid at an upgrade of 1:300. The specific gravity of fuel oil is 0.95 and its kinematic viscosity 20 stokes. Find the power required to pump oil. | CO3 | L3 |
| 21 | There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm. Water leaks through the crack. Find the rate of leakage of water through the crack, if the difference of pressures between the two ends of the crack (fixed plates) is 0.02943 N/cm2. Take the viscosity of water equal to 0.01 poise. | CO3 | L3 |
| 22 | Sketch the shear stress and velocity profile across a section of a circular pipe, for the viscous flow. Derive the expressions governing shear stress and velocity profile. | CO3 | L3 |
| 23 | Water is to be supplied to the inhabitants of a college campus through a supply main. The following data is given :<br>Distance of the reservoir from the campus = 3km,<br>Number of inhabitants = 4000,<br>Consumption of water per day of each inhabitant = 180 litres,<br>Loss of head due to friction = 18m,<br>Coefficient of friction for the pipe, f = 0.007.<br>If half of the daily supply is pumped in 8 hours, determine the size of the supply main. | CO3 | L3 |
| 24 | Three pipes of diameters 300mm, 200mm and 400mm, and length 450m, 255m and 315m respectively are connected in series. The difference in water surface levels in two tanks is 18m. Determine the rate of flow of water if co-efficient of frictions are 0.0075, 0.0078 and 0.0072 respectively. Neglect the minor losses. Also find the equivalent | CO3 | L3 |

| | | | |
|---|---|---|---|
| | diameters of the pipe if the equivalent coefficient of friction is 0.0075. | | |
| 25 | Show that the average velocity is equal to the half of the maximum velocity in a laminar flow through pipe. | CO3 | L2 |
| 26 | Determine i) the pressure gradient ii) the shear stress at the two horizontal plates iii) discharge per meter width for laminar flow of oil with a maximum velocity of 2m/s between two plates which are 150mm apart. Given 1.1= 2.5 Pa-s. | CO3 | L3 |
| 27 | Derive Darcy's equation for the loss of head due to friction in a circular pipe. | CO3 | L3 |
| 28 | Prove that the ratio of maximum velocity to average velocity in a viscous flow of fluid through a circular pipe is 2.0. | CO3 | L3 |
| 29 | Lubricating oil of specific gravity 0.85 and dynamic viscosity 0.1 N-s/m2 is pumped through a 3 cm diameter pipe. If the pressure drop per metre length of the pipe is 15 kPa, determine:<br>i) The mass flow rate of oil in kg/min.<br>ii) The shear stress at the pipe wall.<br>iii) Reynolds number of the flow and<br>iv) The power required per 40 m length of the pipe to maintain the flow. | CO3 | L3 |
| 30 | An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m be 0.3 N/cm3. The width of plates is 200 mm. | CO3 | L3 |
| 31 | The diameter of a horizontal pipe which is 300mm is suddenly enlarged to 600 mm. The rate of flow of water through this pipe is 0.4 m3 /s. If the intensity of pressure in the smaller pipe is 125 kPa. Determine:<br>i)Loss of head, due to sudden enlargement<br>ii)Intensity of pressure in the larger pipe and<br>iii) Power lost due to enlargement. | CO3 | L3 |
| 32 | The flow of liquid in a circular pipe is laminar. At what radial distance from the wall of the pipe, the local velocity is half of the maximum velocity, if the diameter of the pipe is 50mm. | CO3 | L3 |
| 33 | There are two pipes A and B. Diameter of the pipe B is half of diameter of pipe A. Both pipes have same length and same fluid flows through each pipe. If volumetric flow rate is maintained same in both the pipes, compare the loss of head. Assume flow to be laminar. | CO3 | L3 |
| 34 | Three pipes of 400mm, 200mm and 30mm diameters have lengths of 400m, 200m and 300m respectively. They are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks whose difference of water levels is 16m. If co-efficient of friction for these pipe is same and equal to 0.005, determine the discharge through the compound pipe neglecting first the minor losses and then including them. | CO3 | L3 |

## Module – 4

| Title: | Flow over bodies: Dimensional analysis: | Appr Time: | 9 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | **CO** | **Blooms** |
| - | At the end of the topic the student should be able to | - | **Level** |
| 1 | Explain the concept of boundary layer in fluid flow. | CO4 | L3 |
| | | | |
| **b** | ***Course Schedule*** | | |
| **Class No** | **Portion covered per hour** | - | - |
| 1 | Flow over bodies: Development of boundary layer. | CO4 | L2 |
| 2 | Prandtl‟s boundary layer equations, Blasius solution | CO4 | L3 |
| 3 | Integral momentum equation, drag on a flat plate, | CO4 | L2 |
| 4 | Boundary layer separation and its control, streamlined | CO4 | L3 |
| 5 | Bluff bodies -flow around circular bodies and aero foils.calculation of lift and drag. | CO4 | L3 |
| 6 | Dimensional analysis: Introduction, derived quantities, dimensions of physical quantities. | CO4 | L3 |
| 7 | Homogeneity, Rayleigh's method, Buckingham Pi-theorem, | CO4 | L3 |
| 8 | Dimensionless numbers, similitude, types of similitude | CO4 | L3 |
| 9 | Numericals. | CO4 | L3 |
| | | | |
| **c** | **Application Areas** | - | - |
| - | Students should be able employ / apply the Module learnings to . . . | - | - |
| 1 | Design of airfoils in airplanes, Design of automobile parts | CO4 | L3 |
| 2 | We use dimensional analysis for three prominent reasons, they are: Consistency of a dimensional equation Derive relation between physical quantities in physical phenomena To change units from one system to another | CO4 | L3 |
| | | | |
| **d** | **Review Questions** | - | - |
| - | The attainment of the module learning assessed through following questions | - | - |
| 1 | Show that streamlines and equipotential lines are orthogonal to each other. | CO4 | L3 |
| 2 | Explain Model Similitude and Non-dimensional numbers. | CO4 | L3 |
| 3 | The pressure difference 'Ap' in a pipe of diameter D and length '1' due to viscous flow depends on velocity V, viscosity t and density p. Using Buckingham's TE theorem, obtain an expression for Ap. | CO4 | L2 |
| 4 | Define :<br>i) Displacement thickness<br>ii) Momentum thickness<br>iii) Energy thickness<br>iv) Shape factor as with respect to boundary layer. | CO4 | L2 |
| 5 | A man descends the ground from an airoplane with h&j, of a parachute, which is hemispherical having a diameter of 5m against the resist of air with a uniform velocity of 25m/s. Find the weight of the man if the weight of parachute is 9. 81, CD = 0.6. | CO4 | L2 |
| 6 | Explain the different types of similitude. | CO4 | L2 |
| 8 | Assume the viscous force F exerted by a fluid on sphere of diameter D, depends on viscosity 1.t of mass density p and velocity of motion of the sphere, obtain the expression for shear force F, using Buckingham's it -theorem | CO4 | L2 |
| 9 | Explain the terms:<br>i) Lift and drag | CO4 | L2 |

| | | | |
|---|---|---|---|
| | ii) Momentum thickness<br>iii) Sonic and subsonic flow | | |
| 10 | Define Mach number. What is the significance of Mach number in compressible fluid flows? | CO4 | L2 |
| 11 | An aeroplane weighing 40 kN is flying in a horizontal direction at 360 km/hr. the plane has a wing surface area of 35 m2. Determine the lift coefficient and the power required to drive the plane. Assume drag coefficient CD = 0.03 and for air p = 1.20 kg/m3. | CO4 | L3 |
| 12 | A projectile travels in air of pressure 10.1043 N/cm2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kgK. | CO4 | L3 |
| 13 | What is the meaning of boundary layer separation? What is the effect of pressure gradient on boundary layer separation? | CO4 | L2 |
| 14 | A kite 0.8m x 0.8m weighing 3.924N assumes an angle of 12° to the horizontal. The attached to the kite makes an angle of 45° to the horizontal. The pull on the string is 24.525 N wizen the wind is flowing at a speed of 30 km/hr. find the corresponding coefficient of drag and lift. Take density of air = 1.25 kg/m3. | CO4 | L3 |
| 15 | a. Explain the following:<br>(i) Stream line body<br>(ii) Bluff body<br>(iii) Mach number<br>(iv) Mach angle<br>(v) Boundary layer thickness | CO4 | L2 |
| 16 | An aeroplane is flying at a height of 15 km where the temperature is -50°C. The speed of the plane is corresponding to M = 2.0. Assuming K = 1.4 and R = 287 J/kg-K, find the speed of the plane. | CO4 | L3 |
| 17 | Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine<br>(I) Drag force.<br>(ii)Lift force.<br>(iii) Resultant force. | CO4 | L3 |
| 18 | State Buckingham's it theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis? | CO4 | L2 |
| 19 | Derive a relation for the velocity of sound in a compressible fluid. | CO4 | L3 |
| 20 | Find the velocity of a bullet fired in the air, if the Mach angle is 30°. Temperature of air is 22°C, density of air is 1.2 kg/m 3 . Assume y = 1.4 and R = 287 J/kg K. | CO4 | L3 |
| 21 | A flat plate 1.8mx1.8m moves at 36 km/hr in a stationary air of mass density 1.2 kg/m 3 . If the coefficients of drag and lift are 0.15 and 0.75 respectively. Determine<br>i)Drag force<br>ii)Lift force<br>iii)Resultant force<br>iv)Power required to keep the plate in motion. | CO4 | L3 |
| 22 | Explain the dimensional homogeneity, with an example. | CO4 | L2 |
| 23 | Derive an expression for the velocity of sound in terms of bulk modulus (k). | CO4 | L3 |
| 24 | Define Mach number and derive an expression for the same. | CO4 | L2 |
| 25 | The experiments were conducted in a wind tunnel with a wind speed of 50 km/hr on a flat plate of size 2 m long and I m wide. The density of air is 1.15 kg/m'. The coefficients of lift and drag are 0.75 and 0.15 respectively. Determine:<br>i) Lift force<br>ii) Drag force<br>iii) The resultant force<br>iv) Direction of resultant force<br>v) Power exerted by air on plate | CO4 | L3 |

| | | | |
|---|---|---|---|
| 26 | State Buckingham's n theorem. The efficiency ri of a fan depends on density p, dynamic viscosity p. of the fluid, angular velocity co, diameter D, discharge Q. Express rl in terms of dimensionless parameters. | CO4 | L3 |

# E2. CIA EXAM – 2

## a. Model Question Paper - 2

| Crs Code: | 18ME43 | Sem: | IV | Marks: | 30 | Time: | 75 minutes |
|---|---|---|---|---|---|---|---|
| Course: | Energy Engineering | | | | | | |

| - | - | **Note: Answer all questions, each carry equal marks. Module : 3, 4** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Derive Hagen-poiseulle's equation for viscous flow through a circular pipe | 10 | 3 | L2 |
| | b | Sketch the velocity and shear stress distribution across the section of the pipe for viscous flow through it. | 10 | 3 | L2 |
| | | OR | | | |
| 2 | a | Derive Darcy's equation for the loss of head due to friction in a circular pipe. | 10 | 3 | L2 |
| | b | An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m be 0.3 N/cm3. The width of plates is 200 mm. | 10 | 3 | L3 |
| | | | | | |
| 3 | a | Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine<br>(I) Drag force.<br>(ii)Lift force.<br>(iii) Resultant force. | 10 | 4 | L3 |
| | b | Derive a relation for the velocity of sound in a compressible fluid. | 10 | 4 | L2 |
| | | OR | | | |
| 4 | a | Explain the different types of similitude. | 5 | 4 | L2 |
| | b | State Buckingham's it theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis? | 5 | 4 | L2 |
| | c | Assume the viscous force F exerted by a fluid on sphere of diameter D, depends on viscosity 1.t of mass density p and velocity of motion of the sphere, obtain the expression for shear force F, using Buckingham's it - theorem | 10 | 4 | L3 |

L3

## b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 15ME71 | Sem: | VII | Marks: | 5 | Time: | 90 – 120 minutes |
| Course: | Energy Engineering | | | | Module : 3, 4 | | |
| Note: Each student to answer 2-3 assignments. Each assignment carries equal mark. | | | | | | | |

| **SNo** | **USN** | **Assignment Description** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | | Derive Hagen-poiseulle's equation for viscous flow through a circular pipe | 5 | CO3 | L3 |
| 2 | | Rate of water flow through a horizontal pipe is 0.030 m 3/sec. Length of pipe is 1000 meters. Diameter of pipe for first half of length is 200mm and suddenly changes to 400mm for remaining length. Find the elevation difference between the two reservoirs connected by the horizontal pipeline. Take f=0.01 for material of pipeline. | 5 | C03 | L3 |
| 3 | | What are the energy losses that occur in pipes? Derive an expression for loss of head due to friction in pipes. | 5 | C03 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | | A pipe of dia 30cm and length 1000m connects two reservoirs having difference of water levels as 15m. Determine the discharge through the pipe. If an additional pipe of diameter 30cm and length 600m is attached to the last 600m length, find the increase in discharge. Take f = 0.02 and neglect minor losses. | 5 | C03 | L3 |
| 5 | | Sketch the velocity and shear stress distribution across the section of the pipe for viscous flow through it. | 5 | C03 | L2 |
| 6 | | An oil of viscosity 0.1Ns/m 2 and relative density 0.9 is flowing through a circular pipe of diameter 50mm and length 300m. The rate of flow of fluid through the pipe is 3.5 litres/sec. Find the pressure drop in a length of 300m and also the shear stress at the pipe wall. | 5 | C03 | L3 |
| 7 | | A pipeline 50 m long, connects two reservoirs, having water level difference of 10m. Diameter of the pipe is 300 mm. Find rate of water flow, considering all the losses. Coefficient of friction for pipe material is 0.01. | 5 | C03 | L3 |
| 8 | | List the types of losses, with a neat sketch and equations for head losses. | 5 | CO3 | L2 |
| 9 | | Derive a relation for the discharge through a circular pipe of diameter D, for the viscous flow. | 5 | CO3 | L3 |
| 10 | | Fuel is pumped up in a 30 cm diameter and 15 km long pipeline at the rate of 750 kg/min. The pipe is laid at an upgrade of 1:300. The specific gravity of fuel oil is 0.95 and its kinematic viscosity 20 stokes. Find the power required to pump oil. | | CO3 | L2 |
| 11 | | There is a horizontal crack 40 mm wide and 2.5 mm deep in a wall of thickness 100 mm. Water leaks through the crack. Find the rate of leakage of water through the crack, if the difference of pressures between the two ends of the crack (fixed plates) is 0.02943 N/cm2. Take the viscosity of water equal to 0.01 poise. | 5 | CO3 | L3 |
| 12 | | Sketch the shear stress and velocity profile across a section of a circular pipe, for the viscous flow. Derive the expressions governing shear stress and velocity profile. | 5 | CO3 | L2 |
| 13 | | Water is to be supplied to the inhabitants of a college campus through a supply main. The following data is given :Distance of the reservoir from the campus = 3km, Number of inhabitants = 4000,<br>Consumption of water per day of each inhabitant = 180 litres, Loss of head due to friction = 18m,<br>Coefficient of friction for the pipe, f = 0.007.<br>If half of the daily supply is pumped in 8 hours, determine the size of the supply main. | 5 | CO3 | L3 |
| 14 | | Three pipes of diameters 300mm, 200mm and 400mm, and length 450m, 255m and 315m respectively are connected in series. The difference in water surface levels in two tanks is 18m. Determine the rate of flow of water if co-efficient of frictions are 0.0075, 0.0078 and 0.0072 respectively. Neglect the minor losses. Also find the equivalent diameters of the pipe if the equivalent coefficient of friction is 0.0075. | | CO3 | L3 |
| 15 | | Show that the average velocity is equal to the half of the maximum velocity in a laminar flow through pipe. | 5 | CO3 | L2 |
| 16 | | Determine i) the pressure gradient ii) the shear stress at the two horizontal plates iii) discharge per meter width for laminar flow of oil with a maximum velocity of 2m/s between two plates which are 150mm apart. Given 1.1= 2.5 Pa-s. | 5 | CO3 | L3 |
| 17 | | Derive Darcy's equation for the loss of head due to | 5 | CO4 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| | | friction in a circular pipe. | | | |
| 18 | | Prove that the ratio of maximum velocity to average velocity in a viscous flow of fluid through a circular pipe is 2.0. | | CO4 | L2 |
| 19 | | Lubricating oil of specific gravity 0.85 and dynamic viscosity 0.1 N-s/m2 is pumped through a 3 cm diameter pipe. If the pressure drop per metre length of the pipe is 15 kPa, determine:<br>i) The mass flow rate of oil in kg/min.<br>ii) The shear stress at the pipe wall.<br>iii) Reynolds number of the flow and<br>iv) The power required per 40 m length of the pipe to maintain the flow. | 5 | CO4 | L3 |
| 20 | | An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m be 0.3 N/cm3. The width of plates is 200 mm. | 5 | CO4 | L3 |
| 21 | | The diameter of a horizontal pipe which is 300mm is suddenly enlarged to 600 mm. The rate of flow of water through this pipe is 0.4 m3 /s. If the intensity of pressure in the smaller pipe is 125 kPa. Determine:<br>i)Loss of head, due to sudden enlargement<br>ii)Intensity of pressure in the larger pipe and<br>iii) Power lost due to enlargement. | 5 | CO4 | L3 |
| 22 | | The flow of liquid in a circular pipe is laminar. At what radial distance from the wall of the pipe, the local velocity is half of the maximum velocity, if the diameter of the pipe is 50mm. | 5 | CO4 | L3 |
| 23 | | There are two pipes A and B. Diameter of the pipe B is half of diameter of pipe A. Both pipes have same length and same fluid flows through each pipe. If volumetric flow rate is maintained same in both the pipes, compare the loss of head. Assume flow to be laminar. | 5 | CO4 | L3 |
| 24 | | Three pipes of 400mm, 200mm and 30mm diameters have lengths of 400m, 200m and 300m respectively. They are connected in series to make a compound pipe. The ends of this compound pipe are connected with two tanks whose difference of water levels is 16m. If co-efficient of friction for these pipe is same and equal to 0.005, determine the discharge through the compound pipe neglecting first the minor losses and then including them. | 5 | CO4 | L3 |
| 25 | | Water at 15°C flows between two parallel plates at a distance of 1.6 mm apart. Determine:<br>i) Maximum velocity<br>ii) Pressure loss per unit length<br>iii) Shear stress at the plate if the average velocity is 0.2 m/s. Viscosity of water at 15°C is 0.01 poise. Take unit width of the plate. | 5 | CO4 | L3 |
| 26 | | Show that streamlines and equipotential lines are orthogonal to each other. | 5 | CO4 | L2 |
| 27 | | Explain Model Similitude and Non-dimensional numbers. | 5 | CO4 | L2 |
| 28 | | The pressure difference 'Ap' in a pipe of diameter D and length '1' due to viscous flow depends on velocity V, viscosity t and density p. Using Buckingham's TE theorem, obtain an expression for Ap. | 5 | CO4 | L3 |
| 29 | | Define :<br>i) Displacement thickness<br>ii) Momentum thickness | 5 | CO4 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| | | iii) Energy thickness<br>iv) Shape factor as with respect to boundary layer. | | | |
| 30 | | A man descends the ground from an airoplane with h&j, of a parachute, which is hemispherical having a diameter of 5m against the resist of air with a uniform velocity of 25m/s. Find the weight of the man if the weight of parachute is 9. 81, CD = 0.6. | 5 | CO4 | L3 |
| 31 | | Explain the different types of similitude. | 5 | CO5 | L2 |
| 32 | | Assume the viscous force F exerted by a fluid on sphere of diameter D, depends on viscosity 1.t of mass density p and velocity of motion of the sphere, obtain the expression for shear force F, using Buckingham's it - theorem | 5 | CO4 | L2 |
| 33 | | Explain the terms:<br>i) Lift and drag<br>ii) Momentum thickness<br>iii) Sonic and subsonic flow | 5 | CO5 | L2 |
| 34 | | Define Mach number. What is the significance of Mach number in compressible fluid flows? | 5 | CO5 | L2 |
| 35 | | An aeroplane weighing 40 kN is flying in a horizontal direction at 360 km/hr. the plane has a wing surface area of 35 m2. Determine the lift coefficient and the power required to drive the plane. Assume drag coefficient CD = 0.03 and for air p = 1.20 kg/m3. | 5 | CO5 | L3 |
| 36 | | A projectile travels in air of pressure 10.1043 N/cm2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kgK. | 5 | CO5 | L3 |
| 37 | | What is the meaning of boundary layer separation? What is the effect of pressure gradient on boundary layer separation? | 5 | CO5 | L2 |
| 38 | | A kite 0.8m x 0.8m weighing 3.924N assumes an angle of 12° to the horizontal. The attached to the kite makes an angle of 45° to the horizontal. The pull on the string is 24.525 N wizen the wind is flowing at a speed of 30 km/hr. find the corresponding coefficient of drag and lift. Take density of air = 1.25 kg/m3. | 5 | CO5 | L3 |
| 39 | | a. Explain the following:<br>(i) Stream line body<br>(ii) Bluff body<br>(iii) Mach number<br>(iv) Mach angle<br>(v) Boundary layer thickness | 5 | CO5 | L2 |
| 40 | | An aeroplane is flying at a height of 15 km where the temperature is -50°C. The speed of the plane is corresponding to M = 2.0. Assuming K = 1.4 and R = 287 J/kg-K, find the speed of the plane. | 5 | CO5 | L3 |
| 41 | | Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine<br>(I) Drag force.<br>(ii)Lift force.<br>(iii) Resultant force. | 5 | CO5 | L3 |
| 42 | | State Buckingham's it theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis? | 5 | CO5 | L2 |
| 43 | | Derive a relation for the velocity of sound in a compressible fluid. | 5 | CO5 | L3 |
| 44 | | Find the velocity of a bullet fired in the air, if the Mach | 5 | CO5 | L |

| | | | | | |
|---|---|---|---|---|---|
| | | angle is 30°. Temperature of air is 22°C, density of air is 1.2 kg/m 3 . Assume y = 1.4 and R = 287 J/kg K. | | | |
| 45 | | A flat plate 1.8mx1.8m moves at 36 km/hr in a stationary air of mass density 1.2 kg/m 3 . If the coefficients of drag and lift are 0.15 and 0.75 respectively. Determine<br>i)Drag force<br>ii)Lift force<br>iii)Resultant force<br>iv)Power required to keep the plate in motion. | 5 | CO5 | L3 |
| 46 | | Explain the dimensional homogeneity, with an example. | 5 | CO4 | L2 |
| 47 | | Derive an expression for the velocity of sound in terms of bulk modulus (k). | 5 | CO5 | L3 |

# D3. TEACHING PLAN - 3

## Module – 5

| Title: | Compressible Flows: Introduction to CFD: | Appr Time: | 5rs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | - | **Blooms** |
| - | The student should be able to: | - | **Level** |
| 1 | Illustrate and explain the basic concept of compressible flow and CFD. | CO5 | L3 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Portion covered per hour** | - | - |
| 1 | Compressible Flows: Introduction thermodynamic relations of perfect gases, internal energy and enthalpy | CO5 | L2 |
| 2 | speed of sound, pressure field due to a moving source | CO5 | L2 |
| 3 | basic Equations for one-dimensional flow, stagnation and sonic Properties,normal and oblique shocks, | CO5 | L3 |
| 4 | Introduction to CFD,Necessity of CFD,Limitations of CFD,Philosophy and applications . | CO5 | L2 |
| 5 | Numericals | CO5 | L3 |
| **c** | **Applications:** | - | - |
| 1 | 1. Nozzles and Diffusers and converging diverging nozzles<br>2. Turbines, fans & pumps<br>3. Throttles – flow regulators,<br>4. One Dimensional Isentropic Flow – compressible pipe flow. | CO5 | L2 |
| 2 | Some of the applications of CFD in Industries are -<br>1.Electronics- For design and analysis of cooling system.<br>2.2.Turbo machinery- For design and analysis pumps, compressors, fans, bl turbines nozzle and diffusers.<br>3.Sports- Evaluating performance of athletes, design of high performance gear like swimsuit and helmets. | CO5 | L3 |
| | | | |
| **d** | **Review Questions** | - | - |
| - | The attainment of the module learning assessed through following questions | - | - |
| 1 | Write short essay on the engineering application of CFD, brining the advantages and the limitations. | CO5 | L2 |
| 2 | Define the following terms and write the relevant equations for the same : -<br>i) Stagnation Temperature<br>ii) Stagnation Pressure | CO5 | L2 |
| 3 | Define: i) Mach line ii) Mach angle iii) Subsonic and supersonic flow. | CO5 | L2 |
| 4 | Calculate the velocity and Mach number of a supersonic aircraft flying at an altitude of 1200m when temperature is 300K. Sound of aircraft is | CO5 | L2 |

| | | | |
|---|---|---|---|
| | heard 2 seconds after passage of aircraft over the head of an observer Take r=1.41, R = 287 J/kg/k. | | |
| 5 | Explain the terms:<br>i) Lift and drag<br>ii) Momentum thickness<br>iii) Sonic and subsonic flow | CO5 | L2 |
| 6 | Define Mach number. What is the significance of Mach number in compressible fluid flows? | - | L2 |
| 7 | An aeroplane weighing 40 kN is flying in a horizontal direction at 360 km/hr. the plane has a wing surface area of 35 m2. Determine the lift coefficient and the power required to drive the plane. Assume drag coefficient CD = 0.03 and for air p = 1.20 kg/m3. | CO5 | L2 |
| 8 | A projectile travels in air of pressure 10.1043 N/cm2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kgK | CO5 | L2 |
| 9 | Show that the velocity of a sound wave in a compressible fluid medium is given by c = kVP<br>where k and p are bulk modules of elasticity and density of the fluid respectively. | CO5 | L2 |
| 10 | Calculate the velocity and mach number of a supersonic aircraft flying at an altitude of 1000 in where the temperature is 280 K. Sound of the aircraft is heard 2.15 seconds after the passage of the aircraft on the head of an observer. Take y = 1.41 and R = 287 J/kgK. | CO5 | L2 |
| 11 | Define stagnation temperature of a fluid. Show that the stagnation temperature and static temperatures are related by<br>T0/T=1+(r-1/2) where r = ratio of specific heats, m = mach number | CO5 | L2 |
| 12 | Mention the applications and limitations of computational fluid dynamics. | CO5 | L2 |
| | Obtain an expression for velocity of the sound wave in a compressible fluid in terms of change of pressure and change of density. | CO5 | L3 |
| 13 | Calculate the Mach number and Mach angle at a point on a jet propelled aircraft which is flying at 900 km/hour at sea level where air temperature is 15°C. Take K = 1.4 andR = 287 J/kgK. | CO5 | L2 |

# E3. CIA EXAM – 3

## a. Model Question Paper - 3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME43 | Sem: | IV | Marks: | 30 | Time: | 75 minutes |
| Course: | FLUID MECHANICS | | | | | | |

| - | - | **Note: Answer any 2 questions, each carry equal marks.** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Define: i) Mach line ii) Mach angle iii) Subsonic and supersonic flow. | 10 | 5 | L2 |
| | b | Calculate the velocity and Mach number of a supersonic aircraft flying at an altitude of 1200m when temperature is 300K. Sound of aircraft is heard 2 seconds after passage of aircraft over the head of an observer Take r=1.41, R = 287 J/kg/k. | 10 | 5 | L3 |
| | | OR | | | |
| 2 | a | Show that the velocity of a sound wave in a compressible fluid medium is given by c = kVP<br>where k and p are bulk modules of elasticity and density of the fluid respectively. | 10 | 5 | L3 |
| | b | Calculate the velocity and mach number of a supersonic aircraft flying at an altitude of 1000 in where the temperature is 280 K. Sound of the aircraft is heard 2.15 seconds after the passage of the aircraft on the head of an observer. Take y = 1.41 and R = 287 J/kgK. | 10 | 5 | L3 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | a | Write short essay on the engineering application of CFD, brining the advantages and the limitations. | 10 | 5 | L3 |
| | b | Define the following terms and write the relevant equations for the same : -<br>i) Stagnation Temperature<br>ii) Stagnation Pressure | 10 | 5 | L2 |
| | | OR | | | |
| 4 | a | Define stagnation temperature of a fluid. Show that the stagnation temperature and static temperatures are related by T0/T=1+(r-1/2) where r = ratio of specific heats, m = mach number | 10 | 5 | L3 |
| | b | Mention the applications and limitations of computational fluid dynamics. | 10 | 5 | L2 |

## b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME43 | Sem: | IV | Marks: | 10 | Time: | 90 – 120 minutes |
| Course: | FLUID MECHANICS | | | | Module : 5 | | |
| Note: Each student to answer 2-3 assignments. Each assignment carries equal mark. | | | | | | | |

| SNo | USN | Assignment Description | Marks | CO | Level |
|---|---|---|---|---|---|
| 1 | | Explain the terms:<br>i) Lift and drag<br>ii) Momentum thickness<br>iii) Sonic and subsonic flow | 5 | CO5 | L2 |
| 2 | | Define Mach number. What is the significance of Mach number in compressible fluid flows? | 5 | CO5 | L2 |
| 3 | | An aeroplane weighing 40 kN is flying in a horizontal direction at 360 km/hr. the plane has a wing surface area of 35 m2. Determine the lift coefficient and the power required to drive the plane. Assume drag coefficient CD = 0.03 and for air p = 1.20 kg/m3. | | CO5 | L3 |
| 4 | | A projectile travels in air of pressure 10.1043 N/cm2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kgK. | 5 | CO5 | L3 |
| 5 | | What is the meaning of boundary layer separation? What is the effect of pressure gradient on boundary layer separation? | 5 | CO5 | L2 |
| 6 | | A kite 0.8m x 0.8m weighing 3.924N assumes an angle of 12° to the horizontal. The attached to the kite makes an angle of 45° to the horizontal. The pull on the string is 24.525 N wizen the wind is flowing at a speed of 30 km/hr. find the corresponding coefficient of drag and lift. Take density of air = 1.25 kg/m3. | 5 | CO5 | L3 |
| 7 | | a. Explain the following:<br>(i) Stream line body<br>(ii) Bluff body<br>(iii) Mach number<br>(iv) Mach angle<br>(v) Boundary layer thickness | | CO5 | L2 |
| 8 | | An aeroplane is flying at a height of 15 km where the temperature is -50°C. The speed of the plane is corresponding to M = 2.0. Assuming K = 1.4 and R = 287 J/kg-K, find the speed of the plane. | 5 | CO5 | L2 |
| 9 | | Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine | 5 | CO5 | L3 |

| | | | | | |
|---|---|---|---|---|---|
| | | (I) Drag force.<br>(ii)Lift force.<br>(iii) Resultant force. | | | |
| 10 | | Derive a relation for the velocity of sound in a compressible fluid. | 5 | CO5 | L3 |
| 11 | | Find the velocity of a bullet fired in the air, if the Mach angle is 30°. Temperature of air is 22°C, density of air is 1.2 kg/m 3 . Assume y = 1.4 and R = 287 J/kg K. | | CO5 | L3 |
| 12 | | A flat plate 1.8mx1.8m moves at 36 km/hr in a stationary air of mass density 1.2 kg/m 3 . If the coefficients of drag and lift are 0.15 and 0.75 respectively. Determine<br>i)Drag force<br>ii)Lift force<br>iii)Resultant force<br>iv)Power required to keep the plate in motion. | 5 | CO5 | L3 |
| 13 | | Write short essay on the engineering application of CFD, brining the advantages and the limitations. | 5 | CO5 | L2 |
| 14 | | Define the following terms and write the relevant equations for the same : -<br>i) Stagnation Temperature<br>ii) Stagnation Pressure | 5 | CO5 | L2 |
| 15 | | Define: i) Mach line ii) Mach angle iii) Subsonic and supersonic flow. | | CO5 | L2 |
| 16 | | Calculate the velocity and Mach number of a supersonic aircraft flying at an altitude of 1200m when temperature is 300K. Sound of aircraft is heard 2 seconds after passage of aircraft over the head of an observer Take r=1.41, R = 287 J/kg/k. | 5 | CO5 | L3 |
| 17 | | Explain the terms:<br>i) Lift and drag<br>ii) Momentum thickness<br>iii) Sonic and subsonic flow | 5 | CO5 | L2 |
| 18 | | Define Mach number. What is the significance of Mach number in compressible fluid flows? | 5 | CO5 | L2 |
| 19 | | An aeroplane weighing 40 kN is flying in a horizontal direction at 360 km/hr. the plane has a wing surface area of 35 m2. Determine the lift coefficient and the power required to drive the plane. Assume drag coefficient CD = 0.03 and for air p = 1.20 kg/m3. | 5 | CO5 | L3 |
| 20 | | A projectile travels in air of pressure 10.1043 N/cm2 at 10°C at a speed of 1500 km/hr. Find the Mach number and Mach angle. Take K = 1.4 and R = 287 J/kgK | 5 | CO5 | L3 |
| 21 | | Show that the velocity of a sound wave in a compressible fluid medium is given by c = kVP<br>where k and p are bulk modules of elasticity and density of the fluid respectively. | | CO5 | L3 |
| 22 | | Calculate the velocity and mach number of a supersonic aircraft flying at an altitude of 1000 in where the temperature is 280 K. Sound of the aircraft is heard 2.15 seconds after the passage of the aircraft on the head of an observer. Take y = 1.41 and R = 287 J/kgK. | 5 | CO5 | L3 |
| 23 | | Define stagnation temperature of a fluid. Show that the stagnation temperature and static temperatures are related by<br>T0/T=1+(r-1/2) where r = ratio of specific heats, m = mach number | 5 | CO5 | L3 |
| 24 | | Mention the applications and limitations of computational fluid dynamics. | 5 | CO5 | L2 |
| 25 | | Obtain an expression for velocity of the sound wave in a | 5 | CO5 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| | | compressible fluid in terms of change of pressure and change of density. | | | |
| 26 | | Calculate the Mach number and Mach angle at a point on a jet propelled aircraft which is flying at 900 km/hour at sea level where air temperature is 15°C. Take K = 1.4 andR = 287 J/kgK. | 5 | CO5 | L3 |

# F. EXAM PREPARATION

## 1. University Model Question Paper

| Course: | FLUID MECHANICS | | | | | Month / Year | May /2019 |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME43 | Sem: | IV | Marks: | 100 | Time: | 180 minutes |

| Module | **Note** | Answer all FIVE full questions. All questions carry equal marks. | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | Give reasons :<br>i) Viscosity of liquids varies with temperature.<br>ii) Thin objects float on free surface of static liquid.<br>iii) Metacentric height determines stability of floating body.<br>iv) Rise of water in a Calillary tube.<br>v) Mercury is used as Manometric liquid. | 5 | CO1 | L2 |
| | b | An oil film of thickness 2mm is used for lubrication between a square plate of size 0.9m x 0.9m on an inclined plane having an angle of inclination 30 ° . The weight of the square plate is 350N and it slides down the plane with a uniform velocity of 0.3m/sec. Find the viscosity of the oil in poise. | 10 | CO1 | L3 |
| | c | Define following terms with their units.<br>i) Specific weight ii) Kinematic viscosity iii) Surface Tension<br>iv) Specific gravity v) Capillarity | 5 | CO1 | L2 |
| | | **OR** | | | |
| 2 | a | Show that, for a submerged plane surface, the centre of pressure, lies below the centre of gravity of the submerged surface. | 10 | CO2 | |
| | b | Define : i) Buoyancy and centre of buoyancy ; ii) Metacentre and metacentric height. | 10 | CO2 | L2 |
| | | | | | L3 |
| 3 | a | Derive continuity equation for a three dimensional fluid flow in Cartesian co-ordinates. | 10 | CO2 | L3 |
| | b | Explain with neat sketch, working of pitot-static tube. | 10 | CO2 | L2 |
| | | **OR** | | | |
| 4 | a | Derive an expression for discharge through V — notch. | 10 | CO3 | L3 |
| | b | An orifice meter with orifice diameter 10cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter give readings of 19.62 N/cm2 and 9.81 N/cm2 respectively. Cd for the meter is 0.6. Find the discharge of water through the pipe. | 10 | CO3 | L3 |
| | | | | | |
| 5 | a | Derive Hagen-poiseulle's equation for viscous flow through a circular pipe | 10 | CO3 | L3 |
| | b | Sketch the velocity and shear stress distribution across the section of the pipe for viscous flow through it. | 10 | CO3 | L3 |
| | | **OR** | | | |
| 6 | a | Derive Darcy's equation for the loss of head due to friction in a circular pipe. | 10 | CO4 | L3 |
| | b | An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m be 0.3 N/cm3. The width of plates is 200 mm. | 10 | CO4 | L3 |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 7 | a | Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine<br>(I) Drag force.<br>(ii)Lift force.<br>(iii) Resultant force. | 10 | CO3 | L3 |
| | b | Derive a relation for the velocity of sound in a compressible fluid. | 10 | CO4 | L3 |
| | | **OR** | | | |
| 8 | a | Explain the different types of similitude. | 5 | CO4 | L3 |
| | b | State Buckingham's it theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis? | 5 | CO4 | L3 |
| | c | Assume the viscous force F exerted by a fluid on sphere of diameter D, depends on viscosity 1.t of mass density p and velocity of motion of the sphere, obtain the expression for shear force F, using Buckingham's it - theorem | 10 | CO4 | L3 |
| | | | | | |
| 9 | a | Define stagnation temperature of a fluid. Show that the stagnation temperature and static temperatures are related by T0/T=1+(r-1/2) where r = ratio of specific heats, m = mach number | 10 | CO5 | L3 |
| | b | Define the following terms and write the relevant equations for the same : -<br>i) Stagnation Temperature<br>ii) Stagnation Pressure | 10 | C05 | L2 |
| | | **OR** | | | |
| 10 | a | Write short essay on the engineering application of CFD, brining the advantages and the limitations. | 10 | CO5 | L2 |
| | b | Mention the applications and limitations of computational fluid dynamics. | 10 | CO5 | L2 |

## 2. SEE Important Questions

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Course: | FLUID MECHANICS | | | | | Month / Year | May /2019 |
| Crs Code: | 18ME43 | Sem: | IV | Marks: | 100 | Time: | 180 minutes |

| | | | | | |
|---|---|---|---|---|---|
| | **Note** | Answer all FIVE full questions. All questions carry equal marks. | - | - | |
| Module | Qno. | Important Question | **Marks** | **CO** | **Year** |
| 1 | 1 | Give reasons :<br>i) Viscosity of liquids varies with temperature.<br>ii) Thin objects float on free surface of static liquid.<br>iii) Metacentric height determines stability of floating body.<br>iv) Rise of water in a Calillary tube.<br>v) Mercury is used as Manometric liquid. | 5 | CO1 | 2016 |
| | 2 | An oil film of thickness 2mm is used for lubrication between a square plate of size 0.9m x 0.9m on an inclined plane having an angle of inclination 30 ° . The weight of the square plate is 350N and it slides down the plane with a uniform velocity of 0.3m/sec. Find the viscosity of the oil in poise. | 10 | CO1 | 2016 |
| | 3 | Define following terms with their units.<br>i) Specific weight ii) Kinematic viscosity iii) Surface Tension<br>iv) Specific gravity v) Capillarity | 5 | CO1 | 2014 |
| | | **OR** | | | |
| 1 | 1 | Show that, for a submerged plane surface, the centre of pressure, lies below the centre of gravity of the submerged surface. | 10 | CO2 | 2018 |
| | 2 | Define : i) Buoyancy and centre of buoyancy ; ii) Metacentre and metacentric height. | 10 | CO2 | 2016 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| 2 | 1 | Derive continuity equation for a three dimensional fluid flow in Cartesian co-ordinates. | 10 | CO2 | 2015 |
| | 2 | Explain with neat sketch, working of pitot-static tube. | 10 | CO2 | 2014 |
| | | **OR** | | | |
| 2 | 1 | Derive an expression for discharge through V — notch. | 10 | CO2 | 2015 |
| | 2 | An orifice meter with orifice diameter 10cm is inserted in a pipe of 20 cm diameter. The pressure gauges fitted upstream and downstream of the orifice meter give readings of 19.62 N/cm2 and 9.81 N/cm2 respectively. Cd for the meter is 0.6. Find the discharge of water through the pipe. | 10 | CO2 | 2014 |
| | | | | | |
| 3 | 1 | Derive Hagen-poiseulle's equation for viscous flow through a circular pipe | 10 | CO3 | 2016 |
| | 2 | Sketch the velocity and shear stress distribution across the section of the pipe for viscous flow through it. | 10 | CO3 | 2014 |
| | | **OR** | | | |
| 3 | 1 | Derive Darcy's equation for the loss of head due to friction in a circular pipe. | 10 | CO3 | 2017 |
| | 2 | An oil of viscosity 10 poise flows between two parallel fixed plates which are kept at a distance of 50 mm apart. Find the rate of flow of oil between the plates if the drop of pressure in a length of 1.2 m be 0.3 N/cm3. The width of plates is 200 mm. | 10 | CO3 | 2013 |
| | | | | | |
| 4 | 1 | Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m3. The co-efficients of lift and drag are 0.75 and 0.15 respectively. Determine<br>(I) Drag force.<br>(ii)Lift force.<br>(iii) Resultant force. | 10 | C04 | 2015 |
| | 2 | Derive a relation for the velocity of sound in a compressible fluid. | 10 | CO4 | 2017 |
| | | **OR** | | | |
| 4 | 1 | Explain the different types of similitude. | 5 | CO4 | 2014 |
| | 2 | State Buckingham's it theorem. Why this theorem is considered superior over the Rayleigh's method for dimensional analysis? | 5 | CO4 | 2016 |
| | 3 | Assume the viscous force F exerted by a fluid on sphere of diameter D, depends on viscosity 1.t of mass density p and velocity of motion of the sphere, obtain the expression for shear force F, using Buckingham's it - theorem | 10 | CO4 | 2017 |
| | | | | | |
| 5 | 1 | Define stagnation temperature of a fluid. Show that the stagnation temperature and static temperatures are related by T0/T=1+(r-1/2) where r = ratio of specific heats, m = mach number | 10 | CO5 | 2018 |
| | 2 | Define the following terms and write the relevant equations for the same : -<br>i) Stagnation Temperature<br>ii) Stagnation Pressure | 10 | CO5 | 2016 |
| | | **OR** | | | 2017 |
| 5 | 1 | Write short essay on the engineering application of CFD, brining the advantages and the limitations. | 10 | CO5 | 2018 |
| | 2 | Mention the applications and limitations of computational fluid dynamics. | 10 | CO5 | 2018 |

# G. Content to Course Outcomes

## 1. TLPA Parameters

**Table 1: TLPA – Example Course**

| Module-# | Course Content or Syllabus (Split module content into 2 parts which have similar concepts) | Content Teaching Hours | Blooms' Learning Levels for Content | Final Blooms' Level | Identified Action Verbs for Learning | Instruction Methods for Learning | Assessment Methods to Measure Learning |
|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H |
| 1 | **Basics:** Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc,pressure at a point in the static mass of fluid, variation of pressure, Pascal's law,Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges. | 6 | L1,L2 | L2 | Understand | Chalk and board | Assignment |
| 1 | **Fluid Statics:** Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. | 6 | L1,L2,L3 | L3 | Apply | Chalk and board | Assignment |
| 2 | **Buoyancy:**center of buoyancy, meta center and meta centric height its application. | 4 | L1,L2,L3 | L3 | Apply | Chalk and board | Assignment and Slip Test |
| 2 | **Fluid Kinematics:** Velocity of fluid particle, types of fluid flow, description of flow, continuity equation,<br>Coordinate free form, acceleration of fluid particle, rotational & irrotational flow, Laplace's equation in<br>velocity potential and Poisson's equation in stream function, flow net. | 4 | L1,L2,L3 | L3 | Apply | Chalk and board | Assignment |
| 3 | **Fluid Dynamics;** Introduction. Forces acting on fluid in motion. Euler's equation of motion along a streamline.<br>Integration of Euler's equation to obtain Bernoulli's equation, Assumptions and limitations of Bernoulli's<br>equation. Introduction to Navier-Stokes equation. Application of Bernoulli's theorem such as venturi-meter,orifice meter, rectangular and triangular notch, pitot tube. | 5 | L1,L2,L3 | L3 | Apply | Chalk and board | Assignment and slip test |
| 3 | **Laminar and turbulent flow**: Flow through circular pipe, between parallel plates, Power absorbed in viscous<br>flow in bearings, Poiseuille equation – velocity profile loss of head due to friction in viscous flow. Reynolds's | 5 | L1,L2 | L2 | Understand | Chalk and board | Assignment |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | experiment, frictional loss in pipe flow. Introduction to turbulence, characteristics of turbulent flow, laminar turbulent transition major and minor losses. | | | | | | |
| 4 | **Flow over bodies**: Development of boundary layer, Prandtl‟s boundary layer equations, Blasius solution, integral momentum equation, drag on a flat plate, boundary layer separation and its control, streamlined and bluff bodies - flow around circular bodies and aero foils, calculation of lift and drag. | 5 | L1,L2,L3 | L3 | Apply | Chalk and board | Assignment |
| 4 | **Dimensional analysis**: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude | 4 | L1,L2,L3 | L3 | Apply | Chalk and board | Assignment |
| 5 | **Compressible Flows:** Introduction, thermodynamic relations of perfect gases, internal energy and enthalpy, speed of sound, pressure field due to a moving source, basic Equations for one-dimensional flow, stagnation and sonic Properties, normal and oblique shocks. | 3 | L1,L2,L3 | L3 | Understand | Chalk and board | Assignment |
| 5 | **Introduction to CFD:** Necessity, limitations, philosophy behind CFD, and applications. | 2 | L1,L2 | L2 | understand | Chalk and board | Assignment |
| | | | | | | | |

## 2. Concepts and Outcomes:

**Table 2: Concept to Outcome – Example Course**

| Module-# | Learning or Outcome from study of the Content or Syllabus | Identified Concepts from Content | Final Concept | Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or outcome) | CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark) | Course Outcome<br><br>**Student Should be able to ...** |
|---|---|---|---|---|---|---|
| *A* | *I* | *J* | *K* | *L* | *M* | *N* |
| 1 | -<br>- | -<br>- | Fluid properties | Different types of fluid properties. | - Understand<br>- Fluid Properties | Identify and calculate the fluid properties used in the analysis of fluid behaviour |
| 2 | -<br>- | -<br>- | Fluid flow types | Understanding the fluid flow types | - Understand Fluid flows and analysing the flow | Explain the principles of buoyancy and fluid flow concept. |
| 3 | -<br>- | -<br>- | Nature of flow | Understanding the different types of flow | - Understanding<br>-Different flows | Apply the knowledge of fluid statics, kinematics and dynamics while addressing problems of mechanical engineering. |
| 4 | -<br>- | -<br>- | Boundary layer | Understand the different types of boundary layer | - Understand<br>- Different boundary layer<br>- | Explain the concept of boundary layer in fluid flow. |
| 5 | -<br>- | -<br>- | 1)Thermodynamic properties<br><br>2)Computational Fluid Dynamics | Understand the thermodynamic properties and application of CFD | - Understand<br>- Computational Fluid dynamics<br>- - | Illustrate and explain the basic concept of compressible flow and CFD. |