**STATE UNIVERSITY OF NEW YORK**
**COLLEGE OF TECHNOLOGY**
**CANTON, NEW YORK**

# MASTER SYLLABUS

## COURSE NUMBER – COURSE NAME
## MECH 341 – INTERMEDIATE FLUID MECHANICS

**Created by: Dr. Lucas Craig**

**Updated by:**

**Canino School of Engineering Technology**

**Department: MET**

**Semester/Year: Fall 2021**

**A.** **TITLE**: Intermediate Fluid Mechanics

**B.** **COURSE NUMBER:** MECH 341

**C.** **CREDIT HOURS: 3 credit hour(s) per week for 15 weeks**

☒ One hour of (50 minutes) of lecture 3 times a week
☐ Two to three hours of lab or clinical per week
☐ Two hours of recitation per week
☐ 40 hours of internship

**D.** **WRITING INTENSIVE COURSE**: Yes ☐ No ☒

**E.** **GER CATEGORY: None:** ☒ **Yes:** GER
***If course satisfies more than one*:** GER

**F.** **SEMESTER(S) OFFERED: Fall** ☒ **Spring** ☐ **Fall & Spring** ☐

**G.** **COURSE DESCRIPTION:**

This course is an intermediate step in students understanding of fluid mechanics. Topics include fluid kinematics, Bernoulli's equation, mass, energy, and momentum analysis of flow systems, internal flow, external flow, compressible flow, and differential analysis of fluid flows. The continuity, stream function, and Navier-Stokes equations are development for 2-D and 3-D flows. The introduction of similitude and dimensional analysis is also included.

**H.** **PRE-REQUISITES: None Yes Y If yes, list below:**

MECH 241 and 45 credits or more or permission of the instructor

**CO-REQUISITES: None** ☒ **Yes** ☐ **If yes, list below:**

## I. STUDENT LEARNING OUTCOMES: (*see key below*)

By the end of this course, the student will be able to:

| ***Course Student Learning Outcome [SLO]*** | ***Program Student Learning Outcome [PSLO]*** | ***GER*** *[If Applicable]* | ***ISLO & SUBSETS*** | |
|---|---|---|---|---|
| Visualize and calculate fluid flow fields, in particular, streamlines. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Determine the forces acting on a control volume and apply them to Newton's 2nd law. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Apply Reynolds and other non-dimensional numbers in the solution of fluid problems. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Discriminate when to simplify the Navier-Stokes equations and demonstrate its proper use. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Develop the stream functions necessary to solve 2-D problems. | 1,6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Explain the different types of drag associated with external flow and calculate drag and explain the point of flow separation. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |

| | | | | |
|---|---|---|---|---|
| Comprehend the fundamental concept of compressible flow and the development of shock waves. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Produce flow calculations around objects using a CFD package. | 2 | | 2-Crit Think<br>5 – Skills of the industry | PS<br>Subsets<br>Subsets<br>Subsets |

| KEY | **Institutional Student Learning Outcomes [ISLO 1 – 5]** |
|---|---|
| **ISLO #** | **ISLO & Subsets** |
| **1** | **Communication Skills**<br>Oral [O], Written [W] |
| **2** | **Critical Thinking**<br>*Critical Analysis [CA] , Inquiry & Analysis [IA] , Problem Solving [PS]* |
| **3** | **Foundational Skills**<br>*Information Management [IM], Quantitative Lit,/Reasoning [QTR]* |
| **4** | **Social Responsibility**<br>*Ethical Reasoning [ER], Global Learning [GL], Intercultural Knowledge [IK], Teamwork [T]* |
| **5** | **Industry, Professional, Discipline Specific Knowledge and Skills** |

*Include program objectives if applicable. Please consult with Program Coordinator

**J. APPLIED LEARNING COMPONENT:** Yes ☒ No ☐

If YES, select one or more of the following categories:

- ☒ Classroom/Lab
- ☐ Internship
- ☐ Clinical Placement
- ☐ Practicum
- ☐ Service Learning
- ☐ Community Service
- ☐ Civic Engagement
- ☐ Creative Works/Senior Project
- ☐ Research
- ☐ Entrepreneurship (program, class, project)

**K. TEXTS:**

Cengel, Yunus A. and Cimbala, John M., Fluid Mechanics 3e , McGraw-Hill 2014., ISBN: 9780073380322.

Or

Mott, R. Applied Fluid Mechanics (7th Edition). New York: Prentice Hall, 2014.

**L. REFERENCES:**

N/A

**M. EQUIPMENT: None ☒ Needed:**

**N. GRADING METHOD:** A-F

**O. SUGGESTED MEASUREMENT CRITERIA/METHODS:**

**Homework, exams, projects**

**P. DETAILED COURSE OUTLINE:**

I. Basic fluid mechanics (Review)
   - A. Fluid mass & weight
     1. Density
     2. Specific weight
   - B. Ideal gas laws
   - C. Viscosity
   - D. Compressibility of fluids and speed of sound
   - E. Pressure
     1. Vapor
     2. Surface tension

II. Fluid Statics (Review)
   - A. Pressure

1. Incompressible
2. Compressible

B. Pressure measurement
1. Manometry
2. Gauges
3. Electronics

C. Hydrostatic forces
D. Archimedes' Principles (Buoyancy)

III. Fluid Kinematics
A. Newton's Second Law
B. Flow patterns and flow visualization
C. Vorticity and rotationality
D. Reynolds Transport Theorem

IV. Mass and energy analysis of flow systems
A. Continuity equation
B. Mechanical energy and efficiency
C. Bernoulli equation
D. Energy equation

V. Momentum analysis of flow systems
A. Linear and angular momentum
B. Application of momentum equations

VI. Dimensionless analysis
A. Buckingham Pi Theorem
B. Dimensionless groups

VII. Differential analysis
A. Continuity equation
B. Stream function
C. Navier-Stokes equations
D. Flow between parallel plates
E. Steady flow in round tube

VIII. External flows
A. Boundary layer definition, flat plate friction, boundary layer thickness
B. Drag of bodies, lift of bodies
C. Friction vs. pressure drag

IX. Compressible flow
A. Ideal gas relationship
B. Mach number and speed of sound
C. Isentropic flow
D. Non-isentropic flow
E. 2-D compressible flow

**Q. <u>LABORATORY OUTLINE</u>: None ☒ Yes ☐**

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## MECH 341 – INTERMEDIATE FLUID MECHANICS

**Created by: Dr. Lucas Craig**

**Updated by:**

**Canino School of Engineering Technology**

**Department: MET**

**Semester/Year: Spring 2019**

**A.** **TITLE**: Intermediate Fluid Mechanics

**B.** **COURSE NUMBER:** MECH 341

**C.** **CREDIT HOURS: (Hours of Lecture, Laboratory, Recitation, Tutorial, Activity)**

**# Credit Hours:** 3
**# Lecture Hours:** 3 **per week**
**# Lab Hours:** **per week**
**Other:** **per week**

**Course Length:** 15 **Weeks**

**D.** **WRITING INTENSIVE COURSE**: Yes ☐ No ☒

**E.** **GER CATEGORY: None:** ☒ **Yes:** GER
***If course satisfies more than one*:** GER

**F.** **SEMESTER(S) OFFERED: Fall** ☒ **Spring** ☐ **Fall & Spring** ☐

**G.** **COURSE DESCRIPTION:**

This course is an intermediate step in students understanding of fluid mechanics. Topics include fluid kinematics, Bernoulli's equation, mass, energy, and momentum analysis of flow systems, internal flow, external flow, compressible flow, and differential analysis of fluid flows. The continuity, stream function, and Navier-Stokes equations are development for 2-D and 3-D flows. The introduction of similitude and dimensional analysis is also included.

**H.** **PRE-REQUISITES: None** ☒ **Yes** ☒ **If yes, list below:**

MECH 241 and junior level status or permission of the instructor

**CO-REQUISITES: None** ☒ **Yes** ☐ **If yes, list below:**

## I. STUDENT LEARNING OUTCOMES: (*see key below*)

By the end of this course, the student will be able to:

| ***Course Student Learning Outcome [SLO]*** | ***Program Student Learning Outcome [PSLO]*** | ***GER*** *[If Applicable]* | ***ISLO & SUBSETS*** | |
|---|---|---|---|---|
| Distinguish between streamlines, streaklines, pathlines, and timelines. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Develop and understanding of the Bernoulli equation and its applications along with conservation of mass | 1,6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Determine the forces acting on a control volume and apply them to Newton's 2nd law. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Apply Reynolds and other non-dimensional numbers in the solution of fluid problems. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Discriminate when to simplify the Navier-Stokes equations and demonstrate its proper use. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Develop the stream functions necessary to solve 2-D problems. | 1,6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |

| | | | | |
|---|---|---|---|---|
| Analyze fluid flow in different situations such as annulus flow, rotating disc, and round tubes | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Explain the different types of drag associated with external flow and calculate drag and the point of flow separation. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Comprehend the fundamental concept of compressible flow and the development of shock waves. | 6 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |
| Produce flow calculations around objects using a CFD package. | 2 | | 2-Crit Think<br>ISLO<br>ISLO | PS<br>Subsets<br>Subsets<br>Subsets |

| KEY | **Institutional Student Learning Outcomes [ISLO 1 – 5]** |
|---|---|
| **ISLO #** | **ISLO & Subsets** |
| **1** | **Communication Skills**<br>Oral [O], Written [W] |
| **2** | **Critical Thinking**<br>*Critical Analysis [CA] , Inquiry & Analysis [IA] , Problem Solving [PS]* |
| **3** | **Foundational Skills**<br>*Information Management [IM], Quantitative Lit,/Reasoning [QTR]* |
| **4** | **Social Responsibility**<br>*Ethical Reasoning [ER], Global Learning [GL], Intercultural Knowledge [IK], Teamwork [T]* |
| **5** | **Industry, Professional, Discipline Specific Knowledge and Skills** |

*Include program objectives if applicable. Please consult with Program Coordinator

**J. APPLIED LEARNING COMPONENT:** Yes ☒ No ☐

If YES, select one or more of the following categories:

| | |
|---|---|
| ☒ Classroom/Lab | ☐ Civic Engagement |
| ☐ Internship | ☐ Creative Works/Senior Project |
| ☐ Clinical Placement | ☐ Research |
| ☐ Practicum | ☐ Entrepreneurship (program, class, project) |
| ☐ Service Learning | |
| ☐ Community Service | |

**K. TEXTS:**

Cengel, Yunus A. and Cimbala, John M., Fluid Mechanics 3e , McGraw-Hill 2014., ISBN: 9780073380322.

Or

Mott, R. Applied Fluid Mechanics (7th Edition). New York: Prentice Hall, 2014.

**L. REFERENCES:**

N/A

**M. EQUIPMENT: None ☒ Needed:**

**N. GRADING METHOD:** A-F

**O. SUGGESTED MEASUREMENT CRITERIA/METHODS:**

| | |
|---|---|
| **Homework** | **25%** |
| **Exams (3)** | **60%** |
| **Final Exam / Project** | **15%** |

**P. DETAILED COURSE OUTLINE:**

**I. Intro to Fluid Mechanics**
- **A. Fluid as a liquid or gas**
- **B. Power vs. Transportation systems**
- **C. Pascal's, Bernoulli's law (introduced)**

**II. Properties of Fluids**
- **A. Weight, Density, and Specific Gravity**
- **B. Force, Pressure, and Head**
- **C. Pascal's Law**
- **D. Bulk Modulus**
- **E. Viscosity**

**III. Energy and Forces**
- **A. Review Mechanics**

**B. Pressures in liquids at rest**
**C. Atmospheric Pressure**
**D. Manometers**
**E. Forces on plane surfaces**
**F. Forces on inclined surfaces**
**G. Buoyancy**
**H. Bernoulli's Equations applications**

**IV. Sizing pipes and ducts**

**A. Flow Rate**
**B. Laminar flow and Turbulent flow**
**C. Losses due to valves and fittings**
**D. Compressible and Incompressible Flow**

**V. Pump Sizing**

**A. Pumps**
**B. Motors**
**C. Horsepower and Efficiency**
**D. Sizing Hydraulic Cylinders**

**VI. Air Handling Systems**

**A. Sizing Fans**
**B. Velocity and Pressure Measurement**

**Q. <u>LABORATORY OUTLINE</u>: None ☒ Yes ☐**