



# **ME497**

## **Gas Dynamics**

### **Spring 2021**

**LECTURES:** MWF, 10:20 am – 11:15 am  
Synchronous Online

**INSTRUCTOR:** Manohar Chidurala, PhD  
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**OFFICE HOURS:** TR 8:00 am – 9:30 am. Any time you find me available or by appointment  
Zoom Meeting Id: 244-836-8329

**COURSE DESCRIPTION:** This course provides the essential applications and problem-solving techniques used in gas dynamics. In particular, explores the fundamentals of compressible flow and its application to supersonic airfoils, jet and rocket nozzles, normal and oblique shock waves, supersonic wind tunnels, and compressible pipe flows. The emphasis will be on physical understanding of the phenomenon and basic analytical techniques.

**PREREQUISITES:** Math 331 and ME220: 3 Credit hours

**COURSE OUTCOMES:**

The student, upon successful completion of this course, will be able to:

- Apply the fundamental flow equations (conservation of mass and momentum and energy) and basic solution techniques in solving compressible one dimensional flows
- Obtain first order solutions for compressible internal flows for variable geometry ducts
- Obtain first order solutions for compressible internal flows with friction and heat transfer
- Evaluate basic supersonic flight and associated propulsion systems

**TEXTBOOK:**

Currently, a single textbook is not available for this class. Lecture materials will be provided and additional materials will be distributed on the course Blackboard website. Additional reading assignments and reference materials will also be provided throughout the course.

**CLASS FORMAT:**

This course follows a lecture format and meets four times a week for two hours. Assignments will be both individual and group. Groups will be 3-4 people, and pre-assigned by the

instructor. Students are responsible for reading the assigned material prior to the scheduled class. Class participation is required and part of the course grading. Students are encouraged to actively participate and to ask questions freely. Students will be expected to present their work periodically.

### **BLACKBOARD:**

Blackboard will be used extensively throughout this course.

- Homework will be posted in the Announcement Section of the Blackboard site and due dates in the course calendar.
- Class material will be posted in appropriate folder.
- Student grades will be posted in the Grade Center.

### **COURSE GRADE:**

The final course grade will be determined as follows:

Homework	25 %
Participation (Zoom Polling)	10 %
Mid-term Exams (2)	40 %
Final Exam	25 %

Scores for work will be based on the following rubric:

<b>Letter Grade</b>	<b>Numeric Equivalent</b>	<b>Qualitative Description (Typical)</b>
A	> 90%	Exemplar; no to minor mistakes.
B	> 80%	Proficient; several minor mistakes; almost no conceptual mistakes.
C	> 70%	Apprentice; several mistakes, some major; conceptual mistakes.
D	> 60%	Novice; many significant mistakes and conceptual errors.
F	< 60%	Non-response or completely incorrect response.

### **ATTENDANCE:**

- Regular attendance is expected. Note that a portion of your grade is based on class participation and self-initiative. Professional contribution is a goal of this course.
- Attendance will be recorded AT THE BEGINNING of each class and lab session.
- Once attendance has been recorded and class begins, credit WILL NOT be given for late arrival.
- The attendance grade will be calculated as follows:
  - Students are allowed ONE absence (or tardy) per semester.
  - Students who miss or are late to more than two sessions will be penalized 10-point per miss/tardy off their final grade

### **ASSIGNMENTS:**

- Work must be neat. Presentation will affect your grade.
- No late homework will be accepted. Students will be given ample time to complete assignments and ask questions prior to homework submission. DO NOT BEGIN your homework the night before it is due.
- Students will be instructed on the format of the assignment.
- Assignments will be weighted (ie some assignments will count more than others).

- Assignments to be submitted by Blackboard must be posted according to the format provided. Assignments submitted not according to instructions will not be graded.
- DO NOT EMAIL ASSIGNMENTS TO INSTRUCTOR.
- ONLY ASSIGNMENTS THAT ARE SUBMITTED ACCORDING TO INSTRUCTIONS WILL BE GRADED.

### EXAMS:

Exam dates are shown below on the schedule. These are fixed in time and we will adjust material covered on the exam if we are ahead or behind schedule. This will be announced in class. You can only bring your pencils and the approved calculator (**See Calculator Policy Below**) to the exams, no phones/smart watches or backpacks will be allowed in the room. There will be two one hour exams and one two hour final exam. **No makeup exams will be given. No early exams will be given. No late exams will be given.**

**CALCULATOR POLICY:** You will only be allowed to use an NCEES approved calculator on exams, the same calculators used on the FE and PE exams. I suggest you get one now and start practicing. You can find the published list at <http://ncees.org/exams/calculator-policy/>.

### CLASS RULES:

- The syllabus is a contract between the instructor and student. Be sure that you are familiar with the syllabus. Most classroom management questions can be answered by reading the syllabus.
- You are expected to be prepared for class. This means reading assigned material and reviewing previous class notes before coming to class.
- You are expected to attend all class and lab sessions and will be responsible for material presented during these sessions. It is expected that you are professionals who are capable of understanding the importance of attendance.
- To be courteous to your classmates, it is important that there be no talking during class. Also, silence your cell phones prior to class.
- Do not arrive late to class. This is rude to the instructor and disruptive to your classmates.
- The class will proceed at a very fast pace. To optimize your learning, it is important that you keep up with the assignments, readings, and labs. The class will build material all semester. Therefore, it is important that you keep up with assignments and stay current.
- Emails will routinely be sent to your WKU email address regarding homework and class information. You are responsible for any material sent via email.
- Remember email can be used as a professional form of communication. The instructor will not respond to unprofessional emails.
- It is perfectly acceptable to ask questions regarding your grades. Discussions about grades will not be conducted via email. Students may schedule an appointment with the instructor to discuss grades if desired.

### PROFESSIONAL CONDUCT:

It is expected that all students be present in each lesson, will be courteous of others' ideas, and otherwise will conduct themselves in a professional manner in accordance with the WKU Student Handbook. Conduct determined to be unacceptable may result in the loss of points. **Notify the instructor in advance of any absence for in- or out-of-class activities.**

Use of any form of tobacco or alcohol in the classroom is considered inappropriate for this classroom. Cell phones and other devices should be turned off or otherwise left at home. If you need to answer your phone during class, you need to leave the room; re-admittance may or may not be permitted. Other activity that diminishes the professional quality of the class-room will not be tolerated.

### **ACADEMIC DISHONESTY:**

As an engineering student at WKU, you are expected to refrain from any form of academic dishonesty or deception such as cheating, stealing, plagiarism or lying on assignments, homework, quizzes, tests or exams. Furthermore, you understand and accept the potential consequences of punishable behavior, as stated in the WKU Catalog under Academic Dishonesty.

### **STUDENT DISABILITY SERVICES:**

In compliance with university policy, students with disabilities who require accommodations (academic adjustments and/or auxiliary aids or services) for this course must contact the Office for Student Disability Services in DUC A-200 of the Student Success Center in Downing University Center. The phone number is 745-5004.

Please DO NOT request accommodations directly from the professor or instructor without a letter of accommodation from the Office for Student Disability Services.

### **SEXUAL MISCONDUCT/ASSAULT POLICY:**

Western Kentucky University (WKU) is committed to supporting faculty, staff and students by upholding WKU's Title IX Sexual Misconduct/Assault Policy (#0.2070) at <https://wku.edu/eoo/documents/titleix/wkutitleixpolicyandgrievanceprocedure.pdf> and Discrimination and Harassment Policy (#0.2040) at [https://wku.edu/policies/hr\\_policies/2040\\_discrimination\\_harassment\\_policy.pdf](https://wku.edu/policies/hr_policies/2040_discrimination_harassment_policy.pdf).

Under these policies, discrimination, harassment and/or sexual misconduct based on sex/gender are prohibited. If you experience an incident of sex/gender-based discrimination, harassment and/or sexual misconduct, you are encouraged to report it to the Title IX Coordinator, Andrea Anderson, 270-745-5398 or Title IX Investigators, Michael Crowe, 270-745-5429 or Joshua Hayes, 270-745-5121.

Please note that while you may report an incident of sex/gender based discrimination, harassment and/or sexual misconduct to a faculty member, WKU faculty are "Responsible Employees" of the University and **MUST** report what you share to WKU's Title IX Coordinator or Title IX Investigator. If you would like to speak with someone who may be able to afford you confidentiality, you may contact WKU's Counseling and Testing Center at 270-745-3159.

# ME 497 Gas Dynamics

## Spring 2021

### Tentative Schedule

Lecture Topics	Assignments
<b>Module 1: Basic Concepts</b>	
1.1. Concept of Gas Dynamics	
1.2. Review on Thermodynamics/compressible flows	
1.3. Flow through Nozzles	
1.4. Flow through Nozzles and Diffusers	Assignment #1
<b>Module 2: Compressible Flow Through Ducts</b>	Assignment #2
2.1. Fanno Flow	
2.2. Rayleigh Flow	
2.3. Normal Shock waves	Exam #1 Review; Bring your questions
<b>Exam #1: Friday, March 05<sup>th</sup>, 6:00 - 8:00 pm</b>	
<b>Module 3: Oblique Shocks</b>	
3.1. Oblique Shock Waves	
3.2. Prandtl-Meyer Relationship	
3.3. TBD	
3.4. TBD	Assignment #3
<b>Module 4: Jet Propulsion</b>	Assignment #4
4.1. Jet Propulsion Systems	
4.2. Ramjet/Pulse Jet/Turbo Jet Engines	
4.3. Nozzle and Diffuser Efficiencies	Exam #2 Review; Bring your questions
<b>Exam #2: Friday, April 16<sup>th</sup>, 6:00 – 8:00 pm</b>	
<b>Module 5: Space Propulsion</b>	Assignment #5
5.1. Rocket Propulsion	
5.2. Rocket Nozzles	
5.3. Rocket Engine Performance	Final Exam Review; Course Assessment
<b>Final Exam: Friday, April 30<sup>th</sup>, 10:30 am – 12:30 pm</b>	