มหาวิทยาลัยรังสิต

Course Description

College/Faculty **Biomedical Engineering** **Department** **-**

Curriculum **Biomedical Engineering Program, Year 2020 Edition**

Section 1 General Information

BME 102	Thermo fluids and Mechanics Modelling	3	(2-3-6)

Co-requisite Course(s) -

Prerequisite Course(s) -

Semester 2/2024

Section 02, 021, 12

Categorization of Course
- ☐ Preparation Course
- ☐ General Education Courses
- ■ Specific Requirement Courses
- ☐ Free Elective Courses

Responsible Assoc.Prof.Nuntachai Thongpance Instructor

Instructor
1.Assoc.Prof. Nuntachai Thongpance
2. T.Anucha Phanaksri
3. T.Kittiphan Rungprasert
4. Asst. Prof. Dr. Phichit Boonkrong
5.Assoc. Prof. Dr. Nattapon Thanatchangsaeng

■ Instructor ☐ Guest Instructor

Place ■ On Campus ☐ Off Cumpas

Date of preparation 23 December 2024

Section 2 Course objectives and course components

1. Objective of Course

1.1 This course is designed for Biomedical Engineering students. The objectives of this course are as following:

1) To provide students with knowledge and understanding of basic principles and concepts of fluid mechanics, thermodynamics and heat transfer.

2) To provide students with knowledge and understanding of the application of basic principles of fluid mechanics, thermodynamics and heat transfer in medical engineering.

3) To provide students with knowledge and understanding of computerized Thermofluid modeling and Applications in biomedical engineering

2. Course Description

Fluid properties; equation of continuity; flow patterns; pressure distribution in the fluid; hydro static pressure; pressure distribution on a rigid body moving in a fluid; fluid mechanics; fluid flow in pipes; uniform flow; viscosity of fluid; heat transfer; flow with a heat exchanger; dynamic of gas and fundamental principles of thermodynamics; gas and vapor power cycles; refrigeration cycles; air conditioning; fluid flow modeling using finite element calculation; calculation of relationship between various physics using computer programs and applications in biomedical engineering.

3. Number of hours per week for advising and academic counseling for individual students

.....5.....hours/week

■ e-mail : preya.a@rsu.ac.th

☐ Facebook :……

■ Line : Ipompomanu

☐ Others .....

4. Course Learning Outcomes: CLOs

1) Students can explain the properties of fluids. Continuous flow equations, flow patterns, pressure distribution in fluids. hydrostatic pressure The distribution of pressure on a rigid body moving in a fluid. fluid mechanics Fluid flow in pipe systems uniform flow fluid viscosity
2) Students can explain heat transfer. flow with heat transfer Gas dynamics and basic thermodynamic principles. Gas and vapor power cycles refrigeration cycle Air conditioning system
3) Students can use fluid flow models using finite element calculations.
4) Students will be able to explain computational relationships between various physics using computer programs and their applications in biomedical engineering.

Section 3 Learning Outcomes

Development of the standard learning outcomes in the following:

1. Morals and Ethics

●	Expected Outcomes	Methodology	Assessment
1.2	The students need to have self-disciplinary, punctuality and responsibility for ourselves and society.	☐ Teaching indirectly about discipline and punctuality in classroom. ☐ Applying classroom policy.	☐ Observing student behavior and manner in class. ☐ Checking completed assignment submission.

2. Knowledge

●	Expected Outcomes	Methodology	Assessment
2.2 2.3	Able to analyze problems Understand and explain Biomedical Engineering requirements including applying knowledge, skills and using relevant and suitable tools to solve problems. Able to analyze, design, install, improve tooling systems or work in the field Biomedical engineering to meet requirements and needs.	☐ Focus on teaching and learning that is active learning. ☐ Provide learning from real situations.	☐ Assessment of student achievement and performance in various areas, including ☐ Mid-term and final exams ☐ Reporting/Project ☐ Presentations

3. Cognitive Skills

●	Expected Outcomes	Methodology	Assessment
3.1 3.4	Think critically and systematically. The students will be able to apply the basic principles of physics to analyze engineering problems accurately and appropriately.	1. Organize teaching and learning processes that practice thinking skills Both at the individual and group level, such as presentations project preparation laboratory experiments, etc. 2. Organize activities for students to have the opportunity to actually work.	1. Writing a presentation report 2. The use of exams or exercises that allow students to solve problems 3. Interviews that allow students to practice problem solving.

4. Transaction Skills and Responsibility

●	Expected Outcomes	Methodology	Assessment
4.3	Responsible for continuous development of their own and professional learning, learning their own emotional state. Learn to work with others. Learn techniques for asking for help or ask for information to be used for work	1. Organize teaching and learning activities that emphasize group work and tasks that require interpersonal interaction. 2. Provide practical learning experiences	1. Group presentations to assess regularity of participation in group activities. 2. Assess the responsibilities of assigned duties.

5. **Numerical Analysis, Communication and Information Technology Skills**

●	Expected Outcomes	Methodology	Assessment
5.4	Able to use technology, tools, equipment, software or the Internet in research In communication to support work such as interaction, expressing opinions Coordinate work pick-up	☐ Provide learning experiences that encourage learners to choose a variety of and appropriate information and communication technologies.	1. Speaking skills for presentations 2. Report Writing Skills 3. Presentation skills using information technology

Section 4 Teaching Plan and Assessment

1. Course Planning

Week	Topics/Description	Activity and Media	Hours	Instructor
1-2 (6-17/01/25)	Chapter 1 Fluid Statics 1.1 Basic Properties of Fluids 1.2 Fluid Pressure 1.3 Pascal's Law 1.4 Archimedes' Principle 1.5 Surface Tension	1. 1. Lecture Teaching media: ppt Teaching documents,Chapter1 2. Assign a project to model the distribution of temperature and/or pressure and/or heat in related medical devices as follows: 2.1 Incubator 2.2 Autoclave 2.3 Refrigeration 2.4 Pressure distribution in a closed system 2.5 Heat distribution in an Infant Incubator 2.6 Heat distribution in a Radiant Warmer 2.7 Applications in other related biomedical engineering 3. Lab 1: Principles of static pressure measurement (4%) 4. Lab 2: Principles of dynamic pressure measurement (4%)	5	1.Assoc.Prof.Nuntachai Thongpance 2. T..Anucha Phanaksri 3. T.Kittiphan Rungprasert

Week	Topics/Description	Activity and Media	Hours	Instructor
3-5 (20/01-7/02/25)	Chapter 2 Fluid Dynamics 1.1 The equation of continuity 1.2 Bernoulli's Equation 1.3 Application of the equation of continuity and Bernoulli's equation 1.4 Application of fluid dynamics in biomedical engineering	1. Lecture Teaching media: ppt Teaching documents, Chapter 2 2. Lab 3: Principles of measuring flow rate (3%) 3. Lab 4: Measuring air flow rate in pipes (3%)	7.5	1.Assoc.Prof.Nuntachai Thongpance 2. T..Anucha Phanaksri 3. T.Kittiphan Rungprasert
3-5 (20/01-7/02/25)	Chapter 3 Viscous Flow 3.1 Flow Phenomenon • Laminar Flow • Turbulent Flow • Reynolds Number 3.2 Bernoulli Equation in External Energy 3.3 Force and Momentum in Flow 3.4 Power from Pumps 3.5 Flow in Pipes 3.6 Energy Losses in Pipes 3.7 Energy Losses in Laminar and Turbulent Flow 3.8 Series and Parallel Pipe Connections 3.9 Applications of Viscous Flow in Biomedical Engineering	1. 1. Lecture Teaching media: ppt Teaching documents Chapter 3 2. Lab 5 Study of energy loss in pipe flow from the Hagen-Poiseuille equation (3%)	7.5	1.Assoc.Prof. Nuntachai Thongpance 2. T..Anucha Phanaksri 3. T.Kittiphan Rungprasert
First exam: 16/02/68: 20%				
6 (10-14/02/25)	Chapter 4 Gases 4.1 Molecular Models of Gases 4.2 Avogadro's Law 3.3 4.2 Gas Laws	1. Lecture Teaching media: ppt Teaching documents Chapter 4	2	1.Assoc.Prof. Nuntachai Thongpance 2. T..Anucha Phanaksri 3. T.Kittiphan Rungprasert
6 (10-14/02/25)	Chapter 5 Mechanics of Breathing 5.1 Fundamentals of the Respiratory System 5.2 Lung Volume, Pressure, and Compliance 5.3 Mechanics of Breathing	1. Lecture Teaching media: ppt Teaching documents Chapter 5	3	1.Assoc.Prof. Nuntachai Thongpance 2. T.Anucha Phanaksri 3. T.Kittiphan Rungprasert
7 (17-21/02/25)	Chapter 6 Cardiovascular Mechanics 6.1 Fundamentals of the Cardiovascular System 6.2 Application of Fluid Mechanics to the Cardiovascular System 6.2.1 Cardiovascular Pressure 6.2.2 Cardiovascular Work 6.2.3 Cardiovascular Circulatory State 6.2.4 Cardiovascular Resistance 6.2.5 Continuity Law for Cardiovascular Flow State 6.2.6 Laminar and Turbulent Flow of the Cardiovascular System	1.Lecture Teaching media: ppt Teaching documents Chapter 6	5	1.Assoc.Prof. Nuntachai Thongpance 2. T.Anucha Phanaksri 3. T.Kittiphan Rungprasert
8: 24-28/02/68 : Term-Break				
9-10 (3-14/03/25)	Chapter 7 Heat 7.1 Fundamentals of Temperature and Heat 7.2 Heat Quantity and State Changes of Matter 7.3 Vapor Pressure 7.4 Humidity and Relative Humidity 7.5 Heat Transfer 7.6 Applications of Heat in Biomedical Engineering	1. 1. Lecture Teaching media: ppt Teaching documents Chapter 5 2. Computer with Comsol program 3. Lab 6 Study of heat and humidity sources in infant incubators (3%) 4. Lab 7 Principles of Finite Element and heat distribution and flow model using finite element calculations with computer programs and	10	1.Assoc.Prof. Nuntachai Thongpance 2. T.Anucha Phanaksri 3. T.Kittiphan Rungprasert 4. Asst. Prof. Dr. Phichit Boonkrong

Week	Topics/Description	Activity and Media	Hours	Instructor
		applications in biomedical engineering		
11-13 (17-28/03/25)	Chapter 8 Thermodynamics 8.1 Thermodynamic Systems and Environment 8.2 Zeroth Law of Thermodynamics 8.3 First Law of Thermodynamics 8.4 Thermal Processes in Ideal Gas Systems 8.5 Reversible and Irreversible Processes 8.6 Entropy 8.7 Second and Third Laws of Thermodynamics 8.8 Heat Engines 8.9 Refrigeration 8.10 Applications of Heat in Biomedical Engineering	1. Lecture Teaching media: ppt Teaching documents Chapter 8 2. Computer with Comsol program 3. Labo 8 Principles of Finite Element and heat distribution and flow model using finite element calculation with computer program and application in biomedical engineering (3%) 4. Lab 9 Principles of Finite Element and heat distribution and flow model using finite element calculation with computer program and application in biomedical engineering	15	1.Assoc.Prof. Nuntachai Thongpance 2. T.Anucha Phanaksri 3. T.Kittiphan Rungprasert 4. Asst. Prof. Dr. Phichit Boonkrong
30/03/68 2nd exam : 30 %				
14-16 (31/03-18/04/25)	Chapter 9 Rheology 1. Viscoelasticity vs Viscosity Shear thinning vs Shear thickening Rheological properties: Flow experiment testing 2. Loss modulus vs Storage modulus Viscoelastic measurements Rheological properties: Oscillation experiment testing 3. Applications of Rheology in Biomedical Engineering	1. Lecture Teaching media: ppt Teaching documents Chapter 9 2. Lab 10 Principles of Finite Element and heat distribution and flow model using finite element calculation with computer program and application in biomedical engineering 3. Lab 11 Testing Viscoelastic Materials (10 %)	15	1.Assoc.Prof. Nuntachai Thongpance 2. T.Anucha Phanaksri 3. T.Kittiphan Rungprasert 4. Asst. Prof. Dr. Phichit Boonkrong 5.Assoc. Prof. Dr. Nattapon Thanatchangsaeng
17 (21-25/04/25)	Presents a project modeling the distribution of temperature and/or pressure and/or heat in related medical devices as follows: (20%) 1. Incubator 2. Autoclave 3. Cooling machine 4. Pressure distribution in a closed system 5. Heat distribution in an Infant Incubator 6. Heat distribution in a Radiant Warmer 7. Other related biomedical engineering applications	Presents a project modeling the distribution of temperature and/or pressure and/or heat in related medical devices as follows: (20%) 1. Incubator 2. Autoclave 3. Cooling machine 4. Pressure distribution in a closed system 5. Heat distribution in an Infant Incubator 6. Heat distribution in a Radiant Warmer 7. Other related biomedical engineering applications	5	1.Assoc.Prof. Nuntachai Thongpance 2. T.Anucha Phanaksri 3. T.Kittiphan Rungprasert 4. Asst. Prof. Dr. Phichit Boonkrong
27/04/68 3rd exam: 7%				
Total			**75**	

2. Assessment Planning

Learning Outcomes	Evaluation Method	Week of Assessment	Portion of Assessment
1.2,2.2, 2.3, 3.1, 3.4	Lecture Exam 1 Exam 2 Exam 3	 6 13 **17**	 20 % 30 % 7%
1.2,3.1, 3.4, 4.1,4.2, 4.3, 5.4	Practical Report Project (Analysis, Research, Presentation Group Work and Work)	Throughout the semester Throughout the semester Throughout the semester 17	23% 20%

Grading

Grade	Score
A	80-100
B+	75-79
B	70-74
C+	65-69
C	60-64
D+	55-59
D	50-54
F	0-49

Section 5 Learning and Teaching Resources

1. Textbooks and main documents

[1] Assoc. Prof. Nantachai Thongpance,Teaching materials for the subject of Thermofluids and Mechanics Modelling, College of Biomedical Engineering, Rangsit University, 2025

[2] Keith Sherwin and Michael Horsley. (1996). Thermofluids. Chapman&Hill.

[3] Yunus A. Cengel, Robert H. Turnel, and John M. Cimbala, "Fundamentals of Thermal-Fluid Sciences", McGraw Hill, ISBN: 978-0-07-352925-7 (2008)

2. Supplementary Textbooks

1. Cengel,Y.A. and Boles, M.A. (2011). **Thermodynamics: an engineering approach**. (7th ed.) New York : McGraw-Hill, Inc.
2. Deborah A. Kaminski and Michael K. Jensen. (2013). **Introduction to Thermal and Fluid engineering**. U.S.A: John Wiley & Sons, Inc.
3. Devon J. Godfrey, Shiva K. Das and Anthony B. Wolbarst. (2014). **Advances in Medical Physics.** U.S.A.
4. Incropera, F. P., and Dewitt, D. P. (2011). **Introduction to Heat Transfer**. (3rd ed.). U.S.A. John Wiley & Sons, Inc.
5. Irving P. Herman. (2006). **Physics of the human body**, New York: Springer.
6. MUNSON,B.R.,et.al. (2010). **Fundamentals of Fluid Mechanics**. (6th ed.). New York:John Wiley&Sons,Inc.

3. Important documents and information

1. Principle of operation of the autoclave AH-1200T/2 (animation)

   https://www.youtube.com/watch?v=Z2J6l-nxz_E

2. Heat Transfer: Introduction to Heat Transfer (1 of 26)

   https://www.youtube.com/watch?v=TWTQx3W-2k8

Section 6 Assessment and Improvement of Course Operation

1. Course assessment strategies by students

Evaluation of effectiveness in this course prepared by students Organized activities to bring ideas and opinions from students as follows

1.1 Group discussion between teachers and students

1.2 Observation from learners' behavior

1.3 Teacher evaluation form and course assessment form

2. Teaching Development

Changes made in accordance with the previous evaluation are the teaching development by brainstorming activities to find the teaching solution as following:

1.1 Teaching and learning seminars.

1.2 Survey, field trip and conference

3. improving teaching

After the evaluation of teaching in Item 2, teaching has been improved by organizing brainstorming activities and find more information on how to improve teaching as follows:

3.1 Teaching and learning meetings between instructors in the course.

3.2 Use the results of learning assessment as information to improve teaching to be up to date and in line with the current national development situation.

4. Verification of the Achievement of Students

- ☐ Discuss with students
- ☐ Investigate from student behaviors
- ☐ Grading and evaluation of learning outcome
- ☐ Comprehensive knowledge examination
- ☐ Learning outcome report
- ☐ Class evaluation / peer evaluation
- ■ Others: This course will verify student achievements in various aspects as summarized below.

1. The instructor in charge of the course assesses the consistency of the examination. to the learning outcomes according to the curriculum standard framework
2. The Standards Oversight Committee assesses the consistency of the examination with the objectives of the course.
3. Moral and ethical aspects Verification is based on behavior in the area of fraud in the examination.
4. Verification in all courses, both theory and practice, project work must be consistent with the learning assessment strategy. It is the responsibility of instructors to issue examinations or set up examination mechanisms and procedures.
5. Teaching plans are evaluated in relation to exam evaluation. Assessment of teaching and learning achievement from exam results by the program committee and/or the expert committee from within the institution.
6. There is verification from test scores. or assignments Teachers are assessed. and evaluation of teaching and learning by students.
7. The college Committee approves the assessment results of the course.

5. Review and planning for Improvement Subject Course

From the assessment results and verify the achievement and effectiveness of the course, there is a plan to improve teaching and course details. to achieve more quality by improving the teaching of subjects in every semester or based on recommendations and results of verification of achievement standards.