Introduction to Fluid Flow and Heat Transfer

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Course Staff

<table>
<thead>
<tr>
<th>A/Prof. Runyu Yang</th>
<th>Room 349, School of Materials Science and Engineering (Building E10)</th>
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<tbody>
<tr>
<td>Course Coordinator &amp; Lecturer</td>
<td>Phone: 9385 6787</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:r.yang@unsw.edu.au">r.yang@unsw.edu.au</a></td>
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<td>Open door, but make an appointment if important</td>
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Course Objective

This course introduces the basic concepts in fluid flow and heat transfer and their applications in materials and mineral processing. The aims are to develop an understanding of basic principles governing fluid flow and heat transfer and to solve related problems in materials engineering.

Your Course at a Glance

<table>
<thead>
<tr>
<th>What you will learn</th>
<th>Weeks</th>
<th>Assessment task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction of the course, applications of fluid flow and heat transfer in materials and mineral processing.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Introduction of fluids, static fluids, pressure and measurement, Buoyancy force, Archimedes principle</td>
<td>1-2</td>
<td>In-class self-tests and Assignment 1</td>
</tr>
<tr>
<td>Laminar and turbulent flows, viscosity, Newtonian fluid, Reynolds number, transport of momentum, velocity and shear stress distributions in fluids, continuity and Navier-Stokes equations</td>
<td>2-3</td>
<td></td>
</tr>
<tr>
<td>Turbulent flow, turbulence intensity, friction factor, dimensional analysis, flow inside a pipe/over a sphere/plate/through a packed bed, Ergun equation</td>
<td>4-5</td>
<td></td>
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<tr>
<td>Mechanical energy balance, friction loss, Bernoulli's equation and applications</td>
<td>5-6</td>
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Assignment 1 due Week 6

Mid-term exam on fluid flow in Week 7

<table>
<thead>
<tr>
<th>What you will learn</th>
<th>Weeks</th>
<th>Assessment task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction of heat transfer, heat transfer by conduction and convection, Fourier and Newton's laws, thermal conductivity, heat transfer coefficient, steady state conduction, general governing equation for conduction, transient heat transfer.</td>
<td>7-9</td>
<td>In-class self-tests and Assignment 2</td>
</tr>
<tr>
<td>Heat transfer by convection, thermal boundary layer, local heat transfer coefficient, forced and natural convection, Nusselt and Prandtl numbers, Grashof and Rayleigh number.</td>
<td>9-10</td>
<td></td>
</tr>
<tr>
<td>Thermal radiation, radiation, irradiation and radiosity, Blackbody emission, Stefan-Boltzmann law, emissivity, radiation between surfaces, view factor</td>
<td>11-12</td>
<td></td>
</tr>
</tbody>
</table>

Assignment 2 due Week 12

Final exam on heat transfer

Timetable

<table>
<thead>
<tr>
<th>Lecture/Tutorial</th>
<th>Day</th>
<th>Time</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture/Tutorial</td>
<td>Thursday</td>
<td>15:00 – 17:00</td>
<td>Old Main Building 149 (K15-149)</td>
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<tr>
<td>Lecture/Tutorial</td>
<td>Friday</td>
<td>13:00 – 15:00</td>
<td>Central Lecture Block 4 (E19-G05)</td>
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</tbody>
</table>
Course Content

Fluid properties and static fluids, Newtonian fluid, transport of momentum, laminar and turbulent flows, continuity and Navier-Stokes equations, mechanical energy balance and Bernoulli’s equation, heat transfer mechanisms, conduction and conductivity, convection and heat transfer coefficient, thermal radiation, blackbody emission, Stefan-Boltzmann law.

Assessment

• **Assignments (20%)**: Two assignments will be handed out. Assignments will be graded and returned in two weeks. These assignments help assess your understanding of the material, and will count toward your final grade. Students are encouraged to work with others on the homework, but not simply copy someone else.

• **In-class Quiz (10%)**: Self-tests will be conducted in class during the tutorial time. Solutions will be provided and the answer sheets are handed in as the records of class attendance.

• **Mid-term Exam (35%)**: The close-book exam will be given during the lecture time in mid-session to assess students’ knowledge on fluid flow.

• **Final Exam (35%)**: The two-hour final exam will assess the students’ understanding of heat transfer. It will focus on the understanding of basic concepts and the ability to apply fundamental equations to specific system.

Notes:

• All assignments must contain a completed student declaration sheet and will be submitted on the due date.

• Students will lose 10% of the original mark per working day late for late submission of assignments. Requests for special consideration must be submitted using the form available from the Student Desk in the Chancellery and must include medical certificates or other appropriate documents.

**NOTE**: Students who fail to achieve a score of at least 40% for the overall exam component (i.e., mid-session exam and final exam marks combined), but achieve a final mark >50% for the course, will be awarded a UF (Unsatisfactory Fail) for the course. Please refer to the UNSW guide to grades: [https://student.unsw.edu.au/grades](https://student.unsw.edu.au/grades)

References

• Gaskell, An Introduction to Transport Phenomena in Materials Engineering, Macmillan Company.


• Bird, Stewart and Lightfoot, Transport Phenomena, John Wiley & Sons Inc.

• Additional resource materials including recommended web sites will be provided during class lectures
Course Information

<table>
<thead>
<tr>
<th>Units of credit</th>
<th>6</th>
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How the course relates to other course offerings and overall program(s) in the discipline

- This course introduces the basic concepts in fluid flow and heat transfer which are widely used in materials engineering
- This course requires a working knowledge of basic differential and integration.
- This course will give intellectual framework for a number of related materials engineering courses.

Course Aims

To develop an understanding of basic principles governing fluid flow and heat transfer and apply such understanding to specific systems of interest in materials engineering

Expected student learning outcomes (including those related to graduate attributes)

Students are expected:

- To understand the principles and concepts in fluid flow and heat transfer
- To follow proper procedures and apply fundamental equations to analyse fluid flow and heat transfer related problems

Graduate attributes:

- Analytical and problem solving skills
- Information literacy and writing communication

Teaching Strategies used in the course and the ways they support student learning outcomes

- Fundamentals and major concepts with their applications to specific problems will be covered in lectures
- Students are expected to attend classes and prepare for discussion
- Tutorial classes will be conducted to enhance problem solving skills.
- Assignments to enhance student’s understanding
- Report to develop students’ literature review and writing skill
- Teaching material, including course outline, notes, problems, assignments, case studies and course announcements are available on Moodle.

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Based on the professional attributes given in Engineers Australia National Generic Competency Standards - Stage 1 Competency Standard for Professional Engineers and UNSW Graduate Attributes.

Learning and Teaching Philosophy Underpinning the Course

(based on UNSW Learning Guidelines)

- **Students are actively engaged in the learning process.**

  It is expected that, in addition to attending classes, students will read, write, discuss, and engage in analysing the course content.

- **Effective learning is supported by a climate of inquiry where students feel appropriately challenged.**

  Students are expected to be challenged by the course content and to challenge their own preconceptions, knowledge, and understanding by questioning information, concepts, and approaches during class and study.

- **Learning is more effective when students’ prior experience and knowledge are recognised and built on.**
Coursework, tutorials, assignments, laboratories, examinations, and other forms of learning and assessment are intended to provide students with the opportunity to cross-reference these activities in a meaningful way with their own experience and knowledge.

- **Students become more engaged in the learning process if they can see the relevance of their studies to professional and disciplinary contexts**

  The course content is designed to incorporate both theoretical and practical concepts, where the latter is intended to be applicable to real-world situations and contexts.

### Academic Honesty and Plagiarism

**What is Plagiarism?**

All details regarding plagiarism can be found here: [https://student.unsw.edu.au/plagiarism](https://student.unsw.edu.au/plagiarism)

It is important to understand what plagiarism is. The general concept is plagiarism is using the words or ideas of others and passing them off as your own. Examples of plagiarism, including self-plagiarism, are:

- **Copying**

  Using the same or very similar words to the original text or idea without acknowledging the source or using quotation marks. This includes copying materials, ideas or concepts from a book, article, report or other written document, presentation, composition, artwork, design, drawing, circuitry, computer program or software, website, internet, other electronic resource, or another person's assignment, without appropriate acknowledgement.

- **Inappropriate paraphrasing**

  Changing a few words and phrases while mostly retaining the original structure and/or progression of ideas of the original, and information without acknowledgement.

  This also applies in presentations where someone paraphrases another's ideas or words without credit and to piecing together quotes and paraphrases into a new whole, without appropriate referencing.

- **Collusion**

  Presenting work as independent work when it has been produced in whole or part in collusion with other people. Collusion includes:
  - students providing their work to another student before the due date, or for the purpose of them plagiarising at any time
  - paying another person to perform an academic task and passing it off as your own
  - stealing or acquiring another person's academic work and copying it
  - offering to complete another person's work or seeking payment for completing academic work.

  This should not be confused with academic collaboration.

- **Inappropriate citation**

  Citing sources which have not been read, without acknowledging the 'secondary' source from which knowledge of them has been obtained.

- **Self-plagiarism**

  'Self-plagiarism' occurs where an author republishes their own previously written work and presents it as new findings without referencing the earlier work, either in its entirety or partially.
Self-plagiarism is also referred to as 'recycling', 'duplication', or 'multiple submissions of research findings' without disclosure. In the student context, self-plagiarism includes re-using parts of, or all of, a body of work that has already been submitted for assessment without proper citation.

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

Continual Course Improvement

- At the end of the course, students will be asked to provide evaluative feedback through myExperience, the University’s course and teaching evaluation and improvement process.
- Students are encouraged to address any problems regarding teaching of this course at the annual staff-student meeting.
- Student comments on teaching during the session are welcome and will be appreciated.
- At times students may be asked to answer a short questionnaire for feedback on the course.

Administrative Matters

- Students should attend at least 80% of all classes.
- Students unable to submit assignments on time or attend the mid-session quizzes or final exams on health grounds should make a request for special consideration. Information on this process can be found here: https://student.unsw.edu.au/special-consideration. Medical certificates or other appropriate documents must be included. Students should also advise the lecturer of the situation.
- Unless otherwise specified in the task criteria, all assignments must be uploaded via Moodle prior to the due date for submission.
- Assignments/lab reports submitted after the due date for submission will receive a 10% of maximum grade penalty for every day late, or part thereof.
- Students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course coordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit: https://student.unsw.edu.au/disability. Early notification is essential to enable any necessary adjustments to be made.

Rules for Exams

Rules governing conduct during exams are given at: https://student.unsw.edu.au/exam-rules