

ENGPYYS 705
III-V Materials and Devices
Fall 2018
Course Outline

CALENDAR/COURSE DESCRIPTION

An introduction to Group III-V semiconductor materials, heterostructures and devices including HBTs, HEMTs, laser diodes, light emitting diodes, photodiodes, and multi-junction solar cells.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): N/A
Antirequisite(s): N/A

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Ray LaPierre
JHE A315
lapierr@mcmaster.ca
ext. 27764

Office Hours:
By appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

N/A

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://avenue.mcmaster.ca/>

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Describe III-V Material Properties:
 - Crystal structure (lattice constant, Vegard's law, thermal expansion)
 - Band parameters (bandgap, bowing parameter, Varshni equation)
 - Effective mass
 - Electrical properties (resistivity, mobility)
 - Optical properties
- Describe III-V Materials Growth:
 - Epitaxy

- Molecular beam epitaxy
- Metalorganic chemical vapour deposition
- Describe III-V Heterostructures:
 - Stress-strain, dislocations, Matthews-Blakeslee theory of critical thickness
 - Strain compensation
 - Metamorphic layers
 - Effect of strain on band structure (e.g., InGaAsP/InP, InGaAsP/GaAs, x-y-Eg-strain plots)
 - XRD and photoluminescence
 - Surface and interface issues (band bending, Fermi level pinning)
 - Band alignment (valence and conduction band offsets)
 - Type I (straddling) & II (staggered, broken)
 - Quantum wells
 - Superlattices, minibands
 - Quantum dots: SK
 - Quantum wires: VLS
- Describe Device Fabrication and Physics:
 - BJTs
 - 2DEGs
 - HEMTS: GaN/AlGaIn, GaAs/AlGaAs, InAlAs/InGaAs/InP, Sb-based HEMTS
 - Quantum Hall effect, fractional quantum Hall effect
 - Solid-state lighting
 - Laser diodes: DH, QW, strain
 - Quantum cascade lasers
 - Mid-IR photodetectors
 - Multi-junction solar cells
 - Dilute nitrides

MATERIALS AND FEES

Required Texts:

None

Calculator:

Any

Other Materials:

None

COURSE OVERVIEW

Date/Week	Topic	Readings
Week 1-2	Material Properties	N/A
Week 3	Epitaxy	N/A
Week 4	Heterostructures – Fundamentals	N/A

Week 5	Heterostructures - Applications	N/A
Week 6	LEDs	N/A
Week 7	Laser diodes	N/A
Week 8	Photodetectors	N/A
Week 9	Photovoltaics	N/A
Week 10	Transistors	N/A

ASSESSMENT

Component	Weight
4 assignments	10% each
Take-home final exam	60%
Total	100%

ACCREDITATION LEARNING OUTCOMES

N/A

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <http://www.mcmaster.ca/academicintegrity>

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students who require academic accommodation must contact the instructor. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca. For further information, consult McMaster University's Policy for [Academic Accommodation of Students with Disabilities](#).

NOTIFICATION OF STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

1. You are responsible to contact your instructor(s) promptly to discuss the appropriate relief.
2. It is the prerogative of the instructor of the course to determine the appropriate relief for missed term work in his/her course.

NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using Avenue to Learn. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to <http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf>.