Third Year
Prescribed Elective

AY2020-2021
Introduction

• In the third year, students are taught the basic principles, which underpin a broad spectrum of technologies covered by the area of electrical and electronic engineering.

• Apart from the Core Courses, students must select two Major Prescribed Electives from a list of more specialized courses in preparation for more in-depth specialization in their final year.

• Direct-entry Year 3 students are required to take up Professional Internship (PI) in Semester 1, as stated in their course curriculum. This would allow students to have more internship opportunities, instead of competing with their Year 1 peers.
Major Components

- 1 or 2 Year-3 Core Courses + 2 Prescribed Elective Courses

- 4 Core Experiments (2 for each Core) + 2 Elective Experiments associated with the 2 Prescribed Elective courses

- Design & Innovation Project

- Professional Internship (PI) – 20 Weeks
  - Semester 1 = Year 2 Direct-Entry Admission Cohort
  - Semester 2 = Year 1 Admission Cohort
### Third Year Course Structure

<table>
<thead>
<tr>
<th>2018 Cohort (Year 1 Admission)</th>
<th>2019 Cohort (Direct-Entry Year 2 Admission)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE3001 Engineering Electromagnetics</td>
<td>EE3279 Professional Internship</td>
</tr>
<tr>
<td>EE3002 Microprocessors</td>
<td>HY0001 Ethics and Moral Reasoning *</td>
</tr>
<tr>
<td>EE3080 Design &amp; Innovation Project</td>
<td>ET0001 Enterprise And Innovation *</td>
</tr>
<tr>
<td>EE3xxx Prescribed Elective 1</td>
<td></td>
</tr>
<tr>
<td>EE3xxx Prescribed Elective 2</td>
<td></td>
</tr>
<tr>
<td>HW0288 Professional Communications II</td>
<td></td>
</tr>
<tr>
<td>Unrestricted Elective (21 AUs)</td>
<td>EG0001 Engineers &amp; Society (23 AUs)</td>
</tr>
<tr>
<td><strong>(12 AUs)</strong></td>
<td></td>
</tr>
</tbody>
</table>

* Online GER-Core courses only offered in Semester 1
### Prescribed Elective Courses

Choose two (2)

<table>
<thead>
<tr>
<th>Prescribed Elective Courses</th>
<th>Prerequisite</th>
<th>Lab. Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE3010 Electrical Devices &amp; Machines</td>
<td>EE2001</td>
<td>E3010L</td>
</tr>
<tr>
<td>EE3011 Modelling &amp; Control</td>
<td>EE2006</td>
<td>E3011L</td>
</tr>
<tr>
<td>EE3012 Communication Principles</td>
<td>EE2010</td>
<td>E3012L</td>
</tr>
<tr>
<td>EE3013 Semiconductor Devices &amp; Processing</td>
<td>EE2003</td>
<td>E3013L</td>
</tr>
<tr>
<td>EE3014 Digital Signal Processing</td>
<td>EE2010</td>
<td>E3014L</td>
</tr>
<tr>
<td>EE3015 Power Systems &amp; Conversion</td>
<td>EE2001</td>
<td>E3015L</td>
</tr>
<tr>
<td>EE3017 Computer Communications</td>
<td>-</td>
<td>E3017L</td>
</tr>
<tr>
<td>EE3018 Introduction to Photonics **</td>
<td>-</td>
<td>E3018L</td>
</tr>
<tr>
<td>EE3019 Integrated Electronics</td>
<td>EE2002</td>
<td>E3019L</td>
</tr>
</tbody>
</table>

**EE3018 = Only offered in Semester 1**
Choice Of Prescribed Electives

q Select two third year Prescribed Electives.

q Your choice should be guided by your intended Final Year course choices.

q These electives are prerequisites for most Final Year Design and Technical Electives.

q Students can opt for final year courses within an area of specialization or mix-and-match from any areas of specialization.

q Additional Third Year Elective courses may be taken as Unrestricted Electives (UE), subject to availability of vacancies during the registration exercise.
Final Year Broadbased Option Choices

- Electrical & Systems Engineering
- Electronic Engineering
- Infocommunication Engineering
Area of Specialization within the Option Group

Electrical & Systems Engineering
- Biomedical Electronics
- Intelligent Systems & Control Engineering
- Electrical Power & Energy

Electronic Engineering
- Integrated Circuit Design
- Microelectronics + Photonics

Infocommunication Engineering
- Communication Engineering
- Computer Engineering
- Data Intelligence & Processing
Prerequisites to Final Year Course Options

Option Group

Specializations

Third Year Electives

- Intelligent Systems & Control Engineering
- Electrical Power & Energy
- Biomedical Electronics

EE3011 + EE3010/EE3015
EE3010 + EE3015
EE3011 + EE3010/EE3015
Prerequisites to Final Year Course Options

Option Group

ELECTRONIC ENGINEERING

Specializations

Integrated Circuits Design

Microelectronics & Photonics

Third Year Electives

EE3013 + EE3019

EE3013 + EE3018
Prerequisites to Final Year Course Options

Option Group

INFO-COMMUNICATION ENGINEERING

Specializations

Communication Engineering

Computer Engineering

Data Intelligence & Processing

Third Year Electives

EE3012 + EE3017

EE3017 + EE3014

EE3014 + EE3017/EE3011
EE3080
DESIGN & INNOVATION PROJECT (DIP)
(AY2020-2021)

Dr. Muhammad Faeyz
DIP Chairman

Madona Fernandez
DIP Administrator
eeeundgrad@ntu.edu.sg
EE3080 is a compulsory program for all full-time third-year EEE students.

It is a 2-AU course.

It is offered either in Semester 1 or 2.

Through DIP, students will design, prototype, and test innovative electronic, electrical or IT products.

Each project group is supervised by up to two faculty staff.

1. Introduction
Program requires each student to undertake a project in a group environment (5-6 students).

Each group will nominate a Group Leader and a Treasurer.

Each project group will be assigned a laboratory.

DIP students are required to work 6 hours per week over 13 weeks.
  - Every Wednesday (1.30pm - 4.30pm) – Mandatory in the laboratory
  - Another 3 hours are flexible and can be determined by both project supervisor and students.
2. Thematic Programs

- DIP projects are grouped under 9 Thematic Programmes.

<table>
<thead>
<tr>
<th>Thematic Program</th>
<th>Thematic Coordinator (Professor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP01: Smart and Micro Grids for Integration of Renewable Energy Sources</td>
<td>Wang Peng</td>
</tr>
<tr>
<td>TP02: Smart Electronics</td>
<td>Ji-Jon Sit</td>
</tr>
<tr>
<td>TP03: Electromedical and Mobile Computing Technologies</td>
<td>Justin Dauwels</td>
</tr>
<tr>
<td>TP04: UAVIONICS</td>
<td>Lim Meng Hiot</td>
</tr>
<tr>
<td>TP05: Photonics, Radar and Satellite Systems</td>
<td>Ng Boon Poh &amp; Wei Lei</td>
</tr>
<tr>
<td>TP06: Robotics</td>
<td>Wang Han</td>
</tr>
<tr>
<td>TP07: Machine Learning &amp; Data Analytics</td>
<td>Jiang Xudong</td>
</tr>
<tr>
<td>TP08: Escape Game Design &amp; Implementation</td>
<td>Liu Linbo</td>
</tr>
<tr>
<td>TP09: Smart Mobile Apps (SMAPPS)</td>
<td>Muhammad Faeyz Karim</td>
</tr>
</tbody>
</table>
3. Thematic Programs

q Each student inputs up to 3 choices in Studentlink around Week 11 or 12.

q After the deadline, allocation will be randomly done by the DIP system, based on the students’ choices.

q Once the project is allocated to a student, it will not be changed.

Remarks:
- Some programme may be offered only in Semester 1 or Semester 2, and/or may have a quota on the number of students set by its programme coordinator
- Students with allocated DIP projects will be registered to the course, EE3080.
- Thereafter, if a student is unable to take up DIP for reasons like overseas exchange, he/she needs to inform the EEE Academic Programme Office via eeeundgrad@ntu.edu.sg, and the project supervisor.
4. Project Management

- The course covers fundamental methods and techniques to effectively initiate, plan, execute, monitor & control, and close the project.

- The project management will be conducted **online**.

- It is **mandatory** for all the DIP students to complete the online lectures.
5. DIP Assessment

- The performance of each student will be closely and continuously monitored and assessed during the project.

- The overall grade of each student in EE3080 consists of two components:
  - Assessment by Supervisor
  - Assessment by Moderator
5. DIP Assessment

q Assessment areas by Project Supervisor:
  o Technical Knowledge and Skills
  o Project Charter Report
  o Final Project Report
  o Oral Presentation
  o Attendance and Participation

q Assessment areas by Moderator:
  o Logbook/Interview
  o Demonstration
  o Final Project Report
5. DIP Assessment

q Project Charter Report
   o Abstract submitted by supervisor is not in detail.
   o Includes project description, milestone, budget & risk.
   o Project Charter template is available on the EEE DIP website.
   o Submit report by 5 pm, Friday of Week 4 in each semester.

q Project Report
   o Each student needs to contribute to the Group Report (not individual).
   o The Group Leader must submit the group report consisting of 40-50 pages (exc. appendices) through NTULearn at Assignment under your DIP project group ID for plagiarism.
   o Project report template is available on the EEE DIP website.
   o Submit the report by 5 pm on the Friday of Week 13 in each semester.
6. Peer Review

q Each student is required to give peer reviews to all members in the project *(Mandatory)*

q Peer review is available via Studentlink

q Deadlines for Peer Reviews: **Friday of Week 13 in each semester**

**Remarks:**

- *All student should do the peer review ranking seriously and independently, based on each individual member's contributions such as information gathering, initiative/motivation to learn and participate, responsibility, positive collaboration with team members, application of creative/innovative ideas, technical knowledge & skills, problem solving ability, achievement and work quality, personal discipline and attendance, and so on.*

- *Students who purposely manipulate the peer review outcome will face serious consequences including disciplinary action from the School.*

- *During the assessments by supervisor and moderator, the following results will be considered as references:*
  - DIP Competition Result
  - Peer Review Result in terms of ranking
7. DIP Competition

q A DIP competition will be held among projects within respective thematic programme.

q Each student from the winning project will receive a Certificate.

q Competition results will be used as reference for final assessment results.

q Date of DIP Competition: First Monday of Week 14 of each semester.
8. Budget & Claims

q Existing resources in laboratories should be used.

q Each Thematic Programme is provided a total budget of S$1000 x No. of Projects.

q All purchasing should be approved by Project Supervisor.

q To purchase the components required by the project, the supervisor may make petty cash claim if the cost does not exceed $200 per claim.

q For more than $200 per claim, student needs to seek email approval as follows:

Student > Supervisor > DIP Coordinator > Area Lead
9. Important Timelines

- Briefing Session: 12 Aug 2020 (1:30 pm - 3:00 pm)
- Project Management Online Lecture: 19 Aug 2020
- Deadline for Project Charter Report: 04 September 2020
- Deadline for Peer Reviews: 13 Nov 2020
- Deadline for Final Report Submission: 13 Nov 2020
- Official Date of DIP Competition: 16 Nov 2020 (first Monday of Week 14)
Disclaimer Statement

NTU/School of EEE will not be liable to pay or reimburse if there any damage or stolen of personal items if they are used in the project.
For more information on DIP ...

http://www.eee.ntu.edu.sg/Programmes/CurrentStudents/undergraduate/undergraduatefull-time/DIP/Pages/Home.aspx
All information stated in the following slides is correct at time of post and subject to change without notice.
Electrical and Systems Engineering Area

Choose 2 Major Prescribed Electives courses in Third Year as follows:

- **EE3010** Electrical Devices and Machines ¹
- **EE3011** Modelling and Control ²
- **EE3015** Power Systems and Conversion ³

Note:

1,3 - Prerequisites for all final year power courses: EE4503, EE4504, EE4530, EE4532, EE4533, EE4534

2 - Prerequisite for some final year control & biomedical courses: EE4265, EE4268, EE4273, EE4903

<table>
<thead>
<tr>
<th>Final Year Courses that have Prerequisite</th>
<th>Prerequisite (as at Feb 2020)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE4503 Power Engineering Design</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4504 Design of Clean Energy Systems</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4530 Power System Analysis and Control</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4532 Power Electronics and Drives</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4533 Power Apparatus and System Protection</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4534 Modern Distribution Systems with Renewable Resources</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4265 Process Control Systems</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4268 Robotics and Automation</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4273 Digital Control Systems</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4903 Physiological Systems Analysis</td>
<td>EE3011</td>
</tr>
</tbody>
</table>
### How do you choose the 2 Major Prescribed Elective?

<table>
<thead>
<tr>
<th>Major PE</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE3010 + EE3011</td>
<td>Students intend to read any final year courses in either <strong>Control</strong> or <strong>Biomedical</strong>.</td>
</tr>
<tr>
<td>EE3010 + EE3015</td>
<td>Students intend to read at least 1 final year course in <strong>Power</strong> &amp; final year course in <strong>Control/Biomedical (without prerequisite)</strong>. (Both EE3010 and EE3015 are required for Power and Clean Energy Specialization)</td>
</tr>
<tr>
<td>EE3010; EE3015 &amp; EE3011</td>
<td>Students intend to read final year courses in <strong>both Power and Control (with prerequisite)</strong>, then they must take EE3010, EE3011 &amp; EE3015 (one of these must be registered as a UE).</td>
</tr>
</tbody>
</table>

- **EE3010** Electrical Devices and Machines
- **EE3011** Modelling and Control
- **EE3015** Power Systems and Conversion

**Note:**

1,3 - Prerequisites for all final year power courses: EE4503, EE4504, EE4530, EE4532, EE4533, EE4534
2 - Prerequisite for some final year control and biomedical courses: EE4265, EE4268, EE4273, EE4903
Courses to be taken in Final Year

• Students are required to take:
  o 2 DESIGN elective courses, and
  o 3 TECHNICAL elective courses

• For *specialization*, students can choose the design and technical elective courses from the respective areas of specialization.
# Electrical & Systems Engineering (Design Electives)

<table>
<thead>
<tr>
<th>Final Year Design Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE4207 Control Engineering Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4208 Intelligent System Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4503 Power Engineering Design</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4504 Design of Clean Energy Systems</td>
<td>EE3010 + EE3015</td>
</tr>
</tbody>
</table>
## Electrical & Systems Engineering (Technical Electives)

<table>
<thead>
<tr>
<th>Final Year Technical Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE4265 Process Control Systems</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4266 Computer Vision</td>
<td>-</td>
</tr>
<tr>
<td>EE4268 Robotics and Automation</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4273 Digital Control Systems</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4285 Computational Intelligence</td>
<td>-</td>
</tr>
<tr>
<td>EE4530 Power Systems Analysis and Control</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4532 Power Electronics and Drives</td>
<td>EE3010 + EE3015</td>
</tr>
<tr>
<td>EE4533 Power Apparatus and System Protection</td>
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<tr>
<td>EE4534 Modern Distribution Systems with Renewable Resources</td>
<td>EE3010 + EE3015</td>
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<tr>
<td>EE4903 Physiological Systems Analysis</td>
<td>EE3011</td>
</tr>
<tr>
<td>EE4904 Biomedical Instrumentation</td>
<td>-</td>
</tr>
<tr>
<td>EE4840 Biophotonics</td>
<td>-</td>
</tr>
</tbody>
</table>
Final Year Specialization

- Intelligent Systems and Control Engineering
- Power and Clean Energy
- Biomedical Electronics
Intelligent Systems & Control Engineering

- CONTROL is the heart of many engineering systems.

- It synergistically integrates the plants (electro-mechanical, chemical, etc.), with sensors, actuators, computers, communication, and software to yield optimal responses.

- Control systems enables integrations of mechanics, electronics, and computer hardware and software to revolutionize technology in the new economy.
Intelligent Systems & Control Engineering (Career Opportunities)

- Robotics and automated manufacturing
- Aerospace and automotive industries
- Precision engineering and manufacturing
- Process industries (petrochemical processes, pharmaceuticals and biotechnology processes, energy (including alternative energy) systems, environment and water treatment processes, food production processes)
- Building automation
## Intelligent Systems & Control Engineering (Career Opportunities)

<table>
<thead>
<tr>
<th>Final Year Design &amp; Technical Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>[D] EE4207 Control Engineering Design</td>
<td>-</td>
</tr>
<tr>
<td>[D] EE4208 Intelligent System Design</td>
<td>-</td>
</tr>
<tr>
<td>[T] EE4265 Process Control Systems</td>
<td>EE3011</td>
</tr>
<tr>
<td>[T] EE4266 Computer Vision</td>
<td>-</td>
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<tr>
<td>[T] EE4268 Robotics and Automation</td>
<td>EE3011</td>
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<tr>
<td>[T] EE4273 Digital Control Systems</td>
<td>EE3011</td>
</tr>
<tr>
<td>[T] EE4285 Computational Intelligence</td>
<td>-</td>
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</tbody>
</table>
Power & Clean Energy

- Power is a **basic necessity**....Can you think of anything in life without **ELECTRICITY (POWER)**?

- Importance of power engineers

- What do they do?

- Power system control, building services & electrical consulting, energy traders/brokers, power electronics, energy alternatives & renewable energy, intelligent energy system, oil refineries and related companies.

- Registered as a **Professional Engineer (PEng) with PEB**
Power & Clean Energy (Career Opportunities)

- Oil refineries
- Building services
- Electrical consulting companies
- Power equipment sales
- Engineering firms
- Hospitals
- Shipyards
- Singapore Power, MINDEF, SMRT, PSA, JTC, CAAS, LTA
# Power & Clean Energy

## Final Year Design & Technical Electives

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>[D] EE4503</td>
<td>Power Engineering Design</td>
<td>EE3010+EE3015</td>
</tr>
<tr>
<td>[D] EE4504</td>
<td>Design of Clean Energy Systems</td>
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<td>[T] EE4530</td>
<td>Power Systems Analysis and Control</td>
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<tr>
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<td>Digital Control Systems</td>
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</tbody>
</table>
Biomedical Electronics

What is Biomedical Engineering?

- Biomedical Engineering is a multiple disciplines and high technology area
- It is to provide solutions for health care industries and services
- Electrical engineers play a key role in health care industries and services (circuits and electronics, measurement and instrumentation, information and signal processing, medical imaging and image processing, modelling and control, telemedicine)
Biomedical Engineering is an exciting area of specialization.

It is important: Health caring and life saving.

It is profound and challenging (Nobel prizes in medicine in 1979, for the development of computed tomography (CT) and in 2003 for the development of magnetic resonance Imaging (MRI)).

It is high tech.

Health care industry is robust and resilient in the economic crisis.
Biomedical Electronics (Career Opportunities)

- Research institutions
- Hospitals
- Academic institutions/government boards
- Companies
- Sale and marketing of medical instruments and products
## Biomedical Electronics

<table>
<thead>
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<td>[T] EE4266 Computer Vision</td>
<td>-</td>
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</tbody>
</table>
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Why Electronics Engineering?

• Electronics form the backbone of AI, enabling devices to see, think, and talk to each other.

• Electronics enables engineers and inventors to create solutions that tackle the world's problems and to improve lives.

• According to the recent survey, many graduates, who did not take up Electronics specialization, have ended up in the Electronic sector for employment.

• Students should consider reading some Electronic courses to become 'more' employable!

• Singapore has one of the most diverse semiconductor industries in the Asia Pacific.
Electronic Engineering Specialization

- **ELECTRONICS**
  - **Microelectronics**
    - Microelectronics Courses
    - Photonics Courses
  - **IC Design**
    - IC Design Courses
# Year 3 Elective Courses in Electronics

<table>
<thead>
<tr>
<th>Microelectronics Specialization</th>
<th>EE3013 Semiconductor Devices and Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Basic concepts of engineering principles in semiconductor processing, wafer fabrication &amp; physical principles underlying the operation of basic semiconductor devices.</td>
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<tr>
<td></td>
<td>• Lab module: 1 hour video on advanced wafer processing, &amp; 2 hours of cleanroom visit. <strong>Prerequisite for Year 4 courses</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IC Design Specialization</th>
<th>EE3018 Introduction to Photonics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Introductory course on the fundamentals of photonics &amp; their impacts on our daily life. Photonics contributes to the fundamental platform for nanotechnology, green energy, home entertainment, data storage, sensing, imaging, biomedical healthcare, &amp; modern optical communications.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IC Design Specialization</th>
<th>EE3019 Integrated Analog Electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Provides knowledge to pursue advanced topics in analog &amp; digital integrated circuits.</td>
</tr>
<tr>
<td></td>
<td>• Includes the design of elements in bipolar- and CMOS-based op amps, feedback, power supplies, linear &amp; non-linear applications circuits and transistor circuits for realising basic digital circuits. <strong>Prerequisite for Year 4 courses</strong></td>
</tr>
</tbody>
</table>
## Microelectronics/Photonics Specialization

<table>
<thead>
<tr>
<th>Type</th>
<th>Final Year Design &amp; Technical Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design Electives</strong></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>EE4613 CMOS Process and Device Simulation by Tech. CAD</td>
<td>EE3013</td>
</tr>
<tr>
<td></td>
<td>EE4614 Device Parameter Extraction &amp; Layout Implementation</td>
<td>EE3013</td>
</tr>
<tr>
<td><strong>Technical Electives</strong></td>
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</tr>
<tr>
<td></td>
<td>EE4645 Microfabrication Engineering</td>
<td>EE3013</td>
</tr>
<tr>
<td></td>
<td>EE4646 VLSI Technology</td>
<td>EE3013</td>
</tr>
<tr>
<td></td>
<td>EE4647 Microelectronic Devices</td>
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<tr>
<td></td>
<td>EE4694 IC Reliability &amp; Failure Analysis</td>
<td>EE3013</td>
</tr>
<tr>
<td></td>
<td>EE4838 Laser Engineering &amp; Applications</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE4840 Biophotonics</td>
<td></td>
</tr>
</tbody>
</table>
# IC Design Specialization

<table>
<thead>
<tr>
<th>Type</th>
<th>Final Year Design &amp; Technical Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Electives</td>
<td>EE4303 Mixed-Signal IC Design</td>
<td>EE3019</td>
</tr>
<tr>
<td></td>
<td>EE4304 Radio Frequency Integrated System Design</td>
<td>EE3019</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>EE4340 VLSI Systems</td>
<td>EE2004</td>
</tr>
<tr>
<td></td>
<td>EE4341 Advanced Analog Circuits</td>
<td>EE3019</td>
</tr>
<tr>
<td></td>
<td>EE4343 Radio Frequency Circuits</td>
<td>EE3019</td>
</tr>
<tr>
<td></td>
<td>EE4344 Analysis &amp; Design of Integrated Circuits</td>
<td>EE3019</td>
</tr>
<tr>
<td></td>
<td>EE4694 IC Reliability &amp; Failure Analysis</td>
<td>EE3013</td>
</tr>
</tbody>
</table>
Wide Range of Career Opportunities in Electronics Sector with Global Leaders
Singapore’s Semiconductor Ecosystem

*Strong, comprehensive base of top companies*

**IC Design**
- Qualcomm
- Broadcom
- Xilinx
- MediaTek
- Inphi
- Realtek
- 9 of the top 15 fabless semiconductor companies

**Wafer Fabrication**
- GlobalFoundries
- UMC
- TSMC
- 3 of the top wafer foundries

**Assembly and Test**
- JCET
- STATSChipPAC
- ASE
- UTAC
- Powertech
- 4 of the top 6 OSATs

Outsourced Semiconductor Assembly and Test

Have focused on engaging top companies to build up a semiconductor ecosystem in Singapore.
## IC Design Centres

~40 IC Design Centres

~1200 IC designers in Singapore

### N. America
- Avago
- Broadcom
- Finisar
- Intel
- Linear Tech
- LSI
- Marvell
- O₂Micro

### Europe
- Qualcomm
- Silicon Labs
- SMSC
- Texas Instruments
- Volterra
- Xilinx

- CSR
- Infineon
- Lantiq
- ST-Ericsson
- STMicro-Electronics

### Singapore
- Advinno
- BlueChips
- ComSOC
- DSO
- FreeSystems
- FTD Technology
- MEDS Tech
- Yuliantic

### ROW
- HiSilicon
- Lite-On
- MediaTek
- Solomon Systech

### Japan
- Fujitsu Semiconductor
- Panasonic Semiconductor
- Panasonic Electric Works

Top 25 Fabless Companies (2011) are highlighted in pink

Top 10 IDM (2010) are highlighted in blue
14 Silicon Wafer Fabs
~ 867 000 wafers per month output (200mm equivalent)
~ 1000 R&D engineers

<table>
<thead>
<tr>
<th>Ten ≤ 8” (200mm) Fabs</th>
<th>Four 12” (300mm) Fabs</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLOCALFOUNDRIES - 5 Fabs</td>
<td>GLOCALFOUNDRIES</td>
</tr>
<tr>
<td>Micron</td>
<td>UMC</td>
</tr>
<tr>
<td>SSMC (NXP-TSMC)</td>
<td>IM Flash Singapore</td>
</tr>
<tr>
<td>STMicroelectronics - 3 Fabs</td>
<td>Micron</td>
</tr>
</tbody>
</table>

*Black – Logic Fabs; Blue – Memory Fabs*
# Assembly & Test Companies

R&D engineers: ~300 in assembly and ~400 in test

<table>
<thead>
<tr>
<th>3rd Party A&amp;T</th>
<th>In-house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ardentec</td>
<td>AMD</td>
</tr>
<tr>
<td>ASE</td>
<td>Avago</td>
</tr>
<tr>
<td>STATS</td>
<td>Delphi</td>
</tr>
<tr>
<td>ChipPAC</td>
<td>Automotive</td>
</tr>
<tr>
<td></td>
<td>Infineon</td>
</tr>
<tr>
<td></td>
<td>Linear Tech</td>
</tr>
<tr>
<td></td>
<td>Micron</td>
</tr>
<tr>
<td>UTAC</td>
<td>Panasonic</td>
</tr>
<tr>
<td>Nepes</td>
<td>Renesas</td>
</tr>
<tr>
<td></td>
<td>Seiko-Epson</td>
</tr>
<tr>
<td></td>
<td>STMicroelectronics</td>
</tr>
<tr>
<td></td>
<td>Xilinx</td>
</tr>
<tr>
<td></td>
<td>Silicon Labs</td>
</tr>
</tbody>
</table>

*Black refers to companies with both A & T*

*Pink refers to companies with only Assembly*

*Blue refers to companies with only Test*
16 of top 20 global companies have R&D, manufacturing or HQ in Singapore

- **Intel**: World #1, USA #1, CPU #1
- **Samsung**: World #2, Asia #1
- **Texas Instruments**: World #4, USA #2
- **Renesas**: World #5, Japan #2
- **STMicroelectronics**: World #7, Europe #1
- **Micron**: World #8, USA #3, Memory #2
- **Qualcomm**: World #9, USA #4, Comms #1
- **Broadcom**: World #11, USA #5, Comms #2
- **AMD**: World #12, USA #6, CPU #2
- **Infineon Technologies**: World #13, Europe #2
- **Panasonic**: World #15, Japan #5
- **freescale**: World #17, USA #7
- **NXP**: World #17, Europe #3
- **Marvell**: World #18, USA #8
- ** MediaTek**: World #19, Taiwan #1
- **NVIDIA**: World #20, USA #9, Graphics #3

Companies representing >50% of WW semiconductor revenue are in Singapore
Singapore’s Electronics Industry in 2016

4.4% of Singapore's GDP

S$90B manufacturing output

~66,000 employment
17% of total manufacturing jobs

Breakdown of Electronics Industry

1 in 10 chips worldwide are made in Singapore

Semiconductors (53%)

Infocomms & Consumer Electronics (14%)

Electronic Modules & Components (11%)

Data Storage (11%)

Computer Peripherals & EMS (11%)

A Key Pillar of our Economy

singstat.gov.sg, 2016
Photonics Industry in Singapore
Estimated output S$1.2 billion

- Communications
- Sensing, Test & Measurement
- Security, Defense
- Advanced Displays
- Solid State Lighting
- Electronics Mfg Services

Companies:
- JDS Uniphase
- MBE Technology
- 3M
- Finisar
- GLOBALFOUNDRIES®
- NNESS
- innoled
- VENTURE
- FLEXTRONICS
- Nejilock
- Tinggi Tech
- EXFO
- PerkinElmer
- Valen
- WANGI MINNIGAL
- Singapor Technologies Engineering
- CEO
- THALES
The information stated in the following slides is correct at time of post and subject to change without notice.
Infocommunication Engineering

Three Specializations

- Communication Engineering
- Data Intelligence and Processing
- Computer Engineering
Communication Engineering

Mobile Communications

Optical Communications

Satellite Communications

Wireless Communications
Data Intelligence & Processing

Applications

- Media Search Engine
- Mobile Audio
- Video on-demand
- Social Network
- HDTV
- On-line Gaming
- Smart Phones

Consumer Electronics
Communication
Computer
Contents (digital)
Computer Engineering

- All aspects of our lives have been transformed by the emergence of internet, e-commerce, mobile phones/PDA, ultra-high-definition TV, medical imaging, etc.

- It is computer engineers who developed the hardware, software and networking technologies that made them possible.

- Combines computer systems with conventional aspects of electrical and electronic engineering.

- Covers computer hardware, software, and networking.
Smart Phone as an Example

Coding
- Transmission
- Storage

Pre-Processing
- Enhance Quality
- Reduce Cost

Post-Processing
- Enhance Quality
- Reduce Cost

Analysis
- Speech Recognition
- Bar Code Analysis
- Song Identification

Synthesis
- Sound Synthesizer
- 2D & 3D Graphics
Year 3 Prescribed Elective Courses for Infocomm

Recommendation:

Select any 2 courses

- EE3012 Communication Principles
- EE3014 Digital Signal Processing
- EE3017 Computer Communications

Communication Engineering
EE3012 + EE3017

Computer Engineering
EE3014 + EE3017

Data Intelligence & Processing
EE3014 + EE3011 / EE3017
## Infocommunication Engineering (Design Electives)

<table>
<thead>
<tr>
<th>Final Year Design Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE4105 Cellular Communication System Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4109 Wireless System Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4110 Optical Communication System Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4208 Intelligent Systems Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4413 DSP System Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4414 Machine Learning Design &amp; Application</td>
<td>EE4483</td>
</tr>
<tr>
<td>EE4717 Web Application Design</td>
<td>-</td>
</tr>
<tr>
<td>EE4718 Enterprise Network Design</td>
<td>EE3017</td>
</tr>
</tbody>
</table>
## Infocommunication Engineering (Technical Electives)

<table>
<thead>
<tr>
<th>Final Year Technical Electives</th>
<th>Prerequisite</th>
<th>Final Year Technical Electives</th>
<th>Prerequisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE4001 Software Engineering</td>
<td>-</td>
<td>EE478 Digital Video Processing</td>
<td>-</td>
</tr>
<tr>
<td>EE4152 Digital Communications</td>
<td>EE3012</td>
<td>EE483 Artificial Intelligence &amp; Data Mining</td>
<td>-</td>
</tr>
<tr>
<td>EE4153 Telecommunication Systems</td>
<td>EE3012</td>
<td>EE490 Multimedia Systems</td>
<td>-</td>
</tr>
<tr>
<td>EE4188 Wireless Communications</td>
<td>EE3012</td>
<td>EE491 Probability Theory &amp; Applications</td>
<td>EE2010</td>
</tr>
<tr>
<td>EE4266 Computer Vision</td>
<td>-</td>
<td>EE497 Pattern Recognition &amp; Data Mining</td>
<td>-</td>
</tr>
<tr>
<td>EE4285 Computational Intelligence</td>
<td>-</td>
<td>EE4756 Computer Architecture</td>
<td>-</td>
</tr>
<tr>
<td>EE4455 Embedded Systems</td>
<td>EE3002</td>
<td>EE4758 Information Security</td>
<td>-</td>
</tr>
<tr>
<td>EE4475 Audio Signal Processing</td>
<td>-</td>
<td>EE4761 Computer Networking</td>
<td>EE3017</td>
</tr>
<tr>
<td>EE4476 Image Processing</td>
<td>-</td>
<td>EE4791 Database Systems</td>
<td>-</td>
</tr>
</tbody>
</table>
## Recommended Courses within the Area of Specialization

<table>
<thead>
<tr>
<th>Area of Specialization</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communications Engineering</td>
<td>EE4105, EE4109, EE4110, EE4152, EE4153, EE4188</td>
</tr>
<tr>
<td>Computer Engineering</td>
<td>EE4717, EE4718, EE4001, EE4756, EE4758, EE4761, EE4455, EE4483, EE4490, EE4791</td>
</tr>
<tr>
<td>Data Intelligence &amp; Processing</td>
<td>EE4208, EE4413, EE4414, EE4266, EE4285, EE4475, EE4476, EE4478, EE4483, EE4490, EE4491, EE4497</td>
</tr>
</tbody>
</table>
Career Opportunities of EEE Graduates with Infocommunication Engineering

- Research Centre
- Consumer Electronics Industry
- Communications & Broadcasting
- Infocomm – Computers & Communications
- Government & Statutory Boards
- Banking & Financial Institutions
- Private Communication Networks
Industries that require Infocommunication

THIRD YEAR COURSE DECLARATION EXERCISE

27 Feb 2020 to 8 Mar 2020

No Selection = Registration Placement Not Guaranteed

Courses with limited interest will be closed.

Declaration Link

Enquiries: eeeundgrad@ntu.edu.sg