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VISION

To Be One of the World’s Leading Innovative and Creative Technical Universities

MISSION

UTeM is committed to pioneer and contribute towards the prosperity of the nation and the world by:

1. promoting knowledge through innovative teaching & learning, research and technical scholarship.
2. developing professional leaders with impeccable moral values.
3. generating sustainable development through smart partnership with the community and industry.

MOTTO

Excellence Through Competency
EDUCATIONAL GOALS

1. To conduct academic and professional programmes based on relevant needs of the industries.

2. To produce graduates with relevant knowledge, technical competency, soft skills, social responsibility and accountability.

3. To cultivate scientific method, critical thinking, creative and innovative problem solving and autonomy in decision making amongst graduates.

4. To foster research development and innovation activities in collaboration with industries for the development of national wealth.

5. To equip graduates with leadership and teamwork skills as well as develop communication and life-long learning skills.

6. To develop technopreneurship and managerial skills amongst graduates.

7. To instil an appreciation of the arts and cultural values and awareness of healthy life styles amongst graduates.

OBJECTIVES

1. To become a creative and innovative learning and knowledge organization that offers practice and application oriented academic programmes in the fields of engineering and technology.

2. To lead in research, development, innovation, commercialization and consultancy activities based on the needs of the industry.

3. To produce competent graduates with high moral values who will be the preferred choice by the industry.

4. To have competent and highly qualified staff with vast practical experiences.

5. To play an effective role as the main impetus to the industrial development of the nation.

6. To establish cooperation and smart partnership between the university and the industries.

7. To provide infrastructure and conducive environment to generate and maintain excellence.

8. To implement comprehensive and extensive usage of ICT in both academic activities and management of the university.
FACULTY VISION

To become a reputable world-class centre of excellence in Electronic Engineering.

FACULTY MISSION

To produce highly competent electronic engineers through world class higher technical education based on application oriented teaching, learning and research with smart university-industry partnership in line with national aspirations.

FACULTY OBJECTIVES

1. To produce electronic engineers who are responsible to the Creator, the nation and the society.
2. To provide the best and updated courses in Electronics, Computer and Telecommunication Engineering.
3. To create an excellent culture in research, development, innovation and consultancy.
4. To ensure excellent co-operation and relationship between the faculty and the industries.
5. To produce competent graduates who are capable of competing globally.
6. To publish excellent and beneficial academic materials for the nation.
7. To provide up-to-date facilities and equipment for teaching and learning.
8. To provide relevant facilities and equipment for teaching, learning, research and development.
FOREWORD BY THE DEAN

Assalamualaikum wrt.wbt.

All Praise to Allah, the Almighty, the Most Gracious and the Most Merciful. Through His Blessings and Grace, the Faculty of Electronic and Computer Engineering with the cooperation of the University Publisher has managed to successfully publish the faculty’s handbook for the Academic Session of 2015/2016.

Last year, the university took a bold step in reviewing all the engineering programmes and restructures them into broad based programmes which was implemented for the first time in 2014/2015 session. Thus, for the 2015/2016 Academic Session the student intake is purely for the engineering broad based programme, that is, the Bachelor of Electronic Engineering with Honours programme.

This faculty handbook provides the latest information on the academic programmes to be offered in the 2015/2016 Academic Session, the academic curriculum structures, the synopsis and syllabi of all the courses, the academic system applied in the teaching and learning activities and the facilities that support the teaching and learning activities in the faculty.

This handbook also contains general information on the vision, mission, motto, educational objectives and objectives of UTeM and the vision, mission and objectives of the faculty. The Programmes Objectives and the Programmes Outcomes are also included for the students to realize and achieve.

Updated information on the management of the faculty and the members of the academic and support staff in the faculty is included in this handbook for everyone’s reference.

The faculty put great effort to compile and upgrade the handbook with the most accurate data and information. It is hope that this handbook can become an excellent guide to the students in the faculty during their course of studies in UTeM. I would like to thank the faculty publication committee for successfully compiling and publishing this handbook.

On behalf of the faculty, let me take this opportunity to congratulate all the new students for having been offered a place to pursue your studies in UTeM. My best wishes to you and I hope you have a wonderful time while in UTeM. I wish you ever success in your course of studies and in your future endeavour.

Thank you.

Wassalam.

“EXCELLENCE THROUGH COMPETENCY”

DR. NURULFAJAR BIN ABD MANAP
Dean,
Faculty of Electronics and Computer Engineering
Universiti Teknikal Malaysia Melaka
SENIOR ADMINISTRATIVE STAFF
INTRODUCTION

In the year 2000, Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKM), the first technical university was launched and it became the 14th public university in Malaysia. The Faculty of Electronic and Computer Engineering (FKEKK) was among the various faculties officially established on 22 June 2001 and it started its operation at the temporary premises in Taman Tasik Utama, Ayer Keroh, Melaka.

On 22 December 2004, FKEKK created history by being the first faculty to move its operation to the main campus in Durian Tunggal. FKEKK was able to provide the most conducive environment for effective learning, in terms of modern physical buildings and the latest state of the arts equipment and facilities.

In early February 2007, the rebranding of KUTKM to Universiti Teknikal Malaysia Melaka (UTeM) took place and from then on UTeM had played significant role in producing competent and capable graduate engineers recognized globally highly sought after by international and national companies.

FKEKK plays a very important role in producing electronic engineers with strong basic knowledge in science, mathematics and electronic engineering. The students are given all the opportunity to acquire technical expertise which is achieved through outcome based education fully implemented in the faculty.

In the previous years, FKEKK offered four undergraduate programmes, Bachelor of Electronic Engineering (Industrial Electronics) with Honours, Bachelor of Electronic Engineering (Computer Engineering) with Honours, Bachelor of Electronic Engineering (Telecommunication Electronics) with Honours, Bachelor of Electronic Engineering (Wireless Communication) with Honours and Diploma in Electronic Engineering.

Beginning last year, the university had taken a bold step in reviewing all the engineering programmes and restructured them into broad based programmes. FKEKK will be offering Bachelor of Electronic Engineering with Honours in the 2015/2016 Academic Session. However, the various electives available in the curriculum allow a student to choose an option to focus on industrial electronics, computer engineering, telecommunication electronics or wireless communication.

FKEKK is headed by a dean who is assisted by two deputy deans and four heads of department. The departments in the faculty are:

- Department of Industrial Electronics
- Department of Computer Engineering
- Department of Telecommunication Engineering
- Department of Diploma Studies
FACILITIES

FKEKK is equipped with the latest facilities with the aim of providing a comfortable and conducive environment for the process of learning and teaching to take place effectively and efficiently.

All the lecture rooms, each with a capacity to hold 60 students, are equipped with modern audio and visual aids such as computer and LCD projector. There are altogether 18 laboratories and workshops. Besides these, there are 17 student self-study rooms; each room is capable of accommodating 30 students.

All the laboratories are equipped with the latest industrial equipment which are sophisticated enough with the objective of producing highly skilled graduates who will be of great demand by the industries. The laboratories are equipped on the rational of providing an attractive ratio of two students working on one workstation or equipment, providing the students the opportunity to gain enough exposure and learning through each experiment. Each laboratory is further equipped with computers and internet facilities to facilitate the teaching and learning process as well as report and project writing.

Overall FKEKK 19 laboratories are listed as below:

- Basic Electronic Laboratory 1 and 2
- Industrial Electronic Laboratory
- Industrial Automation Laboratory
- Electrical Technology Laboratory
- Computer Engineering Laboratory
- Digital Laboratory 1 and 2
- Microprocessor Laboratory
- Basic Communication Laboratory
- Communication Electronics Laboratory
- Microwave Laboratory
- Wireless Communication Laboratory
- FYP and Fabrication Laboratory
- Postgraduate Research Laboratory I
- Postgraduate Research Laboratory II
- Research Laboratory I
- Research Laboratory II
- Research Laboratory III

All the above laboratories are equipped with the state of the art facilities and simulation software to enable the students to make analytical comparison studies on practical and simulated outcomes or results. Each laboratory is taken charge by a lecturer and assisted by an assistant engineer/technician.
ADMINISTRATION AND ACADEMIC BLOCK

3F
- Tutorial Rooms
- Lecturers’ Rooms
- Lecture Rooms 12, 13, 14
- Professor’s Rooms
- Room 15, 16, 17

2F
- Lecture Room 6, 7, 8
- Meeting Rooms
- Deputy Deans, Heads of Department Office
- Dean’s Office

1F
- Lecture Room 10, 11
- CLEAR Room
- Student’s Room
- Lecture Rooms 1, 2, 3
- Administration Office
- Lecture Room 4, 5

GF
- Students’ Room
- Lecture Room 1, 2, 3
- Administration Office
- Lecturers’ Rooms
LABORATORIES BLOCK

2F
- Electronic Communication Lab
- Microwave Lab
- Industrial Electronics Lab
- Research Lab 2
- Wireless Communication Lab
- Microprocessor Lab

1F
- Basic Communication Lab
- Electronics Lab 1
- Electronics Lab 2
- Electrical Technology Lab
- Digit 1 Lab
- Digit 2 Lab
- Postgraduate Lab

GF
- PSM & Fabrication Lab
- Advanced Communication Lab
- Research Lab 1
- Automation Lab
- Computer Engineering Lab
- Research Lab 3
- Lecturers' Rooms
COURSES OFFERED

FKEKK offers the Diploma and Degree Programmes as below:

- Bachelor of Electronic Engineering with Honours
- Diploma in Electronic Engineering

COURSE DURATIONS

The Bachelor Degree duration is a minimum of 4 years and a maximum of 6 years. The Diploma programme duration is 3 years.

COURSE STRUCTURES

Courses offered are in line to the recommendations from the Engineering Accreditation Council (EAC) of Malaysia. All the subjects in a program have their respective learning outcomes to ascertain that the program outcomes are attained. The students’ theoretical knowledge is acquired through individual and group activities that include lecture sessions incorporating interactive learning, problem-based learning and cooperative learning. Theoretical knowledge is enhanced and reinforced during laboratory sessions that include elements of analysis and design in the experiments.

Self-directed learning and group learning are very much encouraged especially during the laboratory sessions, problem-based learning, computer oriented studies, individual and group assignments, engineering practice, industrial training and the final year project which is related to electronic engineering.

Assessment on the success of the students is based heavily on individual performance such as tests, individual assignments, undertaking project that includes development, oral presentation and report, and the final examination. Group assessment is mainly taken from laboratory reports, group assignments and presentations.
ENTRY REQUIREMENTS FOR THE BACHELOR DEGREE PROGRAMME

The candidate for Bachelor of Electronic Engineering in FKEKK must have the following qualifications:

1. Minimum Entry Requirements For STPM Candidates

   University General Requirements

   A Pass in Sijil Pelajaran Malaysia (SPM) / equivalent with a credit in Bahasa Melayu or credit in Bahasa Melayu July Paper;

   and

   Pass in Sijil Tinggi Persekolahan Malaysia (STPM) with at least CGPA 2.00 and obtained at least:
   - C Grade (NGMP 2.00) in Pengajian Am; and
   - C Grade (NGMP 2.00) in two (2) other subjects.

   and

   Obtained at least Band 2 in the Malaysian University English Test (MUET)

   and

   Faculty Programme Special Requirements

   A pass in Sijil Tinggi Persekolahan Malaysia (STPM) with at least with C Grade (NGMP 2.00) in all of the following subject:
   - Mathematics T / Further Mathematics T / Mathematics S
   - Physics
   - Chemistry
   or
   - Mathematics T / Further Mathematics T / Mathematics S
   - Chemistry
   - Biology and obtained at least credits (4B/ B Gred) in Physics at Sijil Pelajaran Malaysia (SPM) level

   and

   The applicant must not be colour blind and not handicapped that can impair practical work
2. **Minimum Entry Requirements for Matriculation Candidates**

**University General Requirements**

A Pass in *Sijil Pelajaran Malaysia (SPM)* / equivalent with credit in Bahasa Melayu or credit in Bahasa Melayu July Paper;

or

Pass in MOE Matriculation / UM Science Foundation / UiTM Foundation Studies with at least CGPA 2.00;

and

obtained at least **Band 2** in the Malaysian University English Test (MUET)

and

**Faculty Programme Special Requirements**

Obtained at least **C Grade** (NGMP 2.00) in MOE Matriculation / UM Science Foundation / UiTM Foundation Studies in **all** following subjects:

- Mathematics / Engineering Mathematics
- Physics / Engineering Physics
- Chemistry / Engineering Chemistry / Electric and Electronic Engineering Studies / Civil Engineering Studies

or

- Mathematics / Engineering Mathematics
- Chemistry / Engineering Chemistry
- Biology and obtained at least credits **(B Gred)** in **Physics** at Sijil Pelajaran Malaysia (SPM) level

and

The applicant must not be colour blind and not handicapped that can impair practical work
3. Minimum Entry Requirements for Diploma holders

University Entry Requirements

A Pass Sijil Pelajaran Malaysia Pass (SPM) / equivalent with credit in Bahasa Melayu or credit in Bahasa Melayu July Paper;

and

A Pass in Diploma of other qualification recognized as equivalent by the Government of Malaysia and approved by the IPTA Senate;

or

A pass in Sijil Tinggi Persekolahan Malaysia (STPM) with at least
  • C Grade (CGPA 2.00) in Pengajian Am; and
  • C Grade (CGPA 2.00) in two (2) other subjects.

or

A pass in Matriculation with at least CGPA 2.00

and

obtained at least Band 2 in the Malaysian University English Test (MUET)

and

Faculty Programme Special Requirements

A pass in Diploma with at least CGPA 3.00 in a related field from a recognized institution and approved by the University’s Senate;

and

Credit exemption is subjected to the discretion and approval by the Faculty;

and

Passed / completed studies at Diploma level during application.

or
A pass in Sijil Tinggi Persekolahan Malaysia (STPM) with at least C Grade (CGPA 2.00) in all the following subjects:

- Pengajian Am
- Mathematics T / Further Mathematics T / Mathematics S
- Physics
- Chemistry

or

- Pengajian Am
- Mathematics T / Further Mathematics T / Mathematics S
- Chemistry
- Biology and obtained at least credits (4B/B Gred) in Physics at Sijil Pelajaran Malaysia (SPM) level

or

A pass in MOE Matriculation / UM Foundation Studies / UiTM Foundation Studies examination with at least C Grade (NGMP 2.00) in all the following subjects:

- Mathematics / Engineering Mathematics
- Physics / Engineering Physics / Engineering Science
- Chemistry / Engineering Chemistry / Electric and Electronic Engineering Studies / Civil Engineering Studies

or

- Mathematics / Engineering Mathematics
- Chemistry / Engineering Chemistry
- Biology and obtained at least credits (B Gred) in Physics at Sijil Pelajaran Malaysia (SPM) level

and

The applicant must not be colour blind and not handicapped that can impair practical work.

4. Malaysian University English Test (MUET)

Students with Band 2 in MUET upon registration for the Bachelor degree course are required to register and resit for MUET and must at least obtain a Band 3 within two years from the date of registration for the course. Students who fail to do so within the two years are not allowed to continue their studies in the following semester.

The university fully encourages students without Band 4 in MUET to register and take the Foundation English Programme (BLHL 1010) subject offered by the university in order to assist them to be more prepared to re-sit the MUET. Students are required to pay RM100.00 to take the subject.
ACADEMIC SYSTEM

The academic system of this University is based on the semester system which is a common practice in all the Institutions of Higher Education in Malaysia. The Academic Handbook explains the Procedures and University Academic Rules enforced.

Table 1: A Typical Academic Year

<table>
<thead>
<tr>
<th>SEMESTER I</th>
<th>Classes</th>
<th>7 weeks</th>
<th>Semester Break</th>
<th>1 week</th>
<th>Classes</th>
<th>7 weeks</th>
<th>Revision Week</th>
<th>1 week</th>
<th>Final Examination</th>
<th>2 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>18 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Break Between Semesters</td>
<td>3 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEMESTER II</td>
<td>Classes</td>
<td>7 weeks</td>
<td>Semester Break</td>
<td>1 week</td>
<td>Classes</td>
<td>7 weeks</td>
<td>Revision Week</td>
<td>1 week</td>
<td>Final Examination</td>
<td>2 weeks</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>18 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>End of Semester Break</td>
<td>13 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>52 weeks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>SPECIAL SEMESTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes and Examination</td>
</tr>
<tr>
<td>End of Semester Break</td>
</tr>
<tr>
<td>1 week</td>
</tr>
<tr>
<td>4 weeks</td>
</tr>
</tbody>
</table>
GRADING SYSTEM

A student’s achievement for each subject is based on the grades which are illustrated in Table 2.

Table 2: Marks, Grades and Points Awarded

<table>
<thead>
<tr>
<th>Marks</th>
<th>Grade</th>
<th>Points</th>
<th>Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 – 100</td>
<td>A</td>
<td>4.0</td>
<td>Distinction</td>
</tr>
<tr>
<td>75 – 79</td>
<td>A-</td>
<td>3.7</td>
<td>Distinction</td>
</tr>
<tr>
<td>70 – 74</td>
<td>B+</td>
<td>3.3</td>
<td>Merit</td>
</tr>
<tr>
<td>65 – 69</td>
<td>B</td>
<td>3.0</td>
<td>Merit</td>
</tr>
<tr>
<td>60 – 64</td>
<td>B-</td>
<td>2.7</td>
<td>Merit</td>
</tr>
<tr>
<td>55 – 59</td>
<td>C+</td>
<td>2.3</td>
<td>Pass</td>
</tr>
<tr>
<td>50 – 54</td>
<td>C</td>
<td>2.0</td>
<td>Pass</td>
</tr>
<tr>
<td>47 – 49</td>
<td>C-</td>
<td>1.7</td>
<td>Conditional Pass</td>
</tr>
<tr>
<td>44 – 46</td>
<td>D+</td>
<td>1.3</td>
<td>Conditional Pass</td>
</tr>
<tr>
<td>40 – 43</td>
<td>D</td>
<td>1.0</td>
<td>Conditional Pass</td>
</tr>
<tr>
<td>00 – 39</td>
<td>E</td>
<td>0.0</td>
<td>Fail</td>
</tr>
</tbody>
</table>

ACADEMIC STATUS

A student’s achievement is evaluated based on GPA and CGPA. A student’s academic status will be provided at the end of each semester as shown in Table 3.

Table 3: Academic Status Classification

<table>
<thead>
<tr>
<th>STATUS</th>
<th>CGPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good (KB)</td>
<td>CGPA ≥ 2.00</td>
</tr>
<tr>
<td>Conditional (KS)</td>
<td>1.70 ≤ CGPA &lt; 2.00</td>
</tr>
<tr>
<td>Fail (KG)</td>
<td>CGPA &lt; 1.70</td>
</tr>
</tbody>
</table>
ACADEMIC ACHIEVEMENTS

A student’s overall achievement is based on Grade Point Average (GPA) obtained for a particular semester and Cumulative Grade Point Average (CGPA) for the semesters that have been completed. These measure the student’s academic position.

Grade Point Average (GPA)

GPA is the grade point average obtained in a particular semester. It is based on the following calculations:

\[
\text{Total Points, } JMN = k_1m_1 + k_2m_2 + \ldots + k_nm_n \\
\text{Total Calculated Credits, } JKK = k_1 + k_2 + \ldots + k_n \\
\text{GPA} = \frac{JMN}{JKK} = \frac{[k_1m_1 + k_2m_2 + \ldots + k_nm_n]}{[k_1 + k_2 + \ldots + k_n]}
\]

Where:
- \( k_n \) = Credit for \( n \) subject
- \( m_n \) = Points from the \( n \) subject

Cumulative Grade Point Average (CGPA)

CGPA is the cumulative grade point average obtained for the semesters that have been completed. It can be calculated as follows:

\[
\text{CGPA} = \frac{JMN_1 + JMN_2 + \ldots + JMN_n}{JKK_1 + JKK_2 + \ldots + JKK_n}
\]

Where:
- \( JMN_n \) = Total points obtained in \( n \) semester
- \( JKK_n \) = Total credits in \( n \) semester

AWARD

A Bachelor Degree shall be awarded if all the following conditions are fulfilled. A student:

1. must get Good status (KB) in the final semester.
2. has passed all the subjects required as listed in the course curriculum.
3. has applied for the award of the degree, approved by the faculty and certified by the Senate.
4. has passed MUET with **BAND 4** according to the University’s directive.
5. has met all the other University’s requirements.
ACADEMIC ADVISORY SYSTEM

The Academic Advisory System was introduced from the beginning when the faculty first started. Fully aware that the academic semester system implemented in the university is very different as compared to the system followed by students in the schools or in the matriculation colleges, the Academic Advisory System is implemented to provide the platform for students to seek advice and guidance to manage their studies while in the university. In the semester system, the students have the freedom to determine their academic load subject according to their ability but within the conditions stipulated by the faculty and academic regulations. As such students need to plan their studies most suitable and appropriate for themselves. To assist the students, each student is assigned an Academic Advisor who is an academic staff member, well-versed in the Academic System. The Academic Advisor plays a pivotal role as a mentor, advisor, referee and friend in helping the students in their studies and other academic activities.

The Academic Advisory System and its importance

One prominent aspect of the Academic Advisory System is the assignment of Academic Advisors to students ought to be proper advice and guidance to the students in the followings:

1. It is not compulsory for the students to take all the subjects offered in each semester. For those with good academic standings, they are encouraged to register for all the subjects offered but for those with average academic standing, they are advised to take less academic load, a maximum of 12 credits only for those with conditional academic standing, to improve their academic standings for the next semester. Thus, the students need to plan their studies and register the appropriate subjects in each semester according to their ability.

2. The semester system is a flexible education system to cater for students with mixed academic capability of excellent students, average students and not so fast learners. The difference between them is for each and everyone to complete their studies successfully within the prescribed time. The Academic Advisory System will help each student the opportunity to design a study plan to complete the studies successfully.

3. The semester system is a modular system employing the concept of intensive learning and continuous assessment. Therefore, it is imperative for students to adapt with this learning environment and fully utilized the system.

4. In addition of having to adapt to the semester system, the students are also faced with other problems such as cultural shock, time management, self-management and also other personal problems especially for those who are staying away from their parents for the first time.

5. As the students progress along, due to their academic standings, even if they are from the same cohort, they may not be together for a certain subject. In other words, most students may not be together in the same group throughout their studies, and this can be difficult for them to conduct peer groups and subject discussions effectively.
Therefore, to assist the students so that they can adapt to the university environment and at the same time get the full benefit of the semester system, the faculty assigns academic staff members to become academic advisors to take care of around 15 – 20 students each, acting as mentors to provide guidance, encouragement and advice to the students. It is the Academic Advisor’s role to see that the students are given the proper advice, guidelines, action to take, motivation and encouragement from the day of the registration until the students’ graduation from university.

**The roles and responsibilities of the Academic Advisor**

1. Helps students to understand and follow the semester system, academic rules and university examination rules.

2. Guides students in preparing their study charts while in the university, for instance in deciding the total credit hours to be taken in a particular semester and study duration.

3. Advises the students in relation to the choice of subjects and subject registration as well as the add/drop process, based on the students’ academic performance and ability.

4. Monitors students’ performance and provides counselling for them to make changes in their study plan where necessary.

5. Recommends students to take the necessary steps and appropriate action when the students encounter problems that rendered the necessity to do subject withdrawal or/and study deferment.

6. Monitors and keeps records of the students’ personal profile and academic achievement as well as the students’ problems, and inform the faculty when necessary.

7. Reviews and administers students’ subject registration record in order to ensure no subject is left out. This is necessary when it is time to verify the students for the conferment of the degree.

8. Holds meetings with their students during the first week of each semester and subsequently every now and then throughout the semester to facilitate and update on the well-being and welfare of the students. The academic advisor has to devote adequate time meetings in a group or on individual basis when necessary.

**The roles and responsibilities of the Students**

1. Read and understand fully the academic rules & regulations of the University Academic System.

2. Take the necessary actions at the required time such as subject registration, add/drop of subjects, subject withdrawal and study deferment.

3. Monitor and take the necessary actions on personal academic achievement and performance.

4. Take the initiative to meet the academic advisor to update on personal profile, academic performance and personal problems encountered.
Bachelor of Electronic Engineering with Honours
INTRODUCTION

Starting from 2014, UTeM had decided to implement all the engineering programmes along the broad-based curriculum structure. The Bachelor of Electronic Engineering with Honours offered by the faculty is a broad-based course which combines engineering science, mathematics, electrical and electronic engineering fundamentals and develops in students the mastery of electronic engineering principles and applications to solve electronic engineering problems, including the complex ones. All the students will undergo three years of common curriculum upon which they can decide a programme with emphasis on computer engineering, industrial electronics, telecommunication electronics or wireless communication in the final year. The broad-based programme will provide the solid foundation in theoretical understanding of electronic engineering to allow students to undertake problem analysis and identifications, formulation and generate appropriate solutions in the broad field of electrical and electronic engineering. The curriculum helps to hone the generic skills of the students and prepare them the opportunities to perform research, present their findings, implement and provide engineering solutions.

The programme is designed in an integrated manner to build up the students’ engineering expertise from fundamentals to addressing of specific engineering challenges with the opportunity to develop specialization in focused areas of interest. The programme is implemented with a blend of theory and practice, with team-based assignments and projects running alongside with lectures.

All the programmes offered by the faculty have been accredited by the relevant professional institutions and are qualified to register with the Board of Engineers Malaysia as the first step towards becoming a professional engineer.

CURRICULUM STRUCTURE

Year 1 is more of a reinforcement year for the students who have been given the opportunity to begin their journey towards becoming electronic engineers. The subjects offered are Engineering Mathematics, Computer Programming, Electrical and Electronic Engineering Fundamentals and subjects that fortified moral values and co-curriculum.

In second and third year, the students have to study the Bachelor of Electronic Engineering common and programme core subjects. These subjects are carefully selected to fulfil the body of knowledge, the formal educational requirements of graduate engineers, which is closely monitored and assessed by the Engineering Accreditation Council of Malaysia. Apart from that, the students are required to undergo a minimum of 10 weeks industrial training during the Special Semester of Year 3. This exercise provides the students the opportunity to experience and learn the reality of working life besides seeking more knowledge and networking.
In the final year, the students have the opportunity to choose which areas of interest they want to focus in. For those who prefer industrial electronics, they can choose electives listed under that particular specialization. Likewise for the other specializations of computer engineering, telecommunication electronics and wireless communications, the students are given the opportunity to have their preferences. The students are also required to carry out a Bachelor Degree project that is related to field of specialization. The purpose of the project is to provide the students to display their ability to apply engineering knowledge to solve complex engineering problems utilizing components, design systems and processes, undertaking problem identifications, formulation and analysis of complex problems encountered.

A total of 129 credits are required for the Bachelor of Electronic Engineering to be awarded upon successfully completed the programme.

An Electronic Engineering degree graduate from FKEKK, UTeM has an immense range of careers to choose from. The multi-faceted approach in conducting the programme provides the graduates the knowledge, confidence and attributes to enter the workforce with analytical and communication skills, making a significant contribution to the development of the engineering field and to the nation.

CAREER PROSPECT

Career prospect for FKEKK graduates is extremely good. Graduates from this course can be employed in the fields of electronic engineering as industrial electronic engineers, computer engineers, telecommunication engineers and wireless communication engineers and other numerous related engineering professions. They can be engineers in the industrial automation systems, industrial electronic, control systems, electronic instrumentation, computerised system in manufacturing and production industries, plant engineers in industries, manufacturing computer product such as computers and computer peripherals, system engineers in industries manufacturing computer based product, telecommunication systems and wireless communication systems.

Graduates who have special interest in the academic fields can become academicians such as lecturers and researchers in institutions of higher education, the universities and research centres and agencies. Upon being qualified as professional engineers, they can practice locally as well as in countries who are members of the Washington Accord.

Graduates who choose not to become employee can be self-employed and opt to be involved in business and become successful entrepreneurs in their areas of expertise.
PROGRAMME OBJECTIVES

**PEO 01**
**LIFE LONG LEARNING**
To achieve career advancement, professionalism and to pursue lifelong learning in related areas of electronic engineering work or business.

**PEO 02**
**PROBLEM SOLVER**
To produce creative, innovative and sustainable solutions to practical electronic engineering problems.

**PEO 03**
**LEADERS**
To display exemplary interpersonal, leadership, entrepreneurship and social skills as well as upholding high ethical conducts.
PROGRAMME OUTCOMES

01. Apply knowledge of mathematics, science, engineering and electronics fundamentals to solve complex engineering problems.

02. Undertake problem identifications, formulation and analysis of complex engineering problems.

03. Design systems, components, or processes to meet desired needs as well as analyze and interpret the results.

04. Investigate complex problems using research-based knowledge and research methods to provide valid conclusions.

05. Apply appropriate techniques, resources and modern engineering and IT tools to complex engineering activities.

06. Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

07. Understand the needs for sustainable development and the impact of engineering solutions on society and environment.

08. Apply ethical principles and commit to professional ethics, responsibilities and norms of engineering practice.

09. Communicate effectively on complex engineering activities with the engineering community and with society at large.

10. Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary environment.

11. Recognize the needs for, and ability to engage in independent and life-long learning.

12. Apply knowledge and understanding of engineering and management principles as well as identify entrepreneurial and business opportunities in related areas.
# COURSE CURRICULUM FOR BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS

## Semester 1

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**Note:**

* To be taken by International Students Only

**Category:** W: University Compulsory Subjects, P: Common Core Subjects, K: Program Core Subjects, E: Elective Subjects
Pre-requisite Subjects

YEAR 1

Semester 1  Semester 2

BENE 2123  BENE 2133
Electronic Fundamentals  Analogue Electronics

YEAR 2

Semester 3  Semester 4

BLHW 2403  BLHW 3403
Technical English  English for Professional Communication

YEAR 3

Semester 5  Semester 6

YEAR 4

Semester 7  Semester 8

BENU 4972  BENU 4984
BDP 1  BDP 2

Note:
* University compulsory subjects for International Students only
### SUBJECT LIST BASED ON CATEGORIES

#### UNIVERSITY COMPULSORY SUBJECTS (W)

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**Note:**

* University compulsory subjects for International Students only
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<th>Select FOUR(4) subjects : THREE (3) subjects from Programme Specialization Electives and ONE(1) from Open Electives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Select THREE(3) subjects based on specialization</td>
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<td>Computer Engineering</td>
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<td>Microwave Engineering</td>
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<td>Wireless Communication System</td>
<td>Data Communication and Networking</td>
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<td>BENC 4473</td>
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<td>BENC 4463 + BENC 4473 + BENC 4483 + BENC 4493</td>
<td>BENC 4463 + BENC 4473 + BENC 4493 + BENT 4813</td>
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<tr>
<td>Open Electives</td>
<td>Select ONE(1) subject either from the chosen Programme Specialization Electives or from any Programme Specialization Electives or from any Engineering Programme Specialization Electives</td>
</tr>
</tbody>
</table>
SPECIALIZATION

Students who register for the Bachelor of Electronic Engineering program may specialize either in Industrial Electronics, Computer Engineering, Telecommunication Electronics or Wireless Communication as shown in Table 1. All the undergraduate programs offered by the Faculty of Electronics and Computer Engineering are accredited and recognized by the Board of Engineers Malaysia (BEM). Graduates from the Bachelor of Engineering programs above may apply to register with the Board of Engineers Malaysia, as graduate engineer in the engineering fields as shown in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Degree Awarded</th>
<th>Choice of Field Elective</th>
<th>Field of Registration with BEM</th>
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<tr>
<td>Bachelor of Electronic Engineering with Honours [BENG]</td>
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<td>Electronic Engineer</td>
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<td>Computer Engineering</td>
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<tr>
<td></td>
<td>Wireless Communication</td>
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</tbody>
</table>
Syllabus Summary for the Bachelor of Electronic Engineering Programmes
UNIVERSITY COMPULSORY SUBJECTS (W)

BKKX xxx1  Co-Curriculum 1 and 2
BLHW 1702*  Islamic and Asian Civilization (TITAS)*
BLHL 1012**  Malay Language Communication**
BLHW 2403  Technical English
BLHW 2712*  Ethnic Relations*
BLHW 2752**  Malaysian Culture**
BLHW 3403  English For Professional Communication
BLHL xxx2  Third Language
BLHC 4032*  Critical and Creative Thinking*
BLHW 1742**  Malaysian Studies**
BPTW 4012  Technology Entrepreneurship

Note:
* University compulsory subjects to be taken by local students
** University compulsory subjects to be taken by international students

PLEASE REFER TO THE PUSAT BAHASA DAN PEMBANGUNAN INSAN (PBPI) HANDBOOK FOR THE SYNOPSIS AND THE DETAIL SYLLABUS FOR ABOVE SUBJECTS.
COMMON CORE SUBJECTS (P)

**BMFG 1113: ENGINEERING MATHEMATICS**

**Synopsis**
This course consists of three chapters: Function of Several Variables, Multiple Integrals and Vector-valued Functions. The syllabus is developed by introducing the concepts of the functions with several variables, integration and also vector-valued function, followed by learning various techniques in solving the problems and its application in physical and engineering fields.

**References**

**BEKG 1123: PRINCIPLES OF ELECTRICAL AND ELECTRONICS**

**Synopsis**
This course will discuss about the basic principles of electrical and electronics; introductions to electric elements, symbols and components, KCL, KVL, Node and Mesh in solving DC series and parallel circuit. Introduction to magnetism, electromagnetism and AC characteristics. Introduction to semiconductors, atomic structures, energy band, P-type and N-type. Study on structure, principle and application of diode, BJT and Op-Amp circuits.

**References**

**BMFG 1213: ENGINEERING MATERIALS**

**Synopsis**
This course introduces basic concepts of engineering materials that covers introduction to engineering materials, interatomic bonding, crystalline structure and imperfections and diffusion in solid. Explanation on different types of engineering material (i.e. metal, ceramic, polymer and composites), its mechanical properties, basic applications and processing are also included. Introduction to the binary phase diagrams (composition and microstructure correlation) is also given.

**References**

**BEKG 1233: PRINCIPLES OF INSTRUMENTATION AND MEASUREMENT**

**Synopsis**
The subject discusses about units and dimensions, standards, errors, static characteristics, noise and calibration in measurement. It covers most on the measurement devices such as galvanometers, ammeters, voltimeters, wattmeter, temperature, force and torque and pressure measurement as well as accelerometer meter. It also introduces oscilloscope and sensors for instrumentation application.

**References**
BMCG 1013: DIFFERENTIAL EQUATIONS

Synopsis
This course is intended to introduce the concept and theories of differential equations. Second order linear differential equations with constant coefficients will be solved by using the methods of undetermined coefficient, variation of parameters and Laplace transform. Fourier series in relation to periodic functions will be discussed. An introduction to the solution and application of partial differential equations with boundary value problems using the method of separation of variables and Fourier series will also be discussed.

References

BITG 1233: COMPUTER PROGRAMMING

Synopsis
This course covers the introductory topics in programming using C++ language. It includes the introduction to computers and programming, the fundamentals of programming, problem solving and software development. Data types and operators, selection, repetition, function, array, file, structured data and pointer are among the topics covered in the course.

References

BENG 1413: DIGITAL ELECTRONICS

Synopsis
This subject comprises of several topic such as number systems and codes, logic gates and Boolean algebra, combinational logic circuits, MSI logic circuits and flip flops, integrated circuit logic families and Introduction to Finite State Machine (FSM).

References

BMCG 1523: ENGINEERING GRAPHICS AND CAD

Synopsis
The course will provide students with an understanding of the importance of engineering graphics as a communication tool among engineers. Student will be exposed to the engineering graphics fundamentals of manual sketching, geometric dimensioning and tolerancing, graphic projections, sectioning and engineering drawings. Students will develop visualization skills by constructing technical drawings using manual sketches and computer aided design (CAD) software. The course consists of both lecture and practical session where students will be guided in presenting and interpreting engineering drawings correctly.

References
BENG 2142: STATISTICS

Synopsis

References

BEKG 2452: NUMERICAL METHODS

Synopsis
Topics covered: Errors; Solution of Nonlinear Equations; Solution of Linear Systems; Interpolation and Curve Fitting; Eigenvalues and Eigenvectors; Numerical Differentiation; Numerical Integration; Solution of Ordinary Differential Equations; Solution of Partial Differential Equation; Introduction to SCILAB and its application in the numerical computations.

References

BEKG 2433: ELECTRICAL SYSTEMS

Synopsis
This is an introductory subject for students on the fundamental knowledge of electrical power system. The students will be taught on the physics of electrical power system, which includes the theory and analysis of electromagnetism, followed by power concepts & equations (single and three phase), power factor & power factor corrections, single and three-phase system and per-unit calculation. There will also topics on characteristics for static and rotating electric machine principles, including AC, DC, synchronous, induction motor and transformer. Furthermore, students will be introduced to the concepts on the electric power system network (generation, transmission and distribution) and various power generation system and energy sources. The students will also learn on basic characteristics and performance of electrical transmission line and distribution system.

References

BENU 3005: INDUSTRIAL TRAINING

Synopsis
All degree students will be placed in appropriate local industries or government corporations for 10 weeks normally in the special semester of their third year of study. Student will be exposed to real life working environment relevant to their field of study.

Reference
[1] Industrial Training Guide Book, UTeM.
BMFG 4623: ENGINEERING ECONOMY AND MANAGEMENT

Synopsis
This course covers engineering economics and managing risk in an organization. Engineering economics discusses about the time value of money and interest relationships, which are useful to define certain project criteria that are utilised by engineers and project managers to select the best economic choice among several alternatives. Projects examined will include both product and service-producing investments. The effects of escalation, inflation, and taxes on the economic analysis of alternatives are also discussed. Management of risk incorporates the concepts of probability and statistics in the evaluation of alternatives. This allows management to determine the probability of success or failure of the project.

References

BENU 4972: BACHELOR DEGREE PROJECT 1

Synopsis
This course represents the first part of the final year project. Students should produce a project proposal and start work on their project before the end of the semester. Projects can be either the development of useful software or electronic hardware. Projects can also take the form of case studies or solving industrial problems encountered by the students during their industrial training.

BENG 4322: ENGINEER AND SOCIETY

Synopsis
This course covers topics on: Role of engineer in nation building, evaluation of engineering, national development role of engineers in society, laws related to public safety, health & welfare, future engineers, professionalism and codes of ethics, definition of professionalism, understanding engineering as a profession, ethical theories, IEM and BEM code of ethics. Ethical problem solving techniques analysis of issues in ethical problems, line drawing, flow charting, learn to handle conflicting problems. Occupational Safety and Health legislation and management. Rights and responsibilities of engineers. Quality from engineering perspective. Carrier guidance and project management.

References

BENU 4131: ENGINEERING SEMINAR

Synopsis
The main purpose of this course is to instill the recognition of the need for and the ability to engage in life-long learning among students. Through presentation by invited speakers from the industry and academia, students will be exposed to topics such as professional engineering bodies and knowledge of in contemporary issues in related engineering fields. Presentation by successful alumni describing how their careers developed after obtaining their undergraduate degrees will also be included.

BENU 4984: BACHELOR DEGREE PROJECT 2

Synopsis
This is the second part of the final year project. Students are expected to continue the project done in Bachelor Degree Project Part I till completion. At the end of the semester students are required to submit the final year project report both orally and in writing for assessment.
PROGRAMME CORE SUBJECTS (K)

BENG 1132: ENGINEERING PRACTICE

Synopsis
This subject will be offered during the special semester at the end of second year. The topics covered are standard industrial practice, industrial safety and health regulation (OSHA), component soldering and soldering, printed circuit board design and fabrication, simulation tools, component circuit and troubleshooting. Students will also expose to the plan preventive maintenance, quality control and project management’s topics. Besides that, for the first 3 weeks of the course, students will undergo multi engineering courses offered by mechanical, manufacturing and electrical engineering faculty.

References
[1] Environmental, Safety and Health Engineering, Gayle Woodside, WILEY, 1997

BENC 2413: DIGITAL SYSTEMS

Synopsis
This subject comprises of several topics such counters, shift registers, finite state machine, memory devices, programmable logic devices and basic computer architecture, basic microprocessors, buses.

References

BENT 2713: CIRCUIT THEORY I

Synopsis

References

BENE 2123: FUNDAMENTAL OF ELECTRONICS

Synopsis
This course will discuss on:
Introduction to Multisim; Bohr Atomic Model: valency, periodic table of elements, trivalent, tetravalent and pentavalent elements, movement electrons in solid: conductor, insulator and semiconductor, band theory: energy bands, conduction bands and forbidden bands. Doping, p and n materials, pn junction. Diode equation, dynamics resistance, diode equivalent circuits; Silicon Semiconductor Diodes: characteristics and measurement of forward & reverse biased, composite characteristics and load line analysis, clipping, clamping & simple rectifier (half & full) circuits, zener diodes characteristics, and simple regulator; Bipolar Junction Transistor (BJT): construction and operation of BJT, BJT characteristics and measurement technique, limits of operation, $\beta_{dc}$, $\alpha_{dc}$, DC biasing - DC load lines; Field Effect Transistor (FET): construction & operation of FET, FET characteristics & diagram, Shockley’s equation, DC biasing – DC load line; Metal oxide
semiconductor field-effect transistor (MOSFET): construction & operation of MOSFET dc characteristic.

References

BENG 2211: ELECTRONIC ENGINEERING LAB 1

Synopsis
This course covers topics in BENM 2133 Digital System, BENE 2153 Analog Electronics and BENT 2123 Signals and Systems with the following items:

Asynchronous and Synchronous Counter, Finite State Machine, Shift Register, Common-Emitter BJT Amplifiers, Common-Source JFET Amplifiers, Op-Amp Applications, Transients In Inductors, Charging And Discharging Capacitors, Transients In R-L-C Circuits, Band-Pass Filter

References

BENC 2423: MICROPROCESSOR TECHNOLOGY

Synopsis
Topics covered in this subject includes the introduction to microprocessor-based system, the internal and software model of the microprocessor, the assembly language programming design and development, the microprocessor device specification and its related configuration, and also the design configuration of the memory and input/output system interfacing.

References

BENT 2723: CIRCUIT THEORY II

Synopsis
This subject will discuss about capacitors and inductors, series and parallel circuits of capacitors and inductors; first and second-order circuits, step response of the circuits; steady-state analysis; AC power analysis, average power, RMS values, power factor; frequency response and Bode Plot, series and parallel resonance and filters.

References

BENE 2133: ANALOGUE ELECTRONICS

Synopsis
Topics covered: BJT Transistor modeling, CE, CC and CB configuration, BJT small amplifier analysis, FET small-signal analysis, MOSFET, Frequency response, Bode plot, Special amplifiers: cascade, cascode, Darlington, Multistage Amplifiers, Differential amplifier circuit, Feedback Amplifiers, Operational amplifiers: inverting, non-inverting, summing and buffer amplifiers

References

BENG 2431: ELECTRONIC ENGINEERING LAB 2

Synopsis
This course covers topics in Digital Systems and Microprocessor Technology with the following items: Basic and Combinational Logic Gates, Asynchronous and Synchronous Counter, Finite State Machine, Microprocessor Training Board and Applications of ARM Processor.

References

BENC 3443: MULTIMEDIA TECHNOLOGY AND APPLICATION

Synopsis
This subject prepares the students with basic concept of multimedia, technology and the importance of multimedia application. This subject also introduces the students to techniques and tools related with the creation of multimedia application and explore the current issues related to multimedia technology. It covers the topics introduction to multimedia technology, graphic and image data representations, audio technology, video technology and multimedia systems.

References

BENE 3143: ELECTRONIC SYSTEM DESIGN AND ANALYSIS

Synopsis
This course will cover regulated power supply, ripple voltage, filters and voltage regulation, regulators, introduction to switching regulator, discrete, integrated circuit regulator, amplifier class A, AB, B and C, SCR, UJT, PUT Circuits, RC phase shift oscillator, Wien bridge oscillator, tuned oscillator, crystal oscillator, 555 timers, active filters, filter design criteria, higher order Butterworth and switched capacitor filters.

References

BENT 3743: ELECTROMAGNETIC FIELDS AND WAVES

Synopsis
This course will discuss on:
Vector analysis: Vector algebra, coordinate system and transformation, vector calculus; Electrostatics: Electrostatic fields, Gauss Law, Poisson’s equation, electric fields in material space, electrostatic boundary; Magnetostatics: Magnetostatic fields, Stokes Theorem, Biot-Savart Law, Gauss Law, magnetic forces, material and devices; Waves: Maxwell’s equations, Faraday’s Law, time-varying electromagnetic field, electromagnetic wave propagation.

References
BENG 3211: ELECTRONIC ENGINEERING LAB 3

Synopsis
This course covers topics in BENE 2133 Analog Electronics and BENE 3143 Electronic System Design and Analysis. Among the topics that will be covered in this course are: regulated power supply, filters design, and amplifier design.

References:

BENT 3733: SIGNALS AND SYSTEMS

Synopsis
The course will cover various topics such as Continuous-Time signals and systems, Fourier series, Fourier transform, Laplace transform, Discrete-time signals and systems.

References

BENT 3753: COMMUNICATION PRINCIPLES

Synopsis
This course will discuss about Introduction to Telecommunication: Model, Transmission Modes, Need for Modulation and Demodulation, Electromagnetic Frequency Spectrum, Linear Modulation: Amplitude Modulation (AM) Principles, AM Modulation and Transmission, AM Reception and Demodulation, Single-Sidebands


References

BENE 3223: CONTROL PRINCIPLES AND SYSTEMS

Synopsis
Introduction to control system, frequency domain modeling, Laplace transform, transfer function, electric network transfer function, translational mechanical system, rotational mechanical system transfer function, time domain modeling, general state space representation, transfer function and state space conversion, time response, poles, zeros and system response, First and Second order systems, underdamped system, reduction of multiple subsystems, block diagrams, feedback systems, signal flow graphs, Mason’s rule, Routh-Hurwitz criterion and Gain Adjustment compensator design.

References
BENG 4733: DIGITAL SIGNAL PROCESSING

Synopsis
This course consists of topics: Introduction to DSP, discrete-time signals and systems, spectrum of representation of discrete-time signals, discrete Fourier transform, difference equations and discrete-time systems, z-transform and its applications, analysis and design of digital filters and random signal processing.

References

BENG 4453: COMPUTER ARCHITECTURE

Synopsis
This course aims primarily to give the students a general understanding of how computer systems work, both internally (ALU, control unit, registers, etc.) and externally (I/O interfaces, networking, etc.). Such understanding will enable the graduates to make intelligent decisions when confronted with computer-related problems at their workplace. The
knowledge and skills gained in this course will also enable the graduates to further their studies in the field of computer architecture, organization, and design.

References

ELECTIVE SUBJECTS (E)

BENC 4463: MICROCONTROLLER TECHNOLOGY

Synopsis
Topics covered in this subject includes the introduction to microcontroller-based system, the internal architecture of the microcontroller, the programming design and development software, the design configuration and peripheral interfacing of the application system, the development of specific microcontroller application, and the integration of software and hardware subsystems.

References

BENE 4233: INDUSTRIAL CONTROL

Synopsis
This course will discuss about Introduction to Industrial Control: the classification of industrial control systems, the components of control system and its characteristics, Discrete Control Elements and Ladder Diagram: control circuits, line or ladder diagram, power relay, and logic gates and ladder diagram, Programmable Logic Controller (PLC): introduction to PLC, background and development of PLC, PLC hardware, ladder diagram programming for OMRON PLCs: ladder instructions, logic block instructions, branching instructions line, controlling bit status, and other instructions, Discrete Sensors: introduction to sensors in industries, contact arrangement, limit switches, actuators, no-touch sensors, inductive proximity sensors, capacitive proximity sensors, and photoelectric sensors, GRAFCET: introduction to GRAFCET, the needs of GRAFCET, fundamental symbols in GRAFCET, combinational symbols in GRAFCET, control symbols in GRAFCET, evolutionary of GRAFCET (simultaneous sequence), rules of GRAFCET, and relationship between GRAFCET and PLC ladder diagram, Proportional-Integral-Derivative (PID) Controller: introduction to PID controller, the three-term controller, the characteristics of P, I, and D controllers, P controller, PI controller, PD controller, and PID controller, Data Acquisition (DAQ) and Control: definition of DAQ and control, fundamentals of DAQ, DAQ and control systems configuration, and DAQ for sensors and control systems in computer-integrated manufacturing (CIM) environments.

References
BENT 4773: TELECOMMUNICATION SYSTEM ENGINEERING

Synopsis

References

BENT 4783: WIRELESS COMMUNICATION SYSTEMS

Synopsis

References

BENC 4473: DIGITAL INTEGRATED CIRCUIT DESIGN

Synopsis
This course covers several aspects of digital integrated circuit design. Starting with MOSFET equations, we will delve into several areas of digital circuit design, including recent changes in circuit design approaches. We will cover different design styles, memory design, as well as board level design concepts.

References

BENE 4333: ARTIFICIAL INTELLIGENCE
Synopsis
Introduction to artificial intelligence system, Introduction to Fuzzy Logic, Fuzzy set and Fuzzy system, Fuzzy Logic control system, and application, Introduction to Neural Network, McCulloch-Pitts Neuron, Hebb Neural Network, Perceptrons, gradient decreasing studying algorithm, non linear optimization, adding back error algorithm, basic radius function, application and neural network simulation.

References

BENT 4793: MICROWAVE ENGINEERING

Synopsis

References

BENT 4813: DATA COMMUNICATION AND NETWORKING

Synopsis

References

BENC 4483: COMPUTER VISION AND PATTERN RECOGNITION

Synopsis
Topics covered: Overview of Computer Vision and Pattern Recognition, Image and Image Representation, Image Analysis & Enhancement, Feature Detection and Segmentation, Image Restoration, Feature Analysis and Pattern Recognition, Feature Selection and Dimensionality Reduction.

References
BENE 4243: INDUSTRIAL AUTOMATION

Synopsis
Topics covered are: Introduction to Industrial Automation & Control, Common Process variables, measurements and control, Mechanics and control of mechanical manipulator, coordinate mapping and transformation, forward kinematics, inverse kinematics.

References

BENT 4823: DIGITAL COMMUNICATION SYSTEM

Synopsis

References

BENT 4833: ANTENNA AND WAVE PROPAGATION

Synopsis
Definition of Path Loss, Rays and wave-front, Characteristic Impedance of Free Space, Critical Frequency and Critical Angle, Virtual Height, Maximum usable Frequency, Skip Distance and Skip Zone, Free Space Path Loss, Fading And Fade Margin, Friis transmission formula, Concept of Ground, Sky and Space wave, **Mobile Radio Propagation**:
Reflections, Ground Reflection Model, Diffraction, Fresnel Zone, Scattering, Link Budget, Fading, Multipath Propagation.

**References**


**BENC 4493: REAL TIME SYSTEM**

**Synopsis**

**References**


**BENE 4343: POWER ELECTRONICS AND DRIVES**

**Synopsis**
Overview of power electronics fundamentals: General introduction and concepts; Applications and prospects; power switches; switching and related issues (drivers, waveform generators, losses etc); modeling and simulation of AC to DC conversion, DC to DC Conversion, DC to AC Conversion. The introduction to drives is also covered where the speed control of DC motor and induction motor will be discussed in detail.

**References**


**BENT 4843: OPTOELECTRONICS**

**Synopsis**
This module runs for the topics such as Review of Light Properties: Reflection and Refraction, Plane Waves, Polarisation, Concept of Coherence, Principle of Superposition. Light Propagation in Optical Fibre: Fibre Types, Acceptance Angle, Refractive Index, Numerical Aperture, Skew Rays, Total Internal Reflection, Phase and Group Velocity, Snell’s Law, TE and TM modes, Single and Multimode Waveguides, Step Index Fibre, Graded Index Fibre. Laser Fundamentals: Emission and Absorption of Radiation, Population Inversion, Optical Feedback and Gain, Cavity Modes, Single-Mode Operation, Frequency Stabilisation, Mode Locking Techniques, Q-Switching, DBR and DFB Lasers, Class of Non-Semiconductor Lasers. Optical Sources: semiconductor concepts - energy bands, semiconductor statistics; bandgap and E-k diagrams; optical emission from semiconductors - the p-n junction; principle of laser diode; heterostructure laser diodes; elementary laser diode characteristics; quantum well devices; vertical cavity surface emitting lasers; optical laser amplifiers; the light emitting diodes - surface emitter LEDs, edge emitter LEDs, super luminescent LEDs, LED characteristics, modulation bandwidths (electrical and optical). Optical Detection: detector performance parameters, characteristics of noise, detection techniques (incoherent and coherent detections), thermal detectors, photodetectors, p-n junction and p-i-n...
photodiodes, avalanche photodiodes, speed of response, detector array devices. Fibre Optic Components and Applications: optical fibre directional couplers (coupling principle and power exchange, practical parameters of a coupler, fabrication techniques and applications), fibre polarisers and polarisation controllers, fibre Bragg gratings (coupled mode theory, spectral response, fabrication techniques, applications in fibre optic communication and sensing), single-mode optical fibre sensors (Mach-Zehnder interferometric sensors and fibre optic rotation sensors), fibre optic switches, and microelectromechanical systems (MEMS) optical switches.

References

BENT 4853: RADIO NAVIGATION SYSTEM

Synopsis

References
Diploma of Electronic Engineering
INTRODUCTION

Malaysia has been recognized as one of the major exporting countries of semiconductor devices and the main manufacturers of electronic equipment in the last few decades. Continuous development in the field of electronics and widespread application of computers has brought a great impact on the development of the electronics industry in the country.

Industrial electronic manufacturing including consumer products such as computers, audio - video equipment, optical drives, communication devices, mobile phones and so on. In non-electronic-based industries, electronic systems are also needed as a complement in the production process of products such as the oil refining industry, the automobile industry, production of rubber-based industries, etc.

In the process of enhancing the competitiveness of the Malaysia industries, human capital that is knowledgeable and skilled in electronic engineering is very important and necessary. Diploma graduates will be able to meet the needs of semi-professional workforce. In addition, the diploma graduates with outstanding academic performance have the opportunity to further their studies to degree level.

CAREER PROSPECTS

Employment opportunities for graduates of the Diploma in Electronic Engineering are particularly bright. Graduates can work as technical assistants or assistant engineer in government agencies, multinational companies, small and medium industries, as well as manufacturing and production industries. In addition, graduates can also engage in sales and marketing. Graduates who have excellent academic performance can also proceed to a higher level degree.
PROGRAMME OBJECTIVES

The objective of this program is to produce semi-professional human capital that have adequate basic knowledge in the field of electronic engineering. Programme objectives also specified several goals describing an expected achievements of graduates in their career and professional life after graduation.

1. To produce semi-professionals who are competent and able to apply knowledge in the field of electronic engineering

2. To produce semi-professionals in the field of electronic engineering with high moral values and responsible to the Creator, nation and society

3. To produce semi-professionals who are creative and innovative for assisting in research and development to meet the needs of the nation

4. To produce semi-professionals who can communicate and work as individuals and in groups effectively

5. To produce semi-professionals who are able to display a desire for life-long learning through continuous education, technical training, or professional development
PROGRAMME OUTCOMES

Upon graduation, the students should acquire the following abilities:

- **PO 01**: Ability to apply knowledge of mathematics, science and engineering fundamentals to well-defined engineering procedures and practices.
- **PO 02**: Ability to analyze well-defined electronic engineering problems with respect to operation and maintenance, including troubleshooting.
- **PO 03**: Ability to conduct and assist in investigations and provide the solutions electronic engineering system.
- **PO 04**: Ability to apply appropriate techniques, resources, and engineering tools to well-defined engineering activities.
- **PO 05**: Ability to demonstrate an awareness of and consideration for societal, health, safety, legal and cultural issues and their consequent responsibilities.
- **PO 06**: Ability to communicate with the engineering community and society at large, effectively.
- **PO 07**: Ability to function as an individual, and as a member in a diverse technical team, effectively.
- **PO 08**: Ability to demonstrate an understanding of professional ethics, responsibilities and norms of engineering practices.
- **PO 09**: Ability to demonstrate an awareness of management, business practices and entrepreneurship.
- **PO 10**: Ability to demonstrate an understanding of the impact of engineering practices, taking into account the need for sustainable development.
- **PO 11**: Ability to recognize the need for professional development and engage in independent and life-long learning.
CURRICULUM STRUCTURE

The curriculum structure for this program is on par with any other programs offered by other universities in Malaysia. However, the concept of learning in UTeM is a bit different where students will be exposed to applications and practices to strengthen their theoretical knowledge. Diploma program is based on the newly introduced curriculum structure consisting of five regular semester and two special semester, which took almost three years to complete. Students are required to take 91 credit hours minimum in the period of study to graduate. Note that the structure of the previous curriculum takes 3 years to complete and consists of six regular semesters and one special semester with 98 credit hours.

The first year in the diploma program begins with a typical semester where students will learn three compulsory university’s subjects, namely, English Foundation, Tamadun Islam dan Asia (TITAS) and Philosophy of Science & Technology. All three subjects are intended to prepare students to participate in electronic engineering curriculum which is taught in English, and also to bring awareness of the moral values of semi-professional workforce in the future.

Subjects offered for the next semester will prepare students towards the field of electronics such as Fundamental Mathematics, Physics, Computing and Computer Competency; as well as basic subjects related to electronics such as Electrical Principles. Students will also learn the Engineering Workshop subject which provides students with practical work such as electronic circuits design on printed boards, soldering, debugging audio - video system, domestic wiring, safety procedures in the working environment, etc. At the end of the workshop, each student is required to complete a small project to justify the skills acquired during the workshop.

Starting from the second semester, students will follow a curriculum designed towards the Diploma in Electronic Engineering such as Electric Circuit, Communication Principles, Logic Circuit, Computer Aided Design, etc. The students were also given the elements of personality development in the form of communication skills training and extra-curricular activities. Therefore, in addition to producing graduates who are skilled in the technical field, graduates will have excellent communication skills and high moral values. In order to expose the students to the real working environment, they are required to undergo industrial training for 10 weeks in a second special semester. The students can get a training placement in industries throughout Malaysia and supervised by the lecturers and supervisors of the industry. The experience gained during the industrial training will also increase the knowledge they learned at the university.

In the final year, apart from the core subjects and two elective subjects, students will use the knowledge and experience they have gained in the period of study for about two and a half years to produce a mini project on electronic circuits. The project should be completed within one semester and will be assessed by the lecturer in a formal presentation.

In addition to the technical subjects, students will learn about subjects relating to communication and co-curricular activities to prepare them for good communication skills.
## COURSE CURRICULUM FOR DIPLOMA OF ELECTRONIC ENGINEERING

### Semester 1

<table>
<thead>
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<th>SUBJECT</th>
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<td>Engineering Drawing</td>
<td>3</td>
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### Special Semester

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### Special Semester

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**Category:**
- W: University Compulsory Subjects
- P: Core Program Subjects
- E: Elective Subjects

**Note:** * Choose any TWO(2) subjects only.
PRA-SYARAT

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<tr>
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Pre-requisite

Sequential
**SUBJECT LIST BASED ON CATEGORIES**

**UNIVERSITY COMPULSORY SUBJECTS (W)**

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**PROGRAM CORE SUBJECTS (P)**

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**PROGRAM ELECTIVE SUBJECTS (E)**

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Syllabus Summary for the Diploma of Electronic Engineering Programme
UNIVERSITY COMPULSORY SUBJECTS (W)

- DKKX 1xx1  Co-Curriculum 1
- DKKX 2xx1  Co-Curriculum 2
- DLHW 1012  Foundation English
- DTKW 1012  Entrepreneurship Culture Fundamental
- DLHW 1702  Tamadun Islam dan Asia (TITAS)
- DLHW 1712  Ethnic Relations
- DLHW 1722  Falsafah Sains dan Teknologi
- DLHW 2422  English for Professional Communication
- DLHW 3432  English for Marketability

PLEASE REFER TO THE PUSAT BAHASA DAN PEMBANGUNAN INSAN (PBPI) ACADEMIC HANDBOOK FOR SYNOPSIS AND SYLLABUS SUMMARY FOR THE ABOVE SUBJECTS.
PROGRAMME CORE SUBJECTS (P)

DENH 1142    ALGEBRA

Synopsis

References

DENH 1302    PHYSICS FUNDAMENTALS

Synopsis
This course will discuss about **Mechanics**: Physical Quantities and Measurements, Kinematics of Linear Motion, Force, Momentum and Impulse, Work, Energy and Power, Static, Circular Motion, Rotation of A Rigid Body, Gravitation and Simple Harmonic Motion (SHM). **Wave**: Mechanical Waves and Sound Wave. **Properties of Matter**: Static, Dynamics, Circular Motion, Simple Harmonic, Moment of Inertia, Density and Specific Gravity, Hydrostatics, Elasticity, Friction, Viscosity, Osmosis, Diffusion, Acceleration and Newton’s Second Law of Motion, Motion with a Changing Velocity and Ohm law. **Thermodynamics**: Temperature and Heat Transfer, Theory Kinetic of Gases. **Light**: Reflection and Refraction of Light.

References

DENT 1213    ELECTRICAL PRINCIPLES

Synopsis
Topics covered: **Electrical principles**: Basic electrical concept, voltage, current and resistance, basic laws: Ohm’s and Kirchoff’s Law. **Series and parallel circuits**: Resistors in series & parallel, total series parallel resistance, voltage & current dividers, power in series & parallel circuits, series-parallel relationship. **Alternating Current & Voltage**: Introduction to the sinusoidal waveform, sinusoidal voltage sources, voltage and current values, angular measurement of a sine wave, the sine wave formula, introduction to phasors, analysis of ac circuits. **Capacitors & Inductors**: The basic types of capacitor & inductor, series parallel capacitors & inductors, capacitors & inductors in DC, AC circuits. **Magnet and Electromagnetism**: The magnetic field, electromagnetism, electromagnetic devices (Lenz law, faradays law).

References
DENH 1152  CALCULUS

Synopsis

References

DENE 1131  ENGINEERING WORKSHOP I

Synopsis
Safety and Health (OSHA): Introduction to OSHA, Safety measures at workplace and Job Safety analysis (JSA), safety and health practices in workshop and laboratory sessions. Basic Electronic components: Introduction to the function, measuring and testing methods of the components; structure, characteristic, unit and symbol of resistor, diode, capacitor, transistor, inductor, transformer, IC, fuse and relay in electronic circuits. Trouble shooting techniques, workshop on active and passive components. Introduction to

References

DMCG 1523 ENGINEERING DRAWING

Synopsis
The course concentrates on manual drafting and Computer Aided Drafting (CAD) software. For manual drafting, students will be exposed to the basic drafting tools, techniques and the application in producing various types of engineering drawing. For computer aided design, CAD engineering drawing software is exercised to produce engineering drawing. The students will be exposed to CAD interface, editing commands, coordinate system, template preparation and layer in order to produce various types of engineering drawing.

References

DENE 1323 ELECTRONIC PRINCIPLES

Synopsis
This course discuss about the structure and material of semiconductor, diode characteristics and applications (half-wave& full-wave, clamping, clipping), special purpose diode (zener & varactor diode), BJT transistor (DC biasing; common-base, common-emitter & common collector) and FET transistor (DC biasing; common-source, common-drain & common-gate and special purpose of FET-Introduction and characteristics of JFET and MOSFET.

References

DENC 1532 ECADD

Synopsis
Topics covered: Introduction to ECADD: Introduction to ECADD software, selection of computer software simulation: Multisim, PSpice and MATLAB, advantages of ECADD, and the design process. Digital Circuit Simulation: Introduction to Multisim, instrumenting a simulation in Multisim, the concept of Digital Circuit, binary digit and logic level, Boolean algebra, introduction of advanced logic circuit, combinational logic, and sequential circuit. Analog Circuit Simulation: Introduction to PSpice, Use of PSpice with OrCAD capture, DC nodal analysis, DC sweep analysis, diode I-V characteristic, maximum power transfer, AC frequency sweep analysis, transient analysis, and amplifier voltage swing. Signal Processing: Introduction to MATLAB, the MATLAB system, starting MATLAB, entering commands
and expressions, variables, computing with MATLAB, plotting with MATLAB/graphics, MATLAB scripting files and the editor/debugger, and MATLAB Simulink toolbox.

References

DENH 2173 DIFFERENTIAL EQUATIONS

Synopsis
This course will discuss about the classification of differential equations, first order ordinary differential equations, second order ordinary differential equations, Laplace transform, Fourier series and partial differential equations.

References

DENT2253 SIGNAL AND NETWORK

Synopsis
Topics covered: signal and system definition, continuous and discrete signal, signal operations, signal characteristics, types of signals. Fourier series, phase and amplitude spectrum, Parseval theorem. Fourier transform, step and delta function, energy and power spectrum, Laplace Transform and inverse Laplace Transform characteristics, Circuit analysis using Laplace Transform, filters, frequency response and filter analysis.

References

DENE 2333 ELECTRONICS

Synopsis

References

DENC 1433 LOGIC CIRCUITS

Synopsis
Topics covered: Introduction to Digital Concepts: analog and digital quantity, digital waveform, digital and logic circuits, parallel and serial transmission. Number Systems and Operations: Number systems, number conversion, binary codes, binary mathematical operation, signed numbers representation, one’s and two’s complement, two’s complement arithmetic. Combinational Logic Gates: Boolean constants and variables, truth table, Boolean theorems, Demorgan’s theorems, parity generator and checker. Logic Expression and Logic Minimization: Simplifying logic circuits, designing combinational logic circuits, Karnaugh Map method simplifications. Combinational Logic Circuits and Applications: Logic gates, adders, comparator, decoder, encoder, etc. Introduction to Integrated Circuit Technology: Basic operational characteristics and parameters, CMOS circuits, TTL circuits, comparison of CMOS and TTL performance.

References
DENH 2163  ENGINEERING MATHEMATICS

Synopsis
Topics covered: Functions of Several Variables: The concepts of the functions with several variables, Graphing Functions of Two Variables, Level Surfaces of Three Variables, Limit and Continuity, Partial Derivatives, Total Differential and Exact Differential, The Chain Rule and Implicit Differentiation, Local Extreme, Absolute Extreme and Lagrange Multipliers. Multiple Integral: Double Integral over Rectangles, Double Integrals over Nonrectangular Region, Double Integrals in Polar Form, Definition of Triple Integrals (over Non Cuboids Solids, Cylindrical Coordinates, Spherical Coordinates) and Application of Multiple Integrals, Vector-Valued Functions: Operations with Vector-Valued Functions, Derivatives and Integrals of Vector-Valued Functions, Motion in Space, Arch Length, Unit Tangent Vector, Principal Unit Normal Vector and Curvature and Torsion and Unit Binormal Vector.

References

DENC 2443  DIGITAL SYSTEMS

Synopsis
Topics covered: Latches and Flip-Flops: Operation and applications. Counters: counter operation, counter with mod number < 2n, synchronous counters design, cascaded counters, and counter applications. Register: Basic shift register functions, type of registers and its function, shift registers counter and applications. Memory and Programmable Logic Devices: Random-Access Memories (RAMs), Read-Only Memories (ROMs), programmable ROMs (PROMs, EPROMs and EEPROMs), flash memories, memory expansion, special types of memories, magnetic and optical storage, introduction to CPLDs, and introduction to FPGAs. Introduction to Microprocessor, Computers & Buses. The microprocessor and the computer, the Central Processing Unit (CPU), the memory, and the input/output (I/O) port.

References

DENE 2133  ELECTRONIC INSTRUMENTATIONS

Synopsis
wave rectification and full wave rectification in voltmeter and ammeter, Wheatstone Bridge, Kelvin Bridge, bridge controlled circuit, oscilloscope and function generator.

References

DENE 2353 APPLIED ELECTRONICS

Synopsis
Topics covered: Electronic Devices: Application of electronic devices such as SCR, SCS, GTO, LASCRI, DIAC, TRIAC, UJT and PUT. Filter: Filter applications (basic filter concepts, filter response characteristics, active LP filter, active HP filter, active BP filter, active BS filter and filter response measurement). Oscillator circuits: Feedback oscillator principles, oscillators with the RC feedback circuits, LC feedback circuits, crystal oscillator, Astable and Monostable using op-amp, the 555 timer and applications. Power amplifier circuits: Class A, class B and class AB. Power supply: Power supply circuit, IC voltage regulator and application. These topics are very important to students because it gives emphasis on the design of circuits used in electronic systems.

References

DENC 2453 MICROCONTROLLER

Synopsis

References
DENT 2543 COMMUNICATION PRINCIPLES

Synopsis
Topics covered: Introduction to telecommunication, transmission modes, power measurements, electromagnetic frequency spectrum, bandwidth and information capacity, amplitude modulation transmission & reception, single-sidebands communications systems, FM transmission & reception, digital modulation, noise in telecommunication systems, transmission line, VSWR, Smith Chart and transmission lines impedance matching.

References

DENE 2243 ELECTRICAL TECHNOLOGY

Synopsis

References


DENU 2363 INDUSTRIAL TRAINING

Synopsis
All diploma students will be placed in appropriate local industries or government corporations for 10 weeks normally in the special semester of their second year of study. Students will be exposed to real life working environment relevant to their field of study.

References
[1] Industrial Training Guide Book, UTeM.
[2] FKEKK handbook, UTeM

DENU 2372 INDUSTRIAL TRAINING REPORT

Synopsis
All diploma students will be placed in appropriate local industries or government corporations for 10 weeks normally in the special semester of their second year of study. Students will be exposed to real life working environment relevant to their field of study.

References
[1] Industrial Training Guide Book, UTeM.
[2] FKEKK handbook, UTeM

DENE 3153 CONTROL PRINCIPLES

Synopsis
Topics covered: Introduction to control system: Open loop control system, closed loop control system, system response and transfer function. Frequency domain: Laplace transform, transfer function, modelling in frequency domain, transfer function for electrical network, translational mechanical system and rotational mechanical system. Time domain: State space representation, modelling in state space representation for electrical network, translational and rotational mechanical system, conversion of state space – transfer
function and vice versa. **Time response:** Poles and zero
and their effect towards system response. First and
Second order systems. **Reduction of Multiple
subsystem:** Reduction of multiple subsystem using
block diagram method. **Stability:** Determine system
stability using Routh – Hurwitz criterion.

**References**

Engineering Applications”, Springer Science &
Applications”, Springer Science & Business Media,
2013.

**DENE 3563  DIPLOMA PROJECT**

**Synopsis**
The Mini Project course is designed for the final year of
Diploma’s students. Students are expected to do a
hardware project and present it in a product form. At the
end of the semester students are required to submit the
final year project and will be assessed according to the
course evaluation criteria.

**References**


**DENC 3363  COMPUTER ENGINEERING**

**Synopsis**
This course will discuss about **Introduction to
Computers:** Definition of computers, history of
computers, categories of computers, example of
computer usage, its application in society, and current
computing technology. **Computer Organization and
Architecture:** Basic components of a computer system,
Central Processing Unit (CPU), memory, expansion slots
and adaptor cards, ports, I/O devices, and storage
media. **Operating System Concepts:** Introduction to
system software, functions of an operating systems, and
stand-alone utility programs. **Computer
Communications and Networking:** Computer
communications, computer network, network
architectures, network topologies and communication
standards, data communications over telephone
network, communication devices and channels, and the
Internet. **Computer Security, Privacy and Ethics:**
Computer security risks, information privacy, ethics and
society.

**References**

[1] Misty V., Susan Sebok, Steven Freund, Jennifer
Campbell, Mark Frydenberg, “Discovering
[2] Alan Evans, Kendall Martin, & Mary Anne Poatsy,
2014.
Its Applications”, Manikandan Palanisamy,
2014.
[5] B Shuangbao Paul Wang, Robert S. Ledley,
“Computer Architecture and Security: Designing
& Sons, 2012.

DENT 3563  TELECOMMUNICATION ENGINEERING

Synopsis
Topics covered: Basic principles of Communications System: electromagnetic spectrum, power measurement, modulations techniques, noise and exposure to the latest technology in telecommunication systems. Digital Communication: elements of a digital communication system, digital modulation, digital pulse modulation and digital encoding. Optical Fiber Communications: single and multimode fiber, light propagation, light sources and detectors. Antenna and Waveguide: basic antenna and waveguide, radiation patterns, radiation resistance, antenna efficiency, gains, capture area, captured power, polarization, beam width, bandwidth, input impedance. Satellite System: GEO satellite, coordinates, satellite links, power attenuations, transmission errors and error coding, access techniques, link budget. Telephony System: transmission telephone, local loop, line characteristics and conditioning, PSTN, hybrids, echo suppression, central office switching system, switches, switching, trunks circuits.

References
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