Program Kejuruteraan Elektrik & Elektronik
Programme of Electrical & Electronic Engineering

Profesor/*Professors*

Ir. Dr. Ahmad Ashrif A Bakar
SmKej. (UNITEN), MSc (UPMalaysia), Ph.D (UQ)
Komunikasi Optik *(Optical Communication)*

Dr. Aini Hussain
BScEEL (LSU), MSc (UMIST), Ph.D (UKMalaysia), MIEEE Tau Beta Pi
Pemprosesan Isyarat Pintar, Pengecaman & Analisis Corak Pintar
(Intelligence Signal Processing, Smart Recognition & Pattern Analysis)

Dr. Huda Abdullah
BSc (UMalaya), MSc, Ph.D (UPMalaysia), MIEEE, MMASS
Semikonduktor Fizik, Bahan Magnetik, Teknologi Filem Nipis, Fabrikasi Sel Suria
(Physical Semiconductor, Magnetic Material, Thin Film Technology, Solar Cell Fabrication)

Ir. Dr. Mandeep Singh A/L Jit Singh
MSc(USMalaysia), Ph.D (USMalaysia)
Perambatan Gelombang Radio, Satelit *(Radiowave Propagation) (RFID) (Satelite)*

Ir. Dr. Mardina Abdullah
BEng (Ryukyus), SmSn (UKMalaysia), Ph.D (Leeds)
Pembuatan, Pemanduan Arah Satelit dan Kajian Ionosferik
(Manufacturing, Satellite Navigation & Ionospheric Research)

Dr. Mohammad Tariqul Islam
BEng (UBangladesh), MEng (Dhaka),Ph.D (UKMalaysia)
Antennas & Radio Wave Propagation

Ir. Dr. Mohd Syuhaimi Ab Rahman
BEng, MSc, Ph.D (UKMalaysia)
Teknologi Fotonik, Komunikasi Optik, Gentian Menghala Ke Rumah
(Photonics Technology) (Optical Communication) (Fiber to the Home)

Dr. Norbahiah Misran
SmKej (UKMalaysia), Ph.D (Queen's), MIEEE
Kejuruteraan Komunikasi, Rekabentuk Antena
(Communication Engineering)(Antena Design)

Ir. Dr. Norhana Arsad
SmKej (UKMalaysia), SSn(UPMalaysia), Ph.D (Strathclyde)
Teknologi Fotonik, Kejuruteraan Elektrik dan Elektronik
(Photonics Technology, Electronic and Electronic Engineering)

Ir. Dr. Salina Abdul Samad
BSEE (Tennessee), PhD (Nottingham), MIEEE, Eta Kappa Nu
Pemprosesan Isyarat Digit, Pemprosesan Isyarat Multimodal, Biometrik
(Digital Signal Processing, Multimodal Signal Processing, Biometric)

Ir. Dr. Rosdiadee Nordin
SmKej (UKMalaysia), Ph.D (Bristol)
Komunikasi Radio Bergerak *(Mobile Radio Communicaiton)*

Dr. Sawal Hamid Md Ali
BEng (UPMalaysia), MSc., Ph.D (Southampton)
VLSI, Mikroelektronik, Rekabentuk Isyarat Tercampur-Pemodelan Kelakuan
(VLSI, Microelectronics, Mixed Signal Design, Behavioral Modelling)

Profesor Madya/*Associate Professors*

Dr. Afida Ayob
BEng (Manchester), Ph.D (Newcastle)
Elektronik Kuasa *(Power Electronic)*

Dr. Badariah Bais
BSEE/MSEE (WPI),Ph.D (UKMalaysia), MIEE, MSPIE
Mikroelektronik, Mikrofabrikasi, MEMS
(Microelectronics, Microfabrications, MEMS)

Dr. Fazida Hanim Hashim
BSc., MSc. (Pittsburgh),Ph.D (UKMalaysia)
(Intelligent systems, Multi-agent systems, Optimization algorithms, VLSI design)

Dr. Gan Kok Beng
B.Sc. (UTMalaysia), Ph.D (UKMalaysia)
Biomekanik: Permodelan & Instrumentasi *(Embedded system in healthcare & biomechanics)*

Dr. Mohd Asyraf Zulkifley
SmKej (UIAMalaysia), Ph.D (Melbourne)
Penglihatan komputer dan pembelajaran dalam *(Computer vision and deep learning)*

Dr. Mohd Fais Mansor
SmKej(UKMalaysia–UDE), Ph.D (Surrey)
Kejuruteraan Komunikasi *(Communication Engineering)*

Dr. Mohd Saiful Dzulkefly Zan
BEng (Waseda), MEng, Ph.D (Shibaura)
Teknologi Fotonik *(Photonics Technology)*

Ir. Dr. Nasharuddin Zainal
BEng (Tokyo Inst. Of Technology), MEng (UKMalaysia), Dr.Eng.
(TIT, Japan)
Kejuruteraan Komputer, Pemprosesan Imej *(Computer Engineering, Image Processing)*

Dr. Nor Fadzilah Abdullah
SmSn (UTMalaysia), MSc (Manchester), Ph.D (Bristol)
Komunikasi Tanpa Wayar (Wireless Communication)

Dr. Ramizi Mohamed
BEng (Salford), MSc (UKMalaysia), Ph.D (Southampton)
Kejuruteraan Kuasa, Instrumentasi *(Power Engineering, Instrumentation)*

Dr. Wan Mimi Diyana Wan Zaki
B.Eng., MEng.Sc, Ph.D (MMU)
Imej Perubatan, Pemprosesan Imej Digital *(Medical Image, Digital Image Processing)*

Dr. Kalaivani A/P Chellapan
SM(USM), Sarjana, Ph.D (UKMalaysia)
Clinical Cardiovascular Engineering, Data Engineering & Analytics, Industrial Automation & Internet of Things

Ir. Dr. Nazrul Anuar Nayan
BEng (Tokyo), MEng, DEng, Ph.D (Gifu)
Kejuruteraan Elektrik dan Elektronik *(Electrical and Electronic Engineering)*

Pensyarah/*Lecturers*

Dr. Ahmad Asrul Ibrahim
BSc, SmKej (UKMalaysia), Ph.D (Durham)
Sistem Kuasa Kejuruteraan Elektrik *(Electrical Engineering Power Systems)*

Dr. Anuar Mikdad Muad
SmKej., MSc (UKMalaysia), Ph.D (Nottingham)
Pemprosesan Isyarat, Rangkaian Neural Buatan *(Signal Processing, Artificial Neural Network)*

Dr. Aqilah Baseri Huddin
BEng., Ph.D (Adelaide)
Pemprosesan Isyarat *(Signal Processing)*

Dr. Ashrani Aizzuddin Abd Rahni
BA, MEng (Cambridge), Ph.D (Surrey),
Kejuruteraan Komputer dan Sains Maklumat
(Information Science and Computer Engineering)

Dr. Asma' Abu Samah
B.Eng, M.Eng (UJF, Grenoble), Ph.D (UGrenoble-Alpes)
Automatic Control and Production System, Prognostics and Health Management, ICU Glycaemic Control

Dr. Asraf Mohamed Moubark
SmKej (UNITEN), MSc (UKMalaysia), Ph.D (Leeds)
Pengimejan Ultrasound, Pemprosesan Isyarat Digit, Sistem Terbenam
(Ultrasound Imaging, Digital Signal Processing, Embedded system)

Dr. Iskandar Yahya
BA, MEng (Sheffield), MIET, MIEEE, Ph.D (Surrey)
Sistem Terbenam *(Embedded System)*

Dr. Mohd Hadri Hafiz Mokhtar
MEng. (Birmingham), Ph.D (Imperial College)
(Optical Fibre Scanning Microscopy)

Dr. Mohd Faisal Ibrahim
BEng, MEng (UTMalaysia), Ph.D (Adelaide)
Sistem Kawalan dan Kepintaran Buatan *(Control System, Artificial Intelligence)*

Dr. Mohd Hafiz Baharuddin
BEn. MA (SIT US), Ph.D (Nottingham)
Komunikasi Tanpa Wayar, Keserasian Elektromagnetik
(Wireless Communication, Electromagnetic Compatibility)

Dr. Mohd Hairi Mohd Zaman
Dip., BEng (UTMalaysia), MSc., Ph.D (UKMalaysia)
Sistem Kawalan, Pembelajaran Mesin, Identifikasi Sistem
(Control System, Machine Learning, System Identification)

Dr. Muhammad Ammirrul Atiqi Bin Mohd Zainuri
B.Eng. E&E, M.Sc Electrical Power Eng., Ph.D (UPMalaysia)
Power Electronics Converters and Drives, Power Quality Monitoring, Renewable Energy System (Photovoltaic, Wind and Hydro), Artificial Intelligent, and Agriculture-Photovoltiac

Dr. Muhammad Faiz Bukhori
B.Eng (UNITEN), Ph.D (Glasgow)
Kejuruteraan Elektrik dan Elektronik *(Electrical and Electronic Engineering)*

Dr. Noorfazila Kamal
SmKej (UTMalaysia), Ph.D (Adelaide)
Elektronik Komputer *(Computer Electronic)*

Dr. Norazreen Abd Aziz
BEng (Surrey), MSc., Ph.D (UKMalaysia)
MEMS, Mikroelektronik, Fabrikasi Peranti
(MEMS, Microelectronic, Device Fabrication)

Dr. Noraishikin Binti Zulkarnain
B.Eng., Ph.D (UTMalaysia)
Sistem Kawalan, Kejuruteraan Bioperubatan (Pemprosesan Imej), Dinamik Kenderaan
(Control System, Biomedical Engineering (Image Processing),
Vehicle Dynamics)

Dr. Nor Azwan Mohamed Kamari
BEng. (Meiji), MEng. (Ehime), Ph.D (UiTMalaysia)
Stabiliti Sistem Kuasa *(Power Systems Stability)*

Dr. Rosmina Binti Jaafar
SM (Case Western), Sarjana (Hertfordshire), Ph.D (UKMalaysia)
(Biomedical signal processing, Photoplethysmography, Electroencephalography, Electrocardiography, Medical Electronics)

Dr. Seri Mastura Mustaza
BEng (Vanderbilt), MEng (UTMalaysia), Ph.D (Surrey)
Robotik dan Kejuruteraan Sistem *(Robotics and System Engineering)*

Dr. Siti Salasiah Mokri
SmKej (UMalaya), MSc (UIAMalaysia), Ph.D (UPMalaysia)
Sistem Kawalan, Mekatronik *(Control System, Mechatronic)*

Dr. Syahirah Abd Halim
BEng. (UTP), MEng, Ph.D (Malaya)
Kejuruteraan Kuasa, Fana Sistem Kuasa *(Power Engineering, Power System Transients)*

Dr. Yushaizad Yusof
BEng (Japan), MSc. (UTMalaysia), Ph.D (UMalaya)
Elektronik Kuasa *(Power Electronics)*

Dr. Kamarulzaman Mat
SmKej (UKMalaysia), MSc (Loughborough), Ph.D (UKMalaysia)
Komunikasi Data *(Data Communication)*

En. Hilmi Sanusi
BSEE (Hartford), MSEE (Connecticut)
Kawalan Stokastik dan Penganggaran Proses, Penentuan dan Kawalan Orbit, Penentuan Altitud Satelit dan Sistem Kawalan
(Stocastic Control & Estimation Process, Orbit Determination & Control, Altitude Determination and Control of Satellite System)

Tutor/Tutor

Dr. Radin Za'im Radin Umar
BEng (Canterbury), M.Sc. (UKMalaysia), Ph.D (Malaya)
Elektronik Kuasa *(Power Electronics)*

Jabatan Kejuruteraan Elektrik, Elektronik dan Sistem
Department of Electrical, Electronic and Systems Engineering

Pengenalan / *Introduction*

Jabatan Kejuruteraan Elektrik, Elektronik dan Sistem (JKEES) merupakan salah satu jabatan terawal di Fakulti Kejuruteraan dan Alam Bina. Bermula sebagai Unit Elektronik di Jabatan Fizik, Fakulti Sains pada 1hb Mei 1978, ianyatelah berkembang dan akhirnya dinaiktaraf kepada Jabatan Elektronik di Fakulti Sains Fizik dan Gunaan. Dengan usaha gigih ahli-ahli akademik JabatanElektronik dan Jabatan Teknologi Kimia, maka Fakulti Kejuruteraan dan Alam Bina telah ditu¬buhkan pada 1hb November 1984. Dengan penubuhan Fakulti Kejuruteraan dan Alam Bina, nama jabatan telah diubah kepada JabatanKejuruteraan Elektrik, Elektronik dan Sistem. Setelah hampir 33 tahun selepas itu, melalui satu proses penstrukturan baru di Fakulti Kejuruteraan dan Alam Bina pada tahun 2018, jabatan ini telah diberi nama baru dan dikenali sebagai Program Kejuruteraan Elektrik dan Elektronik. Nama jabatan ditukar kembali kepada Jabatan Kejuruteraan Elektrik, Elektronik dan Sistem pada tahun 2020.

The Department of Electrical, Electronic and Systems Engineering (JKEES) was among the first department founded in the Faculty of Engineering and Built Environment. Initially known as the Unit of Electronic under the Department of Physics in the Faculty of Science on 1st May 1978, it became a full department known as the Department of Electronic in the Faculty of Physics and Applied Science. With joint efforts from the staff of the Department of Electronic and the Department of Chemical Technology,the Faculty of Engineering and Built Environment was established on 1st November 1984. Upon the establishment of the Faculty of Engineering and BuiltEnvironment, the name of the department was changed to the Department of Electrical, Electronic and Systems Engineering. After nearly 33 yearsthereafter, through a new restructuring process at the Faculty of Engineer-ing and Architecture in 2018, the department's name was transformed as the Electrical and Electronic Engineering Program. The department name changed to Department of Electrical, Electronic and Systems Engineering again in 2020.

Program Pengajian / *Study Programmes*

Pada peringkat awal penubuhan jabatan, semua penuntut mengikuti program pen¬gajian yang sama, dan membuat pengkhususan dengan memilih kursus-kursus elektif pada tahun tiga dan empat pengajian mereka. Bagaimana pun, mulai tahun 1996, sesuai dengan perkembangan dalam teknologi elektrik dan elektronik, beberapa program pengajian yang memerlukanpengkhususan tugas bagi para jurutera diwujudkan. Pada masa ini, JKEES menawarkan satu program pengajian untuk diikuti oleh para pelajar iaitu Kejuruteraan Elektrik dan Elektronik.

Dengan penawaran program ini, pelajar dapat memilih bidang tujahan mereka pada tahun ketiga pengajian mereka. Ini diharapkan akan memantapkan lagi kualitijurutera yang bakal dikeluarkan. Pada tahun 2020, perubahan kepada silibus program pengajian telah dibuat untuk memenuhi keperluan Lembaga Jurutera Malaysia supaya graduan dari program ini boleh diiktiraf sebagai jurutera dalam bidang elektrik dan elektronik. Program baru ini terdapat pertambahan kursus-kursus dalam disiplin kejuruteraan Elektrik. Pelajar boleh memilih salah satu tujahan daripada mikroelektronik, komputer & kawalan, dan komunikasi pada tahun 3 dan 4. Pada keseluruhannya, semua program pengajian ini mendapat sambutan yang baik daripada pihak industri dan majikan. Pencapaian yang cemerlang ini seharusnya menjadi pendorong kepada pelajar-pelajar ini untuk terus mengejar kejayaan.

During the initial stage of the department's establishment, all undergraduate students had to undertake the same study programmes and specialise by choosing elective courses during their third and fourth year of study. Nevertheless, starting from year 1996, with the advancement of electrical and electronic technology which demands specialisation tasks for engineers, few study programmes have been offered. Currently, PKE offers one study programme which is Electrical and Electronic Engineering.

By offering this program, students can choose their field of specialisation during their third and fourth year of study. This is expected to enhance the quality of potential engineers that are produced. In year 2020, the syllabus of the study programme has been changed to fulfill the requirements of the Board of Engineers so that graduates from this programme would be recognised as engineers in the field of electrical and electronic engineering. This newly developed program has included more courses related to electrical discipline. Students can select their field of interest from microelectronic, computer & control, and communication in year 3 and 4. In general, all the programmes in the department have been well received by the industry and employers. This achievement should inspire students to continue in pursuing success.

Objektif Pembelajaran Program (PEO)

PEO1

Jurutera yang mempunyai sahsiah dan etika, serta profesionalisma yang tinggi dan menyumbang kepada aspirasi kebangsaan.
Engineer who has character and ethics, as well as high professionalism and contributes to the national aspirations.

PEO2

Jurutera yang kompeten dalam amalan bidang masing-masing bersesuaian dengan keperluan semasa dan masa depan.
Engineer who is competent in respective engineering practices that meets current and future needs.

PEO3

Jurutera yang mempunyai daya kreatif dan inovatif, ciri keusahawanan dan sifat kepimpinan yang bersifat glokal.
Engineer who has a creative and innovative, entrepreneurial and leadership qualities that are glocal.

Hasil Pembelajaran Program (PO)

PO1 - Ilmu Kejuruteraan - Mengaplikasi ilmu matematik, sains, asas kejuruteraan dan pengkhususan kejuruteraan dalam memberi penyelesaian masalah kejuruteraan yang kompleks.
Engineering Knowledge - Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialisation to the solution of complexengineering problems.

PO2 - Analisis Masalah - Mengenal pasti, merumuskan, mengkaji literatur dan menganalisis masalah kejuruteraan yang kompleks dengan mencapai kesimpulan yang dapat menyokong dengan menggunakan prinsip pertama matematik, sains tabii dan kejuruteraan sains.
Problem Analysis - Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO3 - Reka bentuk/Pembangunan Penyelesaian - Merekabentuk penyelesaian untuk masalah kejuruteraan yang kompleks dan merekabentuk sistem, komponen atau proses yang menepati keperluan spesifik dengan pertimbangan yang bersesuaian bagi kesihatan dan keselamatan awam, budaya, kemasyarakatan dan alam sekitar.
Design/Development of Solutions - Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PO4 - Penyiasatan - Menjalankan penyiasatan terhadap masalah kejuruteraan yang kompleks menggunakan ilmu berasaskan penyelidikan dan kaedah penyelidikan termasuk reka bentuk uji kaji, analisis dan tafsiran data, sintesis maklumat untuk memberikan kesimpulan yang sah.
Investigation - Conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO5 - Penggunaan Alatan Moden - Mencipta, memilih dan mengaplikasikan teknik, sumber, dan alatan kejuruteraan dan teknologi maklumat yang moden, termasuk ramalan dan permodelan, kepada masalah kejuruteraan yang kompleks dengan memahami kekangan yang wujud.
Modern Tool Usage - Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering problems with an understanding of the limitations.

PO6 - Jurutera dan Masyarakat - Mengaplikasi pemikiran yang berasaskan ilmu kontektual untuk menilai isu-isu kemasyarakatan, kesihatan, keselamatan, perundangan dan kebudayaan serta tanggungjawab berkaitan yang relevan kepada amalan kejuruteraan profesional dan penyelesaian kepada permasalahan kejuruteraan yang kompleks.
The Engineer and Society - Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solutions to complex engineering problems.

PO7 - Alam Sekitar dan Kelestarian – Memahami dan menilai kemampanan dan kesan dari kerja kejuruteraan profesional dalam penyelesaian untuk masalah kejuruteraan yang kompleks dalam konteks masyarakat dan persekitaran.
Environment and Sustainability - Understand and evaluate the sustainability and the impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts.

PO8 - Etika - Mengaplikasi prinsip etika dan komitmen terhadap etika dan tanggungjawab profesional dan norma amalan kejuruteraan yang menyumbang kepada Aspirasi Kebangsaan.
Ethics - Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice and contribute to the National Aspirations.

PO09 – Individu dan Kerja Berpasukan - Berfungsi secara efektif sebagai individu,dan sebagai ahli atau ketua dalam pelbagai kumpulan dan persekitaran pelbagai disiplin.
Individual and Team Work - Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

PO10 - Komunikasi - Berkomunikasi secara efektif berkaitan aktiviti kejuruteraan kompleks bersama komuniti kejuruteraan dan masyarakat secara umum, seperti berkeupayaan untuk memahami dan menulis laporan yang efektif serta mereka bentuk dokumen, melakukan pembentangan yang efektif, serta memberi dan menerima arahan yang jelas.
Communication - Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation,make effective presentations, and give and receive clear instructions.

PO11 - Pengurusan Projek dan Kewangan - Mendemonstrasi ilmu dan pemahaman prinsip pengurusan kejuruteraan dan membuat keputusan berekonomi serta mengaplikasi terhadap tugas yang diberi, sebagai ahli atau ketua kumpulan, untuk mengurus projek dan dalam persekitaran yang pelbagai disiplin. *Project Management and Finance - Demonstrate knowledge and understandingof engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.*

PO12 - Pembelajaran Sepanjang Hayat - Mengenal pasti keperluan dan persediaan serta keupayaan untuk melibatkan diri secara kendiri dalam pembelajaran sepanjang hayat dalam konteks yang luas merangkumi perubahan teknologi.
Life Long Learning - Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Struktur Kursus Kejuruteraan Elektrik dan Elektronik
Electrical and Electronic Engineering Course Structure

Semester	Kod Kursus/ Course Code	Kategori Category	Nama Kursus Course Title
I	KKKF1141	WF	Etika dan Profesional *Ethical and Professional*
	LMCE1062/ LMCE1072/ LMCE1082/	WF	*Academic Interactions (MUET Band 3)/* *Academic Literacy (MUET Band 4)/* *Page to Stage (MUET Band 5 & 6)*
	KKEE1103	WJ	Kejuruteraan Berbantukan Komputer *Computer Aided Engineering*
	KKEE1113	WJ	Teori Litar I *Circuit Theory I*
	KKEE1133	WJ	Fizik Untuk Jurutera *Physics for Engineers*
	KKKQ1123	WF	Matematik Kejuruteraan I (Kalkulus Vektor) *Engineering Mathematics I (Vector Calculus)*
II	LMCW1022	CW	Asas Keusahawanan dan Inovasi *Entreprenuership and Innovation Base*
	KKKQ1223	WF	Matematik Kejuruteraan II (Aljabar Linear) *Engineering Mathematics II (Linear Algebra)*
	LMCRXXX2	C6	Kursus Luar Fakulti/PTj
	KKEE1123	WJ	Teori Litar II *Circuit Theory II*
	KKEE1153	WJ	Bahasa Pengaturcaraan *Programming Language*
	KKEE1142	WJ	*Makmal Elektrik & Elektronik I* *Electrical & Electronics Laboratory I*

III	LMCW2143	CW	Falsafah & Isu Semasa – Warganegara (*for Local students)
	LMCW2143/ LMCW2153	CW	*Falsafah & Isu Semasa /Penghayatan Etika & Peradaban– Bukan Warganegara (*for International students)*
	LMCE2082/ LMCE2092/ LMCE2103	WF	*Pro Talk English (MUET Band 3) (C2)/ Speak to Persuade (MUET Band 4) (C2)/ Advanced Communication Project (MUET Band 5 & 6) (C2)*
	KKKQ2123	WF	Matematik Kejuruteraan III (Persamaan Kebezaan) *Engineering Mathematics III (Differential Equation)*
	KKEE2123	WJ	Isyarat dan Sistem *Signal and System*
	KKKL2152	WJ	Makmal Elektrik & Elektronik II *Electrical and Electronics Laboratory II*
	KKEE2173	WJ	Elektronik Analog *Analogue Electronics*
	KKEE2103	C2	Pembelajaran Mesin *Machine Learning*
IV	LMCW2153	CW	Penghayatan Etika & Peradaban – Warganegara (*for Local students)
	LMCW2193	CW	*Bahasa Melayu Komunikasi 2 – Bukan Warganegara (*for International students)*
	KKEE2133	WJ	Medan dan Gelombang Elektromagnet *Electromagnetic Fields and Waves*
	KKEE2163	WJ	Elektronik Digit *Digital Electronics*
	KKEE2141	WJ	Makmal Elektronik Digit *Digital Electronics Laboratory*
	KKEE2183	WJ	Teori Komunikasi *Communication Theory*
	KKEE2113	WJ	Peranti Semikonduktor *Semiconductor Devices*

V	KKKF3283	C3	Etika Kejuruteraan dan Perkembangan Teknologi *Engineering Ethics and Technological Advancement.*
	KKEE3113	WJ	Pengukuran dan Instrumentasi *Measurements and Instrumentation*
	KKEE3143	WJ	Mikropemproses dan Mikrokomputer *Microprocessor and Microcomputer*
	KKKQ3123	CW	Statistik dan Pengiraan Berangka *Statistics and Numerical Method*
	KKEE3123	WJ	Kejuruteraan Kawalan *Control Engineering*
VI	KKKF3103	C5	Pengurusan Projek *Project Management*
	KKEE3153	C4	Rekabentuk Sistem *System Design*
	KKEE3163	WJ	Pemprosesan Isyarat Digit *Digital Signal Processing*
	KKEE3133	WJ	Analisis dan Sistem Kuasa *Power System and Analysis*
	KKEE3103	WJ	Optoelektronik *Optoelectronic*
	Kursus Elektrif (Pilih SATU sahaja) ***Elective Course (choose ONE only)***		
	KKEC3103	P	Pengaturcaraan Berasaskan Objek *Object Oriented Programming*
	KKEC3113	P	Sistem Terbenam *Embedded Systems*
	KKET3103	P	Komunikasi Data dan Rangkaian Komputer *Data Communication and Computer Networks*
	KKET3113	P	Kejuruteraan Gelombang Mikro *Microwave Engineering*
	KKEM3103	P	Teknologi Pembuatan Litar Bersepadu *Integrated Circuit Manufacturing Technology*
Intersesi	KKKF3066	WJ	Latihan Industri *Industrial Training*

VII	LMCE3061/ LMCE3071	WF	*Corporate Storytelling (MUET Band 3)/ Professional Communication (MUET Band 4)*
	KKEE4142	WJ	Projek Ilmiah I *Final Year Project l*
	KKEE4113	WJ	Elektronik Kuasa *Power Electronics*
	KKEE4103	WJ	Mesin Elektrik, Pemacu dan Aplikasi *Electrical Machine, Drives and Application*
	Kursus Elektrif (Pilih DUA sahaja) ***Elective Course (choose TWO only)***		
	KKEC4103	P	Rekabentuk Sistem Kawalan *Control System Design*
	KKEC4113	P	Pemprosesan Imej Digital *Digital Image Processing*
	KKET4103	P	Antena dan Litar Berfrekuensi Tinggi *Antenna and High Frequency Circuits*
	KKET4113	P	Rangkaian dan Keselamatan *Network and Security*
	KKEM4103	P	Rekabentuk VLSI *VLSI Design*
	KKEM4113	P	Teknologi Peranti Termaju *Advanced Devices Technology*
	KKEM4123	P	Keboleharapan dan Pencirian Litar Bersepadu *Relibility and Characterization of Integrated Circuit*
	KKEM4133	P	Teknologi Fotonik *Photonics Technology*
VIII	KKEE4123	WJ	Ekonomi Kejuruteraan dan Perakaunan Kos *Engineering Economics and Cost Accounting*
	KKEE4154	WJ	Projek Ilmiah II *Project II*
	KKEE4133	WJ	Penjanaan Kuasa Elektrik, Penggunaan dan Voltan Tinggi *Electrical Power Generation, Utilization and High Voltage*
	Kursus Elektrif (Pilih DUA sahaja) ***Elective Course (choose TWO only)***		
	KKEC4123	P	Kualiti dan Perlindungan Sistem Kuasa *Power System Protection and Quality*

	KKEC4133	P	Bioisyarat dan Analisis *Biosignals and Analysis*
	KKEC4143	P	Sistem Kawalan Pintar *Intelligent Control System*
	KKEC4153	P	Perkomputeran Selari *Parallel Computing*
	KKET4123	P	Sistem Komunikasi Optik *Optical Communication System*
	KKET4133	P	Komunikasi Radio dan Satelit *Radio and Satellite Communication*
	KKEM4143	P	Mikropemesinan Transduser *Micromachined Transducers*
	KKEM4153	P	Rekabentuk Litar Bersepadu Analog CMOS *CMOS Analog Integrated Circuit Design*
	KKEM4163	P	Sensor Termaju untuk Sistem Pintar *Advanced Sensor for Intelligent System*

Kategori/Category

- WF - Kursus Wajib Fakulti / *Faculty Courses*
- WJ - Kursus Wajib Jabatan / *Department Courses*
- P - Kursus Pilihan / *Elective Courses*
- CW - Kursus CITRA Wajib / *CITRA Compulsory Course*
- C1-C6 - Kursus CITRA Rentas / *CITRA General Education*

Silibus Kursus
Courses Syllabus

KKEE1113 Teori Litar I
Circuit Theory I

Kursus ini memperkenalkan kepada pelajar konsep utama dan ciri-ciri asas elemen litar iaitu cas, arus, voltan, kuasa dan tenaga. Kursus ini juga menerangkan kepada pelajar mengenai topologi rangkaian, pembolehubah tak bergantung, analisis Nodal dan Mesh, teorem-teorem litar iaitu teorem Superposisi, Thevenin dan Norton serta konsep kelinearan. Ini diikuti dengan pengenalan kepada pemuat dan pearuh beserta analisis litar RL dan RC berdasarkan sumber DC.

This course will introduce to the students the main concept and basic circuit element i.e charge, current, voltage power and energy characteristics. This course will also explain to the students the network topology, independent variables, Nodal and Mesh analysis and other circuit theorems such as Superposition, Thevenin and Norton as well as linearity. This will be followed by introduction to capacitance and inductance as well as its RL and RC circuit analysis based on DC.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
***References*:**

Alexander, C.K. & Sadiku, M.N.O. 2020. Fundamentals of Electric Circuit. 7th Edition. New York: McGraw Hill.

Rizzoni, G. & Kearns, J. 2016. Principles and Applications of Electrical Engineering. 6th Edition. New York: McGraw Hill.

**Irwin, J.D. & Nelms, R.M. 2015. Basic Engineering Circuit Analysis. 11th Edition. New York: John Wiley & Sons.*

Nilsson, J.W. & Riedel, S.A. 2019. Electric Circuits. 11th Edition. New Jersey: Prentice Hall.

Hyat, W.H., Kemmerly, J.E., Philips, J.D. & Durbin, S.M. 2019. Engineering Circuit Analysis. 9th Edition. New York: McGraw Hill.

**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk memperihal konsep dan meringkaskan litar asas menggunakan teorem-teorem litar; *Ability to describe concept and simplify basic circuits using circuit theorems;*
2	Berkebolehan untuk menyelesaikan masalah litar DC/RLC menggunakan analisis teorem litar; *Ability to solve DC/RLC circuit problem using circuit theorems analysis;*
3	Berkebolehan untuk menerangkan konsep litar RLC. *Ability to explain RLC circuit concepts;*
4	Berkebolehan untuk mengenalpasti peralatan makmal dan mengukur parameter isyarat dan parameter litar. *Ability to identify lab equipment and measure signal and circuit parameters.*

KKEE1103 Kejuruteraan Berbantukan Komputer
Computer Aided Engineering

Kursus ini meliputi kefahaman teori mengenai rekabentuk kejuruteraan , penggunaan perisian berasaskan simulasi litar elektronik dan permodelan 2D dan 3D. Selain itu, pelajar juga akan didedahkan kepada teknologi pembuatan aditif dan rekabentuk papan litar bercetak.

This course covers the theoretical understanding of engineering design using software based on electrical and electrical circuit simulation and 2D and 3D modelling. Apart from that, student are also exposed to the additive manufacturing technology and printed circuit board design.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any)*: *None

Bacaan Asas:
***References*:**

Omura, G. 2016. Mastering AutoCAD 2016 and AutoCAD LT. 1st Edition. Sybex.

**Ramirez, A., Schmidt, J. & Smith, D. 2015. Technical Drawing 101 with AutoCAD. SDC Publications.*

**Boylestad, R. 2015. Introductory Circuit Analysis. 13th Edition. Pearson.*

**Boylestad, R. & Nashelsky, L. 2014. Electronic Devices and Circuit Theory. 11th Edition. Pearson New International Edition (versi terkini).*

**Bertoline, G., Wiebe, E., Hartman, N. & Ross, W. 2010. Fundamentals of Graphics Communication. 6th Edition. McGraw-Hill (versi terkini).*

**Mitzner, K. 2009. Complete PCB Design using OrCAD Capture and PCB. Newnes (versi terkini).*

*Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus/** ***Course Outcomes (CO)***
1	Kebolehan untuk mengaplikasi konsep dan kaedah rekabentuk kejuruteran dan komunikasi grafik berasaskan komputer. *To apply the concept and method of computer-based engineering design and graphical communication;*
2	Kebolehan untuk membina model untuk menyelesaikan masalah kejuruteraan mengenai perihalan geometri dan litar elektrik dan elektronik. *Ability to build model to solve engineering problems related to engineering drawing and electrical and electronics circuit;*
3	Kebolehan untuk mengaplikasi perisian rekabentuk kejuruteraan untuk litar elektrik dan elektronik. *Ability to apply the engineering design software for electrical and electronic circuit;*
4	Membincang dan membentang projek kejuruteraan yang berkaitan dengan bidang kejuruteraan berbantukan computer dan membentangkannya secara individu dan berkumpulan. *Discuss and present engineering projects related to the field of computer aided engineering and present them individually and in a group.*

KKEE1133 Fizik Untuk Jurutera
Physics for Engineers

Matlamat kursus ini ialah untuk memperkenalkan pelajar kepada konsep asas fizik yang boleh diaplikasikan dalam bidang kejuruteraan elektrik dan elektronik. Topik-topik meliputi asas sains bahan, asas elektrik, asas magnetik, asas termodinamik dan proses pemindahan haba. Dalam sains bahan, pelajar-pelajar akan didedahkan dengan pengklasifikasian bahan, teori model dan tenaga atom, daya-daya yang mengikat atom, ion dan molekul, struktur bahan hablur dan tidak hablur, dan sifat-sifat optik serta elektrik bahan. Asas elektrik dan magnetikpula meliputi potensi elektrik, kapasitans dan dielektrik, arus, rintangan, hukum Faraday dan induktans. Dalam termodinamik dan proses pemindahan haba, pelajar akan mempelajari konsep haba, suhu, kerja dan sistem, pengembangan haba pepejal, konsep hukum pertama termodinamik dan konsep hukum kedua termodinamik. Dalam proses pemindahan haba, ia merangkumi prinsip dan pengiraan asas pemindahan haba melalui konduksi, perolakan dan radiasi.

The aim of the course is to introduce students to the basic concepts of physics that can be applied in electrical and electronic engineering. The main topics include basic material science, basic electricity, basic magnetism, basic thermodynamics and heat transfer process. In material science, students are exposed to the classifications of material, model theory and atomic energy, atomic

binding energy, ions and molecules, crystalline and non-crystalline structures, and optical and electrical material properties. Basic electricity and magnetism related topics cover electric potential, capacitance and dielectrics, current and resistance, Faraday law and inductance. In thermodynamics, students will learn the concepts of heat, temperature, work and system, thermal expansion of solids, first law of thermodynamics and second law of thermodynamics. Heat transfer process topic includes the basic calculations of heat transfer via conduction, convection and radiation.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any)*: *None

Bacaan Asas:
***References*:**

Callister, W. D. 2018. Materials Science and Engineering: An Introduction. 10th Edition. New York: John Wiley (versi terkini).

Grundmann, M. 2016. The Physics of Semiconductors: An Introduction Including Nanophysics and Applications. 3rd Edition. Springer.

Freedman, R.A. &Young, H.D. 2016. University Physics with Modern Physics. 14th Edition. Pearson.

**Cutnell, J.D., Johnson, K.W., Young, D. & Stadler, S. 2015. Introduction to Physics. 10th Edition. Wiley.*

**Cengel, Y. A. 2007. Introduction to Thermodynamics and Heat Transfer. 2nd Edition. New York: McGraw Hill.*

**Serway, R.A., & Jewett, J.W. 2014. Physics for Scientists and Engineers. 9th Edition. Cengage Learning.*

**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran:
Course Outcomes:

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan mendefinasikan istilah asas sains bahan, elektrik dan magnetik, dan termodinamik dalam bidang kejuruteraan; *Ability to define basic terms related to material science, electric and magnetism, and thermodynamics in engineering;*
2	Berkebolehan menerangkan teori, konsep dan prinsip-prinsip asas dalam sains bahan, elektrik dan magnetik, dan termodinamik; *Ability to explain theories, concepts and basic principles in material science, electric and magnetism, and thermodynamics;*

3	Berkebolehan menganalisa dan menyelesaikan pelbagai pengiraan masalah kejuruteraan dalam sains bahan, Elektrik dan Magnetik, dan termodinamik; *Ability to analyze and solve mathematical engineering problems in material science, electric and magnetism, and thermodynamics;*
4	Berkebolehan mengaplikasikan konsep dan hubungan kepada permasalahan kualitatif dan kuantitatif dalam topik-topik yang berkaitan. *Ability to apply the concept and relationship of qualitative and quantitative in the related topics.*

KKEE1123 Teori Litar II
Circuit Theory II

Kursus ini adalah kesinambungan daripada kursus Teori Litar I. Ia memperkenalkan kepada pelajar mengenai teori asas dan konsep matematik bagi menganalisa litar AC. Kursus ini turut menerangkan kepada pelajar mengenai sistem kuasa sefasa dan tiga-fasa, serta pengubah. Teknik jelmaan Laplace; teorem nilai awal dan akhir; fungsi pindah; lohong dan sifar; sambutan frekuensi dan gambarajah Bode akan diaplikasikan dalam analisa litar analog dalam domain frekuensi. Rangkaian dua-pangkalan diperkenalkan kepada pelajar di akhir kursus ini.

This course is the continuation of Circuit Theory I. In this course, students will be introduced to basic theories and mathematical concepts to analyze AC circuits. Course contents will cover single-phase and 3-phase power systems; as well as transformers. Laplace transform; Initial- and Final Value Theorem; transfer functions; poles and zeros; frequency response and Bode plot will be applied in the analysis of analog circuits in frequency domain. At the end of the course, two-port networks will be introduced.

Pra-Keperluan (*jika ada*): KKEE1113 Teori Litar I
Pre-Requisite (if any): *KKEE1113 Circuit Theory I*

Bacaan Asas:
***References*:**

Alexander, C.K. & Sadiku, M.N.O. 2020. Fundamentals of Electric Circuit. 7th Edition. New York: McGraw Hill.

Rizzoni, G. & Kearns, J. 2016. Principles and Applications of Electrical Engineering. 6th Edition. New York: McGraw Hill.

**Irwin, J.D. & Nelms, R.M. 2015. Basic Engineering Circuit Analysis. 11th Edition. New York: John Wiley & Sons.*

Nilsson, J.W. & Riedel, S.A. 2019. Electric Circuits. 11th Edition. New Jersey: Prentice Hall.

Hyat, W.H., Kemmerly, J.E., Philips, J.D. & Durbin, S.M. 2019. Engineering

Circuit Analysis. 9th Edition. New York: McGraw Hill.

**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran
Course Outcomes

Bil No.	Hasil Pembelajaran Kursus *Course Outcomes (CO)*
1	Berkebolehan untuk menyelesaikan masalah litar AC menggunakan teknik analisis fasor dan dan fungsi pindah dalam satah s dalam gambarajah Bode; *Ability to solve AC circuit problem using phasor analysis and transfer function in s-domain for Bode Plot;*
2	Berkebolehan untuk menganalisis litar gandaan teraruh dan menyelesaikan litar AC menggunakan Jelmaan Laplace; *Ability to analyse magnetically coupled circuits and solve AC circuit using Laplace Transform;*
3	Berkebolehan untuk menerangkan konsep poli-fasa, Jelmaan Laplace dan rangkaian dua pangkalan dalam menyelesaikan masalah litar; *Ability to explain poly-phase concept, Laplace Transform and two port network in solving circuit problem;*
4	Berkebolehan untuk membina litar menggunakan teknik analisis frekuensi. *Ability to construct circuits using frequency analysis technique.*

KKEE1153 Bahasa Pengaturcaraan
Programming Language

Matlamat kursus ini adalah untuk memberi pengetahuan, pemahaman dan kemahiran kepada pelajar mengenai praktis pengaturcaraan komputer yang bagus. Kursus ini merangkumi pengenalan kepada sistem komputer dan bahasa pengaturcaraan. Konsep dan elemen utama bahasa pengaturcaraan aras tinggi seperti pernyataan kawalan, fungsi, tatasusunan, struktur data dan lain-lain akan didedahkan secara mendalam. Kursus ini menjadi asas kepada penggunaan bahasa pengaturcaraan dalam bidang kejuruteraan. Bahasa pengaturcaraan yang digunakan ialah bahasa C.

The objective of this course is to equip the student with knowledge, comprehension and ability to code based on good programming language practices. This course includes an introduction to the computer system as well as programming language. The students are exposed to main concepts and elements in high level programming that covers decision control, function, array, data structure and many more. This course will be the foundation to programming language the in the engineering field. The programming language that is used is the C language.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any)*: *None

Bacaan Asas:
References:

Deitel, H. M. & Deitel P. J. 2015. C: How to Program. 8th.edition. Prentice-Hall.
**Stephen G. Kochan. 2014. Programming in C. 4th Edition. Addison-Wesley Professional.*
**Greg P. & Dean M. 2013. C Programming Absolute Beginner's Guide. 3rd. Edition. Que Publishing.*
Jeri R. H. & Elliot B. K., 2016. Problem Solving and Program Design in C. 8th Edition. Prentice-Hall
**Hanly, J. R. & Koffman E. B. 2000. C Program Design for Engineers. 2nd Edition. Addison-Wesley*
**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk memperihalkan konsep utama dalam bahasa pengaturcaraan; *Ability to describe key concepts in programming languages;*
2	Berkebolehan menyelesaikan masalah kejuruteraan dengan kaedah pengaturcaraan computer; *Ability to solve engineering problems with computer programming methods;*
3	Berkebolehan menghasilkan aplikasi pengaturcaraan yang mesra pengguna; *Capable of producing user-friendly application-based programming;*
4	Berkebolehan bekerja dalam satu kumpulan untuk membangunkan dan menilai satu program untuk aplikasi kejuruteraan dunia sebenar. *Ability to work in a team to develop and value a program for real-world engineering applications.*

KKEE1142 Makmal Elektrik dan Elektronik I
Electrical and Electronics Laboratory I

Kursus ini bermatlamat untuk membolehkan pelajar memahami dengan mendalamkonsep,pemasangandanpengukuranlitarelektrikdanelektronikanalog. Kursus makmal ini melibatkan aspek-aspek uji kaji litar elektrik dan elektronik analog yang merangkumi asas litar, litar pembahagi voltan dan arus, litar Thevenin/ Norton, jambatan Wheatstone, litar RLC asas, penuras pasif, pencirian diod dan rangkaian dua port. Di pertengahan dan penghujung semester, pelajar berpeluang untuk mengaplikasi pengetahuan dan kemahiran teknikal mereka dalam penilaian individu menjalankan ujikaji atau menyelesaikan masalah secara praktikal.

This course is aimed to enable students to acquire in-depth understanding in the concepts, construction and measurements on electrical and electronic analogue circuits. This laboratory course consists of experiments on basic analogue electrical and electronics circuits that include basic circuit construction, votlage and current divider circuits, Thevenin/Norton circuits, Wheatstone Bridge, basic RLC circuit, basic passive filters, diode characteristics and two port networks. In the middle and towards the end of the semester, the students will be given the opportunity to apply their acquired knowledge and technical competencies in individually assigned experiments or problems for practical assessments.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any)*: *None

Bacaan Asas:
***References*:**

Manual Makmal Elektrik & Elektronik 1. 2020. Jabatan Kejuruteraan Elektrik, Elektronik & Sistem, Fakulti Kejuruteraan dan Alam Bina Universiti Kebangsaan Malaysia.

Alexander, C.K. & Sadiku, M.N.O. 2016. Fundamentals of Electric Circuit. 6th Edition. New York: McGraw Hill.

Rizzoni, G. & Kearns, J. 2016. Principles and Applications of Electrical Engineering. 6th Edition. New York: McGraw Hill.

**Irwin, J.D. & Nelms, R.M. 2015. Basic Engineering Circuit Analysis. 11th Edition. New York: John Wiley & Sons.*

**Nilsson, J.W. & Riedel, S.A. 2014. Electric Circuits. 10th Edition. New Jersey: Prentice Hall.*

**Svoboda, J. & Dorf, R.C. 2013. Introduction to Electric Circuits. 9th Edition. New York: McGraw Hill (versi terkini).*

**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk mendemonstrasi ciri-ciri pelbagai litar yang berbeza, termasuk litar penuras pasif; *Ability to demonstrate the characteristics of different circuits including the different type of passive filters;*
2	Berkebolehan menerangkan pengetahuan asas dalam pemasangan litar dengan menggunakan komponen-komponen elektronik yang sesuai; *Ability to explain basic knowledge in circuit construction using suitable electronic components;*
3	Berkebolehan untuk mengaplikasi pengukuran pelbagai litar termasuk litar pembahagi voltan dan arus serta litar salunan RLC; *Ability to apply various circuits including voltage and current divider circuits, and RLC resonance circuit measurements;*
4	Berkebolehan untuk membina litar pengukuran jambatan Wheatstone dan mereka bentuk prosidur eksperimen; *Ability to construct Wheatstone Bridge measurement circuit and design experiment procedure.*

KKEE2173 Elektronik Analog
Analogue Electronics

Matlamat kursus ini ialah untuk memberikan pengetahuan, kefahamamdan sintesis dalam bidang elektronik analog. Kursus dimulakan dengan pengenalan kepada peranti peranti asas analog iaitu diod, transistor BJT, dan transistor MOS. Kefahaman tentang ciri-ciri diod, BJT dan MOS yang menjadi asas kepada pemahaman rekabentuk suatu litar elektronik akan ditekankan.Teknik-teknik pincangan dan analisaarus ulang alikjugaakan diberikan secara kuantitatif. Sambutan frekuensi, kesan hingar dan kestabilan litar akan dibin-cangkan.Pelajarakandidedahkankepadapelbagaijenisamplifierdanpengoperasian nya. Kegunaan amplifier operasian lelurus dan tak lelurus akan diberikan secara mendalam. Litar-litar elektronik yang lebih kompleks akan dianalisa dankesan suap balik dan frekuensi terhadap litar akan dikaji. Penggunaan perisian simulasilitarelektronikuntukmemodelkanlitar-litarelektronikjugadiperkenalkan.

The aim of this course is to impart knowledge, understanding and synthesis of the analogue electronic circuits. The course begins with an introduction to the basic analogue devices, such as BJT and MOS transistor. Understandingon the fundamental characteristics of the diode, BJT and MOS design will be emphasized at the later part of the course. Technical analysis and current biasing shuttle technique will also be given quantitatively. Frequency response,noise effects and the stability of the circuit will also be discussed. Students will be exposed to various types of amplifier and its operation. Linear and non- linear operational amplifiers (op-amp) will be given in deta The aim of this course is to impart knowledge, understanding and synthesis of the analogue electronic circuits. The course begins with an introduction to the basic analoguedevices, such as BJT and MOS transistor. Understanding on the fundamental characteristics of the diode, BJT and MOS design will be emphasized at the later part of the course. Technical analysis and current biasing shuttle technique will also be given quantitatively. Frequency response, noise effects and the stability of the circuit will also be discussed. Students will be exposed to various types of amplifier and its operation. Linear and non-linear operational amplifiers (op-amp) will be given in detail. More complex electronic circuits will be analyzed, where the effect of feedback and frequency will be further studied. The use of the electronic circuit simulation software to model the electronic circuits will also be introduced. More complex electronic circuits will be analyzed, where the effect of feedback and frequency will be further studied. The use of the electronic circuit simulation software to model the electronic circuits will also be introduced.

Pra-Keperluan (*jika ada*): KKEE1113 Teori Litar I
Pre-requisite (if any): *KKEE1113 Circuit Theory I*

Bacaan Asas:
References :

Thomas L. F. 2018. Electronic Devices (Conventional Current Version). 10th Edition. Pearson.

Safa O. K. 2018. Principles of Electronic Materials and Devices. 4th Edition. McGraw-Hill.

**Horowitz P. & Hill W. 2015. The Art of Electronics. 3rd Edition. Cambridge University Press.*

**Boylestead, R. L. & Nashelsky, L. 2014. Electronic Devices and Circuit Theory. 11th Edition. Essex: Pearson Education Limited.*

**Neamen, D.A. 2010. Microelectronics: Circuit Analysis and Design. 4th Edition. Mc-Graw Hill (versi terkini).*

**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk membincangkan konsep, operasi dan kegunaan pelbagai jenis peranti semikonduktor dalam litar elektronik analog; *Able to discuss the concepts, operations and applications of various semiconductor devices in analogue electronic circuits;*
2	Berkebolehan menerangkan pelbagai jenis litar penguat menggunakan analisis DC dan AC; *Able to describe various types of amplifier circuit using DC and AC analyses;*
3	Berkebolehan menyelesaikan analisis sambutan frekuensi untuk litar penguat; *Able to solve frequency response analysis of amplifier circuits;*
4	Berkebolehan untuk menganalisa rekabentuk dan simulasi pelbagai jenis litar elektronik analog. *Able to analyse the design and simulation of a variety of analogue electronic circuits.*

KKEE2123 Isyarat dan Sistem
Signals and Systems

Kursus ini bertujuan untuk memberi pengetahuan asas tentang kaedahmatematik untuk menganalisa isyarat dan sistem lelurus dalam domain masa dandomain frekuensi. Tajuk-tajuk yang terkandung dalam kursus ini ialah konsep isyarat dan sistem, sistem linear masa-tak-berubah (LTI), siri Fourier, jelmaan Fou-rier, teori pensampelan, jelmaan Laplace, sambutan frekuensi dan penuras analog.

This course aims to give basic knowledge of mathematical methods to analyze signals and the linear systems in time domain and frequency domain. Topics included in this course are the concept of signals and systems, linear time-invariant system (LTI), Fourier series, Fourier transform, sampling theorem, Laplace transform, frequency response and analog filters.

Pra-Keperluan (jika ada): KKEE1113 Teori Litar I
Pre-requisite (if any): *KKEE1113 Circuit Theory I*

Bacaan Asas:
References :

Lathi, B.P. 2017. Principles of Linear Systems and Signals. 2nd Edition. New York: Oxford University Press.
**Oppenheim, A.V., Willsky, A.S. & Nawab, S.H. 2015. Signals and Systems. 2nd Edition. Pearson.*
Roberts, M.J. 2017. Signals and Systems: Analysis using Transform Methods and

MATLAB. 3rd Edition. McGraw-Hill.
Chaparro, L. & Akan, A. 2018. Signals and Systems using MATLAB. 3rd Edition. Academic Press.
Alkin, O. 2016. Signals and Systems: A MATLAB Integrated Approach. 1st Edition. CRC Press.
**Nota: Terdapat rujukan yang diterbitkan melebihi 5 tahun terkini diperlukan untuk penjelasan teori atau konsep kursus.*

Hasil Pembelajaran/
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menyelesaikan permasalahan isyarat masa selanjar dan sistem linear masa tak berubah; *Ability to solve problems related to continuous-time signals and linear time-invariant (LTI) systems;*
2	Berkebolehan melakukan manipulasi ke atas siri Fourier dan jelmaan Fourier. *Ability to manipulate Fourier series and Fourier transform;*
3	Berkebolehan mempraktikkan jelmaan Laplace; *Ability to practice Laplace transform;*
4	Berkebolehan menggunakan penuras analog dalam permasalahan sambutan frekuensi. *Ability to use analog filters to solve problems related to frequency response.*

KKEE2152 Makmal Elektrik dan Elektronik II
Electrical and Electronics Laboratory II

Kursus makmal ini ditawarkan pada Semester 1, untuk pelajar tahun 2. Makmal ini terbahagi kepada lapan ujikaji, satu projek berkumpulan serta peperiksaan pertengahan semester dan projek akhir. Eksperimen- eksperimen ini akan memberi pendedahan kepada pelajar dalam bidang elektronik analog, instrumentasi dan pengukuran, serta dalam bidang elektro- magnet. Bagi projek pelajar, ianya merangkumi topik-topik berkaitan dengan instrumentasi dan elektronik analog seperti penguat, sensor dan sebagain-
ya.

This laboratory-based course is offered for the second year students in Semester 1. The laboratory session can be divided into eight experiments, one group project, mid-semester examination and final project. These experiments will give exposure to the students to the field of analogue electronics, instrumentation and measurement and electromagnetic field. The student project covers topics related

to the electronic instrumentation and analogue devices such as amplifiers, sensors and many other topics, which are covered throughout the course.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Boylestead, R. L. & Nashelsky, L. 2013. Electronic Devices and Circuit Theory. 11th Edition. Pearson (versi terkini).*

**Irwin, J.D. & Nelms, R.M. 2015. Basic Engineering Circuit Analysis. 11th Edition. New York: John Wiley & Sons.*

**Horowitz, P. & Hill, W. 2015. The Art of Electronics. 3rd Edition. Cambridge University Press.*

Alexander, C.K. & Sadiku, M.N.O. 2016. Fundamentals of Electric Circuit. 6th Edition. New York: McGraw Hill.

Rizzoni, G. & Kearns, J. 2016. Principles and Applications of Electrical Engi neering. 6th Edition. New York: McGraw Hill.

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menganalisa teori litar menerusi eksperimen; *Ability to analyse circuit theory through experimental works;*
2	Berkebolehan menganalisa penguat menggunakan peranti aktif seperti penguat kendalian atau transistor (BJT/FET); *Ability to analyse amplifier using active devices such as operational amplifier or transistor (BJT/FET);*
3	Berkebolehan menggunakan peranti aktif untuk aplikasi sebagai penuras aktif atau sistem fungsi pindah; *Ability to use active devices for the application of an active filter or a transfer function system.*
4	Berkebolehan untuk membina eksperimen yang berkaitan menggunakan teknik yang betul. *Ability to construct relevant experiments using appropriate techniques.*

KKEE2103 Pembelajaran Mesin
Machine Learning

Matlamat kursus ini ialah memberikan pengetahuan dan kefahaman mengenai algoritma pembelajaran mesin menggunakan perisian Python. Kursus ini memperkenalkan beberapa kaedah pembelajaran mesin secara teori dan praktikal. Kursus ini terdiri daripada tiga komponen utama iatu asas-asas pengaturcaraan menggunakan Python, algoritma pembelajaran berpenyelia dan algoritma pembelajaran tanpa penyelia.

The aim of this course is to provide knowledge and understanding of machine learning algorithms using Python. This course introduces several machine learning methods through theoretical explanation and practical applications. This course consists of three main components, which are basic programming principles using Python, supervised learning algorithm and unsupervised learning algorithm.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any)*: *None

Bacaan Asas:
References:

Deitel, H. M. & Deitel, P. J. 2019. Intro to Python for Computer Science and Data Science. Prentice-Hall.

**Jones, M. 2015. Pyhton for Complete Beginners: A Friendly Guide to Coding, No Experience Required. Createspace Independent Publishing.*

Kirk, M. 2017. Thoughtful Machine Learning with Python: A Test Driven Approach. O'Reilly.

Muller, A. C. & Guido, S. 2016. Introduction to Machine Learning with Python: A Guide for Data Scientists. O'Reilly.

**Ramalho, L. 2015. Fluent Python: Clear, Concise, and Effective Programming. O'Reilly.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berupaya menggunakan bahasa pengaturcaraan Python bagi aplikasi kejuruteraan; *Ability to use the Python programming language for engineering applications;*
2	Berkeupayaan mensyorkan algoritma pembelajaran berpenyelia untuk aplikasi kejuruteraan; *Ability to suggest supervised learning algorithm for engineering applications;*
3	Berkeupayaan mensyorkan algoritma pembelajaran tanpa penyelia untuk applikasi kejuruteraan; *Ability to suggest unsupervised learning algorithm for engineering applications.*
4	Berkeupayaan menghasilkan penilaian keberkesanan algoritma pembelajaran mesin. *Ability to evaluate the effectiveness of the machine learning algorithm.*

KKEE2163 Elektronik Digit
Digital Electronics

Kursus ini mendedahkan pelajar kepada sistem nombor dan kod, unsur-unsur litar logik gabungan dan asas jujukan. Penjanaan persamaan keluaran dan jadual kebenaran bagi tujuan realisasi dengan menggunakan kaedah pengurangan rekabentuk, dimana kos juga akan diberikan penekanan. Pelajar juga akan didedahkan kepada jujukan dalam flip–flop dan teknik penyelesaian masalah melalui rekabentuk Mesin Mealy dan Mesin Moore dan implementasinya menggunakan flip-flop. Pelajar juga akan didedahkan kepada pengaturcaraan VerilogHDL dan mengunakannya untuk merekabentuk mesin keadaan.

In this course, the students are exposed to code and numerical system, combinational logic elements and sequential basics. Output equation generation and truth table that are used for realization purpose using design minimization technique and cost are also emphasized. Students are also exposed to sequences in flip-flop systems and problem solving teachniques through Mealy and Moore machine designs and their implementation using flip-flops. In addition, exposure on VerilogHDL programming and its use for state machine design are also put into emphasis.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): ***None***

Bacaan Asas:
References:

Anand Kumar, A. A. 2016. Fundamentals of Digital Circuits. 4th edition. PHI Learning Private Limited.

**Floyd, T. 2015. Digital Fundamentals. Global Edition. 11th Edition. Pearson International.*

Mano, M.M.R., Kime, C.R. & Martin, T. 2016. Logic & Computer Design Fundamentals. 5th Edition. Pearson International.

Tocci, R., Widmer, N., & Moss, G. 2017. Digital Systems Principles and Applications. 12th edition. Pearson International.

Mandal, S.K. 2018. Digital Electronics. McGraw-Hill Education.

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menerangkan kaedah penyelesaian masalah berkaitan konsep asas dalam sistem nombor, litar berkombinasi dan litar berjujukan menggunakan kaedah konvensional dan HDL; *Able to explain the problem solving methods in fundamental concepts of number systems, combinational circuits, sequential circuits using conventional and HDL techniques;*
2	Berkebolehan menganalisis masalah berkaitan litar berkombinasi dan litar berjujukan termasuk mesin keadaan menggunakan formulasi dan kemahiran analitikal; *Able to analyse problems relating to combinational circuits and sequential circuits including state machines using analytical skill and formulation;*
3	Berkebolehan mengaitkan impak penyelesaian masalah kejuruteraan dalam rekabentuk litar logik dalam konteks masyarakat dan alam sekitar; *Able to relate the impact of engineering solutions in logic circuits designs in societal and environmental context;*
4	Berkebolehan menyampaikan idea dan cadangan dalam penyelesaian masalah kejuruteraan kompleks dalam rekabentuk litar logik secara efektif. *Able to explain effectively ideas and propose design solutions for complex engineering problems in digital logic circuits.*

KKEE2183 Teori Komunikasi
Communication Theory

Kursus ini merupakan kursus asas kepada teori komunikasi analog dan digit. Sistem modulasi analog dan digit diperkenalkan. Perbandingan sistem tersebut seperti pengunaan lebar jalur dan kesan hingar akan dilakukan. Dimulakan dengan pengenalan kepada komunikasi analog dan digit. Teori asas pemodulatan, perwakilan isyarat modulatan, kebaikan dan kelemahan modulatan, jenis pemodulat dan penyahmodulatan serta prestasi modulatan dalam keadaan hingar bagi sistem analog dan digit. Antara sistem analog yang dikaji ialah AM, FM dan PM sementara sistem digit yang dikaji ialah ASK, PSK, FSK, BPSK, QPSK, QAM. Kaedah penukaran isyarat analog ke digit seperti PCM, pengkuantuman dan pengkodan turut dibincangkan. Kursus ini disimpulkan dengan perbincangan aplikasi semasa teknologi komunikasi.

This is a basic course on analog and digital communication theory. Analogue and digital modulation systems are introduced. System comparisons will be carried out based on broadband and noise effects. The course starts with introduction to analogue and digital communication followed by modulation basic theory, modulating signal representation, advantage and disadvantage of modulation, types of modulation and demodulation as well as modulation performance under noisy condition for analogue and digital systems. Several analogue systems that will be studied are AM, FM and PM and in terms of digital system, ASK, PSK, FSK, BPSK, QPSK, and QAM. Other topics included are conversion of analogue signal to digital such as PCM, quantization and coding. This course is concluded with discussions on current applications of communication technology.

Pra-Keperluan (jika ada): KKEE2123 Isyarat dan Sistem
Pre-Requisite (if any): *KKEE2123 Signal and System*

Bacaan Asas:
References:

Lathi, B.P. & Zhi Ding. 2018. Modern Digital and Analog Communication (The Oxford Series in Electrical and Computer Engineering). 5th Edition. Oxford University Press.

Samuel O. A & Sadiku, M.N.O. 2017. Principles of Modern Communication Systems. Cambridge University Press.

**Frenzel, L. 2015. Principles of Electronic Communication Systems (Engineering*

Technologies & the Trades). 4th Edition. McGraw-Hill.
**Couch, L. W. 2012. Digital and Analog Communication Systems. 8th Edition. New Jersey: Prentice-Hall.*
**Blake, R. 2012. Electronic Communication Systems. 2nd Edition. Cengage Learning India Pvt. Ltd. (versi terkini).*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	*B*erkebolehan untuk menerangkan blok asas sistem komunikasi; *Able to describe basic blocks of communication system;*
2	Berkebolehan untuk mengaplikasi teori pemodulatan analog dan digit dalam sistem komunikasi; *Able to apply analogue and digital modulation theory in communication system;*
3	Berkebolehan untuk menentukan kesan hingar terhadap prestasi sistem komunikasi analog dan digit; *Able to identify noise effect on communication system performance of both analogue and digital;*
4	Berkebolehan untuk menerangkan hubungkait teori komunikasi dengan memberi contoh aplikasi dunia sebenar. *Ability to describe the relations of communication theory through examples of real applications.*

KKEE2133 Medan dan Gelombang Elektromagnet
Electromagnetic Fields and Waves

Kursus ini adalah salah satu asas kepada kejuruteraan elektrik dan elektronik yang memperkenalkan konsep medan elektrik dan magnetik statik di dalam aplikasi kejuruteraan elektrik. Matlamatnya ialah supaya para pelajar dapat memahami dan mengaplikasikan ilmu pengetahuan medan dan gelombang elektromagnet di dalam kejuruteraan. Bermula dengan topik analisa skalar dan vektor dalam tiga sistem kordinat berlainan iaitu Cartesian, silinder dan sfera, seterusnya kursus ini membincangkan: ciri-ciri dan sifat elektrik statik dan magnetik statik serta persamaan-persamaan berkaitan; hukum-hukum asas dalam elektromagnet statik; Keupayaan elektrik dan magnet; Jenis-jenis dan syarat-syarat sempadan medan; Kemuatan dan Kearuhan; Persamaan Maxwell.

This course is one of the fundamental courses in electrical and electronic engineering which will introduce the concept of electromagnetic wave and magneto static in electrical engineering applications. The aim of is this subject for students to understand the basic theory and apply their knowl-edge of electromagnetic wave and field. The course starts with the topic of scalar and vector analysis in three different fields, which are Cartesian, Cy- lindrical and Spherical. Then, it follows with: Electrostatic and magneto static

characteristics and related equations; Electric and magnetic potentials; types and boundary conditions; insulator and impedance in medium; Maxwell's Equation.

Pra-Keperluan (jika ada): KKKQ1123 Matematik Kejuruteraan I (Kalkulus Vektor)
Pre-Requisite (if any): *KKKQ1123 Engineering Mathematics I (Vector Calculus)*

Bacaan Asas:
References :

Sadiku, M.N.O. 2018. Elements of Electromagnetics. 7th Edition. Oxford Uni versity Press.

Hayt, W. 2018. Engineering Electromagnetics. 9th Edition. McGraw-Hill. Jin Jian-Ming. 2018. Theory and Computation of Electromagnetic Fields. Wiley-IEEE

**Inan, U.S., Inan, A. & Said, R. 2014. Engineering Electromagnetics and Waves. 2nd Edition. Prentice Hall.*

**Ulaby, F.T. 2014. Fundamentals of Applied Electromagnetics. 7th Edition. Prentice Hall International.*

Hasil Pembelajaran
Course Outcomes

Bil No.	Hasil Pembelajaran Kursus *Course Outcomes (CO)*
1	Berkebolehan menerangkan konsep algebra dan kalkulus vektor, pembezaan dan pengkamiran dalam tiga sistem koordinat, dan konsep-konsep asas medan elektromagnet static; *Ability to describe the concept of vector algebra and calculus, differentiation, and integration in three coordinate systems, and basic concept of static electromagnetic field;*
2	Berkebolehan menganalisa masalah-masalah kejuruteraan menggunakan hukum-hukum dan konsep-konsep elektromagnetstatik; *Capable of analysing engineering problems by implementing laws and concept of static electromagnetic;*
3	Berkebolehan menentukan dan menerangkan kesan aplikasi gelombang elektromagnet terhadap kelestarian alam, dan berpegang kepada tanggungjawab awam sebagai jurutera; *Ability to identify and explain the effect of electromagnetic waves applications towards sustainability, and to adhere to the responsibility as an engineer.*
4	Berkebolehan untuk membina eksperimen di makmal bagi membuktikan konsep asas medan elektromagnet statik. *Ability to construct lab experiment to prove basic static electromagnetic field concept.*

KKEE2141 Makmal Elektronik Digit
Digital Electronics Laboratory

Kursus makmal ini mendedahkan pelajar kepada implementasi get-get logik dalam unsur-unsur logik gabungan dan asas jujukan. Penggunaan get dalam penjanaan persamaan output dan jadual kebenaran bagi tujuan realisasi dengan menggunakan kaedah peminimuman rekabentuk dan kos juga diberikan penekanan. Pelajar juga didedahkan kepada jujukan dalam sistem flip flop dan penyelesaian masalah melalui rekabentuk mesin keadaan dan implementa- sinya dalam flip flop. Pelajar juga didedahkan kepada pengaturcaraan Verilog dan menggunakannya untuk rekabentuk mesin keadaan. Pelajar juga perlu membentangkan projek.

This laboratory-based course exposes students to logical gate implementation in the elements of combinational logic and sequential logic. Usage of gates in generating output equations and truth tables for equation realisation are covered, with the importance for minimizing design through reducinggates and cost. Students are also exposed to sequential flip-flop system and problem solving using state machine and implementing it in flip-flops. In addition, students are taught on the Verilog programming language, using it to design statemachines. In the end, students will be given a project to assess their lab skills.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Floyd, T. 2015. Digital Fundamentals. Global Edition. 11th Edition. Pearson International.*

Mano, M.M., Kime, C.R., & Martin, T., 2016. Logic and Computer Design Fundamentals. Pearson International.

Vaibbhav, T. 2016. Digital Logic Design Using Verilog: Coding and RTL Synthesis. Springer.

Ming-bo, L. 2016. An Introduction to Verilog HDL. 1st Edition. CreateSpace Independent Publishing Platform.

**Roth, C.H. & Kinney, L. 2014. Fundamentals of Logic Designs. 7th edition. Mn: West Publishing Co.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menganalisis dan mengubahsuai litar kombinasi untuk menyelesaikan persamaan logic; *Ability to analyse and rearrange a combinational circuit to solve logical equation.*
2	Berkebolehan untuk mengenalpasti dan menerangkan prinsip asas flip flop, rangkaian jujukan dan aplikasi; *Ability to identify and explain the basic principles of flip-flops, sequential networks and its applications*
3	Berkebolehan untuk memahami dan mendapatkan mesin keadaan, serta menyelesaikan dengan mengurangkan bilangan keadaan. *Ability to understand and obtain state machines and solving it using minimal states;*
4	Berkebolehan untuk membina bahasa aturcara verilog untuk litar logik dan mengaplikasikannya pada papan litar FPGA. *Ability to construct the Verilog programming language for logical circuits and applying it on the FPGA board.*

KKEE2113 Peranti Semikonduktor
Semiconductor Devices

Kursus ini bertujuan untuk memberi pengetahuan dan membangunkan pemahaman serta kemahiran sintesis dalam fizik peranti semikonduktor. Konsep asas dan sifat-sifat fizikal bahan semikonduktor diperkenalkan dan diterokai, iaitu termasuk bahan semikonduktor intrinsik dan ekstrinsik, sifat statik dan pengangkutan caj, jalur tenaga, kesan dopan, simpang p-n, simpang logam-semiconductor dan simpang MOS. Dari sini, struktur, mekanisma operasi dan sifat peranti uni-polar dan dwi-polar diperkenalkan, seperti p-n diod, transistor simpang dwikutub (BJT), kapasitor MOS, dan transistor kesan medan (MOSFET, JFET dan MESFET). Asas fenomena kuantum dan kesan yang berkaitan, serta konsep yang mendasari heterosimpang, dan beberapa peranti optoelektronik diperkenalkan di akhir kursus.

This course is aimed to provide knowledge and to develop understanding and synthesis skills in the physics of semiconductor devices. Basic concepts and physical properties of semiconductor materials are introduced and explored, which includes intrinsic and extrinsic semiconductor materials, static properties and transportation of charge, energy band theory, doping effect, p-n junction, metal-semiconductor junction and MOS junction. Furthermore, the structure, working mechanism and properties of unipolar and bipolar devices are introduced, such as p-n junction diode, bipolar junction transistors (BJT), MOS capacitor, and field effect transistors (MOSFET, JFET and MESFET). Basic quantum phenomena and associated effects, concepts underlying heterojunctions, and some optoelectronics devices are also introduced towards the end of the course.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Rudan, M. 2018. Physics of Semiconductor Devices. New York: Springer-Verlag.
Maurizio, D. P. E. 2017, Microelectronics: From Fundamentals to Applied Design. Switzerland: Springer International Publishing.
Safa, K. 2018. Principles of Electronic Materis and Devices. 4th Edition. McGraw-Hill Education.
Streetman,B.G.2015.SolidStateElectronicDevices,7thEdition(Global).Pearson.
Christo, P. 2014. Solid-State Electronic Devices: An Introduction. New York: Springer-Verlag.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menerangkan konsep asas fizik semikonduktor (jalur tenaga, kepekatan pembawa, angkutan cas) dan peranannnya dalam pembentukan simpangan p-n; *Ability to explain the basic concepts of semiconductor physics (energy band, carrier concentration, charge transport) and its role in the formation of p-n junction.*
2	Berkebolehan untuk menerangkan fizik dan mengenalpasti ciri-ciri utama simpangan semikonduktor-semikonduktor, semikonduktor-logam serta variasi simpangan lain yang membentuk peranti-peranti elektronik; *Ability to explain the physics and identify key features of the semiconductor-semiconductor junction, metal-semiconductor junction, as well as other structure variations that make up electronic devices.*
3	*B*erkebolehan memperihalkan fungsi asas peranti semiconductor seperti kapasitor MOS, transistor kesan medan (MOSFET, JFET, MESFET), transistor simpang dwikutub (BJT), peranti optoelektrinik termasuk fenomena quantum dan kesannya, serta konsep asas heterosimpang; *Ability to describe the basic functions of semiconductor devices such as the MOS capacitor, field effect transistors (MOSFET, JFET and MESFET), bipolar junction transistors (BJT), optoelectronic devices including quantum phenomena and their effects, and the basic concept of heterojunction.*
4	Berkebolehan untuk mengatur kajian kepustakaan dan membuat laporan bertulis tentang penyelidikan terkini dalam teknologi peranti semikonduktor; *Ability to organise literature review and make written reports on the latest research in the current advancement of semiconductor device technologies.*

KKKQ3123 Statistik dan Pengiraan Berangka
Statistics and Numerical Methods

Matlamat kursus ini memperkenalkan statistik sebagai satu kaedah untuk membantu menyelesaikan masalah berdasarkan pengumpulan data dan pensampelan. Tajuk-tajuk utama termasuklah kebarangkalian, teorem Bayes, pembentangan data rawak, pemboleh ubah rawak diskret; fungsi ketumpatan kebarangkalian, taburan-taburan kebarangkalian, min dan varians, analisisralatrawakdansistematik,ketumpatandantaburankebarangkalian,taburan kebarangkalian seragam, taburan eksponen dan normal, anggaran parameter min dan varians, anggaran titik dan anggaran selang, pensampelan, ujian keerertian dan hipotesis, regresi dan korelasi. Kesemua tajuk yang dibincangkan pada silibus statistik akan juga diajar dari sudut pengetahuan secara pembelajaran mesin. Kaedah berangka dalam kejuruteraan diperkenalkan seterusnya.Antara tajuk-tajuk utama adalah persamaan linear, punca persamaan, interpolasi, regresi, terbitan dan kamiran berangka dan persamaan kebezaan biasa. Subjek ini mengintegrasikan teori dan aplikasi kaedah berangka bagi menyelesaikan masalah kejuruteraan. Dengan ini diharapkaniamenjadijambatanpenghubungantarabidangstatistikdankejuruteraan.

The aim of this course introduces statistics as an approach to help solveproblems based on data collection and sampling. The main topics under this course include; probability, the Bayes's theorem, random data distributions, discrete random variables, probabilistic density functions, probabilistic distributions, mean and variance, random and systematic error analyses, proba- bilistic distribution and density, uniform probabilistic distribution, exponent andnormal distributions, mean and variance parameter estimations, point and interval estimations, sampling, significance testing and hypothesis, also regression and correlation. All topics discussed in the statistical syllabus will also be taught from a machine learning perspective. Numerical methods in engineering is then introduced in the second part of the course. Among the main topics that will be covered are linear equations, roots equation, interpolation, regression, derivational and numerical integrations, and the solution to ordinary differential equations. This subject integrates the theory andapplication of the numerical methods in solving engineering problems. This course is expected to bridge both the fields of statistics and engineering.

Keperluan Kursus untuk Menduduki Peperiksaan
(Rujuk Peraturan UKM Pengajian Sarjana Muda pindaan 2020).

Pelajar perlu memenuhi 80% keperluan kursus yang merujuk kepada keperluan kehadiran kuliah, ujian atau/dan penghantaran tugasanpentaksiran semasa minggu pengkuliahan tidak termasuk pentaksiran/ peperiksaan akhir.

Pra-Keperluan(jika ada): KKKQ1213 Matematik Kejuruteraan I (Kalkulus Vektor)
KKKQ1223 Matematik Kejuruteraan II (Aljabar Linear)

Pre-Requisite (if any): *KKKQ1223 Engineering Mathematics II (Linear Algebra)*
KKKQ1213 Engineering Mathematics I (Vector Calculus)

Bacaan Asas:
References:

Esfandiari, R. S. 2017. Numerical Methods for Engineers and Scientists using MATLAB. 2nd edition, CRC Press.

Devore, J. L. 2015. Probability and Statistics for Engineering and the Sciences. 9th edition, Cengage Learning.

Chapra, S. & Canale, R. 2014. Numerical Methods for Engineers. 7th edition, McGraw-Hill.

Holický, M. 2013. Introduction to Probability & Statistics for Engineers. Springer.

Montgomery, D. C. & Runger, G. C. 2018. Applied Statistics and Probability for Engineers. 7th edition. Wiley.

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk mengenal pasti konsep asas taburan kebarangkalian dan ujian hipotesis menggunakan teori pensampelan; *Ability to identify basic concepts of probability distributions and hypothesis testing;*
2	Berkebolehan untuk meneliti teknik asas pembelajaran mesin dan analitik data; *Ability to perform basic technique of machine learning and data analytic;*

3	Berkebolehan untuk menyelesaikan beberapa teknik penganggaran dalam analisis berangka; *Ability to use various approximation methods in numerical analysis;*
4	Berkebolehan untuk menganalisis kaedah berangka yang sesuai dalam menyelesaikan masalah kejuruteraan elektrik. *Ability to analyse suitable numerical methods in solving electrical engineering problems.*

KKEE3123 Kejuruteraan Kawalan
Control Engineering

Matlamat kursus ini ialah memberikan pengetahuan dan kefahaman asas dalam bidang sistem kawalan. Ia merupakan kursus yang memberi penekanan terhadap kaedah analisis sistem kawalan yang meliputi topik teknik kawalan, pengkelasan teknik kawalan, sistem suap balik, sistem gelung terbuka, permodelan fizikal sistem dinamik, model fungsi pindah, graf aliran isyarat, sambutan fana sistem, kestabilan, tatasusun Routh, indek prestasi, teknik punca londar, kaedah sambutan frekuensi, plot Bode, kriteria Nyquist.

The objective of this course is to equip students with the knowledge and basic understanding of control system. Students will learn about analysis methods in control system such as classification of control techniques, feedback system, open loop system, physical modeling of dynamic system, transfer function model, signal flow graph, transient response, stability, Routh array, performance index, root locus technique, frequency response methods, Bode plot and Nyquist criterion.

Pra-Keperluan (jika ada): KKEE2123 Isyarat dan Sistem
Pre-Requisite (if any): *KKEE2123 Signals and Systems*

Bacaan Asas:
References:

**Nice, N.S.. 2015. Control Systems Engineering. 7th Edition. John Wiley & Sons Inc.*

**Ogata, K. 2013. Modern Control Engineering. 5th Edition. Pearson.*

Dorf, R.C. & Bishop, R.H. 2016. Modern Control Systems. 13th Edition. Pear son.

De Oliveira, M.C. 2017. Fundamentals of Linear Control: A Concise Approach. Cambridge University Press.

**Franklin, G.F., Powell, J.D. & Emami-Naeini, A. 2014. Feedback Control of Dynamic Systems. 7th Edition. Pearson.*

Golnaraghi, F. & Kuo, B.C. 2017. Automatic Control Systems. 10th Edition. Mc-Graw Hill.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Kebolehan untuk menerangkan konsep asas sistem kawalan dan mendapatkan fungsi pindah melalui konsep pemodelan; *Ability to describe basic concepts of a control system and determine its transfer functions through modelling concept;*
2	*K*ebolehan untuk mensintesis sambutan sistem kawalan dalam domain masa dan domain frekuensi; *Ability to synthesize system response in time domain and frequency domain;*
3	Kebolehan untuk mensintesis dan menerangkan kestabilan sesuatu sistem kawalan; Ability to synthesize and tell the stability of a given control system;
4	Kebolehan untuk menggunakan teori system kawalan di dalam permasalahan sebenar. *Ability to use control system theories in real problems.*

KKEE3113 Pengukuran dan Instrumentasi
Measurements and Instrumentation

Kursus ini membincangkan aspek pengukuran seperti unit, simbol, piawai dan jenis-jenis-jenis ralat. Kursus ini juga menerangkan jenis-jenis instrumen-instrumen elektronik yang biasa digunakan dalam industri untuk pengukuran arus, voltan, rintangan, jarak, suhu, tekanan. Ini diikuti dengan pengenalan kepada litar penyesuaian dan penukaran analog-digital dan digital-analog.

This course discusses aspects of measurement such as unit, symbol, standard and types of error. Various electronics instrumentations commonly used in industry to measure current, voltage, resistance, displacement, temperature and pressure are also explained followed with introduction to matching circuit and analogue-digital and digital-analogue conversion circuits.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Morris, A.S. & Langari, R. 2020. Measurement and Instrumentation: Theory and Application Academic. 3nd Edition. Academic Press.
Sachan, V.K., 2019, Fundamentals of Electronic Measurement & Instrumenta-

tion. Independently published.
Van Putten, A.F.P. 2019. Electronic Measurement Systems: Theory and Practice. Routledge.
**Figliola, R.S. & Beasley, D.E. 2015. Theory and Design for Mechanical Measurements. 6th Edition. John Wiley & Sons, Inc.*
**Bolton, W. 2015. Instrumentation and Control Systems. 2nd Edition. Newnes*
**Bentley, J. P. 2005. Principles of Measurement Systems. Prentice Hall* (versi terkini).

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menerangkan konsep asas system pengukuran; *Able to explain basic concept of measurement system;*
2	Mempunyai kebolehan untuk menerangkan dan mengenalpastikan ralat pengukuran dan spesifikasi instrumen; *Able to explain and identify measurement error and instrument specification;*
3	Berkebolehan untuk mengaplikasi dan memilih elemen utama sensor, konsep asas elemen litar penyesuaian dan pemprosesan isyarat dalam sistem pengukuran; *Able to apply and choose the key element of sensors, basic concept of signal conditioning and signal processing of a measurement system;*
4	Berkebolehan untuk merancangkan, merekabentuk dan mencadangkan suatu sistem pengukuran. *Able to plan, design and propose a measurement system.*

KKEE3143 Mikropemproses dan Mikrokomputer
Microprocessor and Microcomputer

Kursus ini bermula dengan pengenalan kepada jenis-jenis mikroprosesor (4-bit hingga 16-bit) yang terdapat di pasaran. Mikroprosesor 16-bit keluaran Intel, iaitu Intel 8086 akan digunakan sebagai mikropemproses kajian di mana pelajar akan didedahkan kepada konsep asas, arkitektur dalaman, perantaramukaan ingatan dan pengurusannya, sistem pemasaan, termasuk konfigurasi dan fungsi pin-pin mikropemproses. Ini diikuti dengan konsep pengaturcaraan bahasa mesin dan penghimpun serta teknik-teknik pengaturcaraan. Kursus ini juga mendedahkan pelajar kepada teknik-teknik pengalamatan ingatan dan I/O serta peranti perantaramuka selari dan sesiri.

The course introduces the various types of microprocessors (4-bit to 16-bit) available in the market. Microprocessor 8086 by Intel will be made as a case study. The students will be exposed to the fundamental concepts of microprocessor,

internal architecture, programming model, functions and configuration of the pins. This will be followed by the assembly languages programming concepts, and programming techniques. This course will also introduce the students to memory addressing techniques and I/O devices. The students will also acquire the knowledge on the operations and applications of serial and parallel peripherals.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Mary, P. , Jeebananda, P. 2016. Microprocessors and Microcontrollers. PHI Learning Pvt. Ltd.

**Ganguly, A.K & Ganguly, A. 2015. Microprocessors and Microcontrollers: 8085, 8086 and 8051. 3rd edition. Alpha Science International, Ltd.*

Indra Gunawan, ST., M.Kom., CEH., CHFI. 2019. Pemrograman Assembly Mikroprosesor 8086. Guepedia.

**Brey, B. B. 2011. INTEL Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, PrentiumProProcessor, Pentium II, III, 4 .8/e. Pearson International)* (versi terkini).

**Kant, K. 2014. Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096. PHI Learnig Private Limited.*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menulis aturcara bahasa mesin untuk menyelesaikan masalah; *Able to write codes to solve problems;*
2	Berkebolehan merekabentuk dan membangunkan litar perantaramuka; *Able to design and develop interfacing circuits;*
3	Berkebolehan mengenalpasti arkitektur mikrokomputer dan hubungkait antara perkakasan dan perisian dari aspek rekabentuk; *Able to identify microcomputer architecture and the relations between hardware and software design aspect;*

4	Berkebolehan berfungsi dengan efektif dalam aktiviti berkumpulan dan membentangkan serta menerangkan dengan efektif idea dan cadangan rekabentuk sistem mikrokomputer lengkap yang dibangunkan. *Able to function effectively in group activities and to present and explain effectively ideas and proposals of complete microcomputer system that has been developed.*

KKKE3103 Optoelektronik
Optoelectronics

Matlamat kursus ini ialah untuk menerapkan kefahaman teknologi optoelektronik dalam dunia aplikasi fotonik hari ini. Kursus ini dimulai dengan memperkenalkan lebih mendalam mengenai peranti optoelektronik, seperti konsep laser, penguat optik dan komponen-komponen pasif. Asas-asas dan hukum-hukum cahaya seperti persamaan Maxwell, persamaan Fresnel, hukum snell, pantulan dalam penuh diulangkaji semula berdasarkan gelombang semula jadi cahaya di dalam pandu gelombang dielektrik dan gentian optik. Bab-bab seterusnya merangkumi polarisasi cahaya, modulasi cahaya. Trend teknologi optoelektronik yang terkini akan dibincangkan khususnya dari aspek sistem telekomunikasi, pengesan, pengimejan dan paparan. Kursus ini juga akan memberikan pendedahan makmal terhadap aktiviti pengukuran dan pencirian peralatan dan komponen optoelektronik. Para pelajar juga didedahkan kepada pengenalan penggunaan perisian simulasi bagi merekabentuk komponen optoelektronik.

The goal of this course is to apply the understanding of optoelectronic technology in the world's today photonic applications. This course begins by introducing in greater depth of optoelectronic devices, such as the concept of lasing, optical amplification and working concept of passive components. Fundamental principles and laws of light, such as Maxwell's equations, Fresnel equation, snell law, total internal reflection will be revisited, based on the phenomenon of wave nature of light in dielectric waveguides and optical fibers. Subsequent chapters include light polarization, modulation of light, wavelength division multiplexing (WDM) concepts and components that involved. The current trends of optoelectronic technology will be discussed from the aspect of telecommunications systems, sensors, imaging and display. This course will provide laboratory exposure to the measurement and characterization equipment and optoelectronic components. The students are also exposed to the introduction of the use of simulation software for the design of optoelectronic components.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Saleh, B.E.A. & Teich, M.C. 2019. Fundamentals of Photonics. Edisi ke-3.Wiley.
Eugene H. 2016. Optics. Edisi ke-5.Addison-Wesley.
Reider, G. A. 2016. Photonics. Springer.
**Keiser, G. 2014. Optical Fiber Communications. Mc Graw Hill Education. Edisi ke-5.*
**Kasap, S. O., 2013. Optoelectronics & Photonics: Principles & Practices. Edisi ke-2. Prentice Hall.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan merekabentuk komponen dan sistem aktif berdasarkan pengetahuan teknologi opto-elektronik; *Ability to design an active component and system based on knowledge of optoelectronic technology;*
2	Berkebolehan memasang dan mengukur peranti optik dan sistem menggunakan perisian pemodelan dan alat optik; *Ability to assemble and measure optical device and system using modelling software and optical tools;*
3	Berkebolehan menyelesaikan masalah berkaitan teknologi asas opto-elektronik; *Ability to solve problems associated with the fundamental optoelectronic;*
4	Berkebolehan membentangkan penyelesaian dan menyelesaikan masalah yang diberikan berkenaan applikasi teknologi optoelektronik.Berkebolehan merekabentuk dan menyelesaikan masalah yang diberikan berkenaan applikasi teknologi optoelektronik; *Ability to propose a solution and to solve problems related to optoelectronic application;*

KKEE3163 Pemprosesan Isyarat Digital
Digital Signal Processing

Kursus ini merangkumi asas bagi teknik pemprosesan isyarat digital. Matlamat kursus ini adalah untuk membolehkan pelajar untuk menganalisis sistem diskret masa dalam domain masa dan frekuensi. Ia dimulakan dengan pengenalankepada isyarat, ciri dan klasifikasi, teori pensampelan, penukar analog-ke- digital dan digital-ke-analog. Isyarat dan sistem diskret masa dianalisis dan diperihalkan dengan menggunakan persamaan pembeza dan gambarajahblok. Kaedah analisis termasuk menggunakan domain masa domain Z dandomain Fourier. Sistem masa tak-varian (LTI) dianalisis dan disintesis. Diakhir kursus, pelajar didedahkan dengan rekabentuk dan analisis bagi penuras

sambutan denyut terhingga (FIR) dan sambutan denyut tak-terhingga (IIR).

This course covers the basis for digital signal processing techniques. The aim of this course is to enable students to analyze the discrete-time systems in time and frequency domains. It begins with an introduction to the signal, characteristics and classifications,samplingtheory,analog-to-digitalanddigital-to-analogconverters. Signals and discrete-time systems are analyzed and described by differential equations and block diagram. Analysis methods include using time domain, z-domain and Fourier domain. Linear time-invariant system (LTI) are analysed and synthesized. At the end of the course, students are exposed to the design and analysis of finite impulseresponse filter (FIR) and non-finite impulseresponse (IIR).

Pra-Keperluan (*jika ada*): KKKL2123 Isyarat dan Sistem
Pre-Requisite (if any): *KKKL2123 Signal and System*

Bacaan Asas:
References:

Vijay Madisetti, 2017, Digital Signal Processing Fundamentals, 2nd Edition, Taylor & Francis

**Oppenheim & Schafer. 2015. Digital Signal Processing. 1st Edition. Pearson Education.*

**Kumar. 2015. Digital Signal Processing. 2nd Edition. Prentice Hall India Learning Private Limited.*

Ingle , V.K. & Proakis J.G. 2016. Digital Signal Processing Using MATLAB: A Problem Solving Companion, 4th Edition. Cengage Learning.

Jiang, L.T.J. 2018. Digital Signal Processing: Fundamentals and Applications. 3th Edition. Academic Press.

**Mitra, S. 2011. Digital Signal Processing: A Computer-Based Approach. 4th Edition. New York: McGraw-Hill (versi terkini)*

**Proakis J. G. & Manolakis, D. K. 2006. Digital Signal Processing:*
Principles, Algorithms and Applications. 4th Edition. New Jersey: Pearson. (versi terkini).

**Ambardar. 2012. Digital Signal Processing: A Modern Introduction. Cengage Learning (versi terkini).*

**Lyons R.G. & Fugal D.L. 2014. The Essential Guide to Digital Signal Processing (Essential Guide Series). Prentice Hall.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menganalisis isyarat diskret masa dari segi pensampelan, aliasing, pendigitalan, dan pengkuantuman; *Ability to analyse discrete time signals in terms of sampling, aliasing, digitization, and quantization;*
2	Berkebolehan menganalisis isyarat dan sistem diskret masa dalam domain masa dan domain frekuensi; *Able to analyse discrete time signals and systems in the time and frequency domains;*
3	Berkebolehan menganalisis penuras digital IIR dan FIR. *Ability to analyse the IIR and FIR digital filters;*
4	Berkebolehan membina program MATLAB untuk merekabentuk, menilai dan mensintesis isyarat dan juga system diskret masa. *Able to build MATLAB program to design, evaluate and synthesize the signal behaviour and discrete-time systems.*

KKEE3153 Rekabentuk Sistem
Systems Design

Kursus ini memerlukan pelajar bekerja dalam kumpulan untuk menyelesaikan masalah teknikal yang dihadapi oleh suatu komuniti. Ia bermula dengan mengenalpasti punca masalah dan seterusnya mencadangkan pelbagai penyelesaian yang mungkin dengan menggunakan pengetahuan teknikal yang telah dipelajari. Kemudian, pelajar akan mengaplikasi kaedah penyelesaianyang optimum dalam rekabentuk mereka. Pelajar perlu mengubahsuai proses rekabentuk untuk memenuhi spesifikasi tertentu dengan mengambilkira kekangan yang ada dalam menghasilkan prototaip kejuruteraan dan prototaip hasilan. Secara keseluruhan, pelajar perlu merancang danmengurus suatu projek berdasarkan kepada pendekatan kejuruteraan sistem.

The course requires the student to work in a group in order to solve technical problems encountered by a community. It starts with identifying the root cause and proposing various possible solutions using learned technical knowledge. Then, the student will apply the optimum solution method in their design. Student needs to modify the design process in order to meet certain specifications by considering constraints to produce engineering and product prototype. Overall, student should plan and manage a project based on the system engineering approach.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Paul Sherz & Simon Monk. 2016. Practical Electronics for Inventors, 4th edition. McGraw-Hill.

**Paul Horowitz & Winfield Hill. 2015. The Art of Electronics, 3rd edition. Cambridge University Press.*

**Ulrich, K. & Eppinger, S. 2015. Product Design and Development. 6th edition, New York: McGraw-Hill.*

**Michael Jay Geier. 2015. How to Diagnose and Fix Everything Electronic, 2nd edition. McGraw-Hill.*

**Dennis M. Buede. 2011. The Engineering Design of Systems: Models and Methods. 2nd edition. John Wiley & Sons.*

Hasil Pembelajaran:
Course Outcomes:

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk mengenalpasti punca masalah dan mencadangkan pelbagai penyelesaian kepada suatu masalah teknikal; *Ability to identify the root cause and propose various possible solutions for a technical problem;*
2	Berkebolehan untuk membina suatu prototaip bagi menyelesaikan masalah teknikal dengan menggunakan pengetahuan teknikal yang telah dipelajari; *Ability to construct a prototype for solving the technical problem using learned technical knowledges;*
3	Berkebolehan untuk mengubahsuai proses rekabentuk untuk memenuhi spesifikasi tertentu dengan mengambil kira isu-isu setempat; *Ability to modify design process in order to meet certain specification concerning with local issues;*
4	Berkebolehan untuk mengkaji maklumat berkenaan dengan isu-isu projek rekabentuk sistem dengan etika. *Ability to study information on given issue of the system design project ethically.*

KKEE3133 Analisis dan Sistem Kuasa
Power System and Analysis

Matlamat kursus ini ialah memberikan pengetahuan dan kefahaman tentang analisis aliran kuasa, analisis kerosakan atau litar pintas dan analisis kestabilan fana dalam sistem kuasa. Analisis aliran beban adalah dengan menggunakan teknik lelaran seperti teknik Newton Raphson dan Gauss Seidel. Termasuk dalam kursus ini adalah analisis kerosakan seimbang dan tak seimbang yang merangkumi teori komponen simetri dan penggunaannya. Analisis kerosakan meliputi analisis terhadap berbagai jenis kerosakan seperti kerosakan satu-talian-ke-bumi, dua-talian-ke-bumi dan tiga fasa. Analisis kestabilan fana dalam sistem kuasa turut diajar dengan mengambilkira terbitan persamaan buai dan penggunaan kaedah kriteria luas sama bagi penilaian kestabilan. Simulasi sistem kuasa dilakukan dengan menggunakan perisian analisis sistem kuasa seperti Digsilent, PSS/E, PSAT, Power World Simulator dan Matpower untuk tujuan analisis aliran beban, kerosakan dan kestabilan.

The objective of this course is to provide knowledge and understanding on power flow analysis, fault analysis or short circuit and stability analysis in power system. Load flow analysis will be done by using iterative techniques such as the Newton Raphson and Gauss Seidel techniques. Other topics includebalanced and unbalanced fault analyses which cover symmetrical component theory and its application. Fault analyses comprise single-line to ground, double-line to ground and three phase faults. Transient stability analysis in power systems will be taught considering derivation of the swing equation and using the equal area criteria for stability assessment. Power system simulationswill be carried out using softwares such as Digsilent, PSS/E, PSAT, Power World Simulator and Matpower for load flow, fault and stability analyses.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Glover J. D., Overbye, T. J., Sarma, M. S. 2017. Power System Analysis and Design. USA: Cengage Learning
Grainger, J.J, Stevenson, W. D. & Chang, G. W. 2016. Power System Analysis. USA: McGraw Hill Higher Education
Murty, P. S. R. 2017. Power System Analysis. India: Butterworth-Heinemann.
**Kothari, D. P., Nagrath, I. J. 2011. Modern Power System Analysis. India: Tata McGraw Hill*
**Saadat, H. 2011. Power System Analysis. USA: PSA Publishing*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menjalankan kaedah Gauss Seidel dan Newton Raphson untuk analisis aliran beban; *Ability to perform Gauss Seidel and Newton Raphson techniques for power flow analysis;*
2	Berkebolehan untuk menganalisa kerosakan seimbang dan tak seimbang menggunakan komponen simetri; *Ability to analyse balanced and unbalanced faults using symmetrical component;*
3	Berkebolehan untuk mengaplikasi kaedah kriteria luas sama untuk analisis kestabilan fana; *Ability to apply equal area criterion method for steady state stability analysis;*
4	Berkebolehan membangunkan model rangkaian kuasa dengan menggunakan perisian seperti Digsilent, Power World Simulator, Matpower dan PSAT. *Ability to construct power network models using software tools such as Digsilent, Power World Simulator, Matpower and PSAT.*

KKEC3103 Pengaturcaraan Berasaskan Objek
Object Oriented Programming

Kursus ini adalah sambungan kepada kursus Bahasa Pengatucaraan Tahun 1. Dalam kursus ini, pelajar akan diperkenalkan kepada pengaturcaraan berasaskan objek (OOP), salah satu daripada paradigma pengaturcaraan penting yang digunakan di dalam banyak bahasa pengturcaraan terkenal seperti C++, Java dan Python. Gaya OOP berasaskan kelas dengan C++ akan digunakan sebagai bahasa utama untuk mempelajari konsep-konsep OOP. Pelajar akan diperkenalkan kepada konsep-konsep utama OOP iaitu pewarisan dan polimorfisme, serta konsep pengendalian kekecualian. Pengaturcaran generik dalam bentuk templat juga akan diperkenalkan. Setelah mengenali OOP, pelajar akan belajar menggunakan UML bagi rekabentuk perisian dan diperkenalkan kepada corak rekabentuk dan pemfaktoran semula. Pelajar dikehendaki merekabentuk perisian menggunakan bahasa pengturcaraan OOP pilihan sebagai projek mini bagi menunjukkan kefahaman mereka terhadap konsep-konsep OOP yang dipelajari dalam kursus ini.

This course is a continuation of the programming language course in Year 1. In this course, students will be introduced to object oriented programming (OOP), one of the important programming paradigms used in many popular languges such as C++, Java and Python. The class based style of OOP with C++ will be used as the main languge to learn OOP concepts. Students will be introduced to the main concepts of OOP namely inheritence and polymorphism, as well as the concept of exception handling. Generic programming in the form of templates will also be introduced. Once familiar with OOP, students will learn how to use UML for software design and be introduced to design patterns and code refactoring. Students will have to design software using an OOP language of choice as a mini project to demonstrate their understanding of OOP concepts learned in this course.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Deitel, H. M. & Deitel P. J. 2016. C: How to Program, Global Edition. Prentice-Hall.

**Booch, G., Rumbaugh, J., & Jacobson, I., 2005. The Unified Modeling Language User Guide, 2nd Edition. Addison-Wesley.*

*Gamma, E., Helm, R., Johnson, R., & Vlissides, J. 2002. Design Patterns: Elements of Reusable Object Oriented Software. Addison-Wesley.
*Sommerville, I. 2015. Software Engineering. 10th Edition. Addison-Wesley.
*Pressman, R. S. 2014, Software Engineering, A Practitioner's Approach. 8th Edition, McGraw Hill.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	*Kebolehan menggunakan bahasa pengaturcaraan berasaskan objek;* *Ability to use object oriented programming languages.;*
2	Kebolehan menggunakan konsep-konsep pengaturcaraan berasaskan objek untuk merekabentuk perisian; *Ability to use object oriented programming concepts to design software;*
3	Kebolehan menggunakan Bahasa Pemodelan Bersatu di dalam rekabentuk perisian berorientasikan objek; *Ability to use the Unified Modelling Language in the design of object-oriented software;*
4	Kebolehan menghasilkan perisian menggunakan konsep-konsep pengaturcaraan berasaskan objek. *Ability to produce software using object oriented programming concepts.*

KKEC3113 Sistem Terbenam
Embedded Systems

Kursus ini adalah sambungan kepada kursus Mikropemproses Tahun 3. Kursus ini menggunakan senibina ARM yang merupakan asas banyak sistem terbenam moden. Kursus ini memperkenalkan pengturcaraan sistem terbenam menggunakan sistem pengoperasian masa nyata terbenam (RTOS) bagi memanfaati ciri- ciri lanjut sistem tersebut. Keupayaan berbilang bebenang sebuah RTOS akan diperkenalkan pada separuh pertama kursus dari segi penjadualan dan penyegerakan bebenang. Pada separuh kedua kursus, pelajar akan diperkenalkan bagaimana sebuah RTOS menguruskan ingatan, fail serta masukan/keluaran. Di akhir kursus, pelajar akan menggunakan teori yang dipelajari bagi melaksanakan satu penyelesaian sistem terbenam menggunakan senibina ARM.

This course is a continuation of the microprocessor course in Year 3. This course will use the ARM architecture which is the basis of many modern embedded systems. This course introduces embedded systems programming with the use of a real time embedded operating system (RTOS) to leverage advanced features of these systems. The multithreading capabilities of an RTOS will be introduced

in the first half of the course in terms of thread scheduling and synchronistion. In the second half of the course, students will be introduced to how an RTOS manages memory and files as well as input/output. At the end of the course, students will use the theory learnt to implement an embedded system solution using the ARM architecture.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Wang K.C. 2017. Embedded and Real-Time Operating Systems. Springer.

**Valvano J.W. 2012. Embedded Systems: Real-Time Operating Systems for ARM® Cortex™-M Microcontrollers. 2nd Edition. CreateSpace.*

**Yiu J. 2013. The Definitive Guide to the ARM Cortex-M3 and Cortex-M4 Processors. 3rd Edition, Newnes.*

Silberschatz A. et al., 2018. Operating System Concepts. 10th Edition. Addison Wesley, USA.

Stallings W., 2018. Operating Systems: Internals and Design Principles. 9th Edition. Prentice Hall, USA.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menggunakan keupayaan berbilang bebenang sebuah sistem pengoperasian masa nyata terbenam; *Ability to use the multithreading capabilities of a real time embedded operating system;*
2	Berkebolehan melaksanakan pengurusan ingatan dan fail menggunakan sistem pengoperasian masa nyata terbenam; *Ability to perform memory and file management using a real time embedded operating system;*
3	Berkebolehan melaksanakan pengurusan masukan/keluaran menggunakan sistem pengoperasian masa nyata terbenam; *Ability to perform input/output management using a real time embedded operating system;*
4	Kebolehan melaksanakan satu penyelesaian sistem terbenam menggunakan sistem pengoperasian masa nyata terbenam. *Ability to implement an embedded system solution using of a real time embedded operating system.*

KKEM3103 Teknologi Pembuatan Litar Bersepadu
Integrated Circuit Manufacturing Technology

Matlamat kursus ini ialah memberikan pengetahuan dan kefahaman konsep dalam proses-proses fabrikasi peranti semikonduktor dan litar bersepadu. Topik-topik yang diliputi adalah penggunaan bilik-bersih, proses-proses fotolitografi, punaran, oksidasi, difusi, pembenaman ion, deposit filem-nipis, pelogaman, perwayaran dan pempakejan litar bersepadu.

The aims of this course are to provide knowledge and comprehension on the chronological fabrication processes of semiconductor devices, mainly integrated circuits. Topics covered are cleanroom facility, photolitography, etching, oxidation, diffusion, ion-implantation, thin-film deposition, metallization, interconnects, and IC packaging.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Jaeger, R. C. 2002. Introduction to Microelectronic Fabrication. Prentice Hall.*

**Campbell, S. A. 2012. Fabrication Engineering at the Micro- and Nanoscale. Oxford University Press.*

**Zant, P. V. 2014. Microchip Fabrication: A Practical Guide to Semiconductor Processing, 6th edition. McGraw-Hill Education.*

Geng. H, 2017. Semiconductor Manufacturing Handbook, 2nd Edition. McGraw-Hill Education.

Plummer, J. D. 2020. Silicon VLSI Technology: Fundamentals, Practice, and Modeling. Pearson.

Swaminathan, P. 2017. Semiconductor Materials, Devices and Fabrication. Wiley India.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus/** ***Course Outcomes (CO)***
1	Berkebolehan menerangkan ciri-ciri bahan semikondukor dan kepentingannya dalam proses fabrikasi; konsep bilik-bersih; pencemaran dan kontaminasi; aspek keselamatan dan protokol. *Ability to explain the characteristics of semiconductor materials and its importance in fabrication processes; cleanroom facility; pollution and contaminant; safety aspect and protocol.*
2	Berkebolehan menghubungkaitkan proses-proses fabrikasi; dan mengenal pasti dan menilai proses/ peralatan yang sesuai bagi fabrikasi peranti semikonduktor. *Ability to inter-relate the fabrication processes; and to identify and evaluate suitable processes/ instruments for the fabrication of semiconductor devices.*
3	Berkebolehan merekabentuk carta aliran proses bagi fabrikasi peranti semikonduktor peranti seperti diod PN dan transistor CMOS. *Ability to design a process flow for the fabrication of semiconductor devices such as PN junction diodes and CMOS transistors.*
4	Berkebolehan untuk memodelkan proses-proses fabrikasi peranti semikonduktor dengan menggunakan perisian komputer. *Ability to model the fabrication processes of semiconductor devices using computer software.*

KKET3103 Komunikasi Data dan Rangkaian Komputer
Data Communication and Computer Networks

Kursus ini mengambilkira rangkaian komunikasi komputer yang berstruktur lapisan. Ia meliputi senibina, protokol dan model komunikasi yang digunakan dalam Model Rujukan OSI. Masalah kawalan aliran dan ralat dan penyelesaiannya dibincangkan. Skim kawalan capaian medium (MAC) dan kawalan pautan data (DLC) diperkenalkan. Skim pencegahan perlanggaran MAC tanpa wayar juga turut dipersembahkan. Kemudian, teknik pensuisan litar & paket (litar maya & datagram) dibincangkan dengan algoritma penghalaan (laluan singkat). Setelah mengambil kursus ini, pelajar akan berupaya untuk merekabentuk rangkaian setempat (LAN) sendiri dan hubungan dengan LAN yang lain melalui rangkaian luas (WAN). Pelajar juga akan memahami tentang operasi protokol ini yang luas penggunaannya dalam penyediaan hubungan Internet dan Intranet.

This course considers computer communication network and structural layers. It covers communication models, architecture and protocols which are considered in OSI Reference Model. Flow and error control problems and their solutions are then discussed. Medium access control (MAC) and Data Link Control (DLC) schemes are introduced. Wireless MAC collision prevention schemes are also presented. Then, circuit & packet (virtual circuit & datagram) switching

techniques are discussed with routing algorithms (shortest path). After completing this course, the student will be able to design a Local Area Network (LAN) and connection of LAN with wide area network (WAN). The students will also be able to understand the operational protocol with usage of Internet and Intranet.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Ibe, O. 2017. Fundamentals of Data Communication Networks. 1st Edition. Wiley.

Comer, D. 2018. Computer Networks and Internets. 6th Edition. Pearson.

Kurose, J.F. & Ross, K.W. 2017. Computer Networking: A Top-down Approach. 7th Edition. Pearson.

**Stallings, W. 2014. Data and Computer Communications. 10th Edition. Prentice Hall (versi terkini).*

**Forouzan, B.A. 2012. Data Communications and Networking. 5th Edition. McGraw Hill (versi terkini).*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Kebolehan dalam menganalisa teknik-teknik asas komunikasi data, kekangan dan kelebihannya; *Ability to analyse the main data communication techniques, their limitations and advantages;*
2	Kebolehan dalam menganalisa prestasi penggunaan talian komunikasi dan mekanisma kawalan ralat; *Ability to analyse the performance of a communication link and error control mechanisms;*
3	Kebolehan dalam membincangkan teori-teori dalam sistem pensuisan asas dan topologi rangkaian; *Ability to discuss the theories in main switching systems and network topologies;*
4	Kebolehan menerangkan kemajuan rangkaian dan kekangannya. *Ability to explain the network progress and its constraint.*

KKET3113 Kejuruteraan Gelombang Mikro
Microwave Engineering

Merupakan kursus lanjutan selepas kursus Medan dan GelombangElektromagnet yang memberi penekanan kepada perambatan gelombang dan medium penghantaran. Kursus dimulai dengan perambatan gelombang satah, penghantaran dan pemantulan gelombang dalam pelbagai media. Seterusnya, konsep medium penghantaran terpandu akan diperkenalkan di mana dua jenis utama medium terpandu akan diperhalusi iaitu talian penghantaran jalur mikro dan pandu gelombang. Selepas itu, pelajar akan diperkenalkan dengan analisa rangkaian gelombang mikro dalam mengkaji prestai sistem gelombang mikro. Akhirnya, konsep pemadanan galangan akan diperkenalkan di mana teknik-teknik pemadanan akan digunakan bersama-sama Carta Smith. Objektif utama kursus ini adalah untuk memperkenalkan pelajar kepada unsur-unsur penting dalam bidang kejuruteraan mikro gelombang seperti fenomena perambatan gelombang, talian penghantaran dan aplikasi gelombang mikro dalam kejuruteraan.

This course is the extension of Electromagnetic Field and Waves which gives emphasis on wave propagation and transmission medium. The course begins with plane wave propagation, waves transmission and reflection in various media. Then, guided transmission media will be introduced where the focus is on two main types of guided media: microstrip transmission line and waveguide. Futhermore, microwave network analysis will be introduced for evaluating performance of mirowave system. This course will be ended by by the introduction of impedane matching techiques together with Smith Chart. The main objective is to introduce the students to the important elements in electromagnetic waves concepts e.g. waves propagation phenomena, transmission medium concept and the application of microwaves in engineering.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Matthew, N.O. Sadiku. 2018. Element of Electromagnetic. 7/e. Oxford University Press.
Chaturvedi, P. K. 2018. Microwave, Radar & RF Engineering: with Laboratory Manual. 1/e. Springer.

Hayt, W. 2018. Engineering Electromagnetics. 9/e, McGraw-Hill.
**Pozar, D. M. 2011. Microwave Engineering. 4/e. Addison-Wesley.*
**Khan, A.S., 2014, Microwave Engineering: Concepts and Fundamentals. 1/e, CRC Press.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menyelesaikan masalah-masalah kejuruteraan dengan mengaplikasikan prinsip-prinsip gelombang elektromagnet; *Ability to solve related engineering problems by applying the electromagnetic waves principles;*
2	Berkebolehan merekabentuk talian penghantaran sepadan menggunakan teknik pemadanan dan menerangkan prestasi rekabentuk tersebut; *Ability to design a matched transmission line using impedance matching techniques and to explain the performance of the design;*
3	Berkebolehan menganalisis dan mengkategorikan pandu gelombang elektromagnet berdasarkan parameter gelombang; *Ability to analyse and categorize the electromagnetic waveguide based on its parameters;*
4	Berkebolehan menilai secara teori dan amali prestasi sistem rangkaian gelombang mikro. *Ability to evaluate theoretically and experimentally the performance of microwave network system in various applications.*

KKEE4142 Projek Ilmiah l
Final Year Project l

Satu kajian ilmiah yang berkaitan dengan bidang kajian/pengkhususan di Jabatan Kejuruteraan Elektrik, Elektronik dan Sistem yang mesti disediakan oleh setiap pelajar tahun akhir sebagai memenuhi syarat bagi penganugerahan Ijazah Sarjanana Muda Kejuruteraan. Projek ini berbentuk penyelidikan yang merangkumi penganalisian data, pembangunan perisian atau perkakasan. Setiap pelajar dikehendaki menyediakan satu laporan lengkap yang sekurang-kurangnya mengandungi pengenalan, objektif kajian, kajian kepustakaan, metodologi kajian, jadual kerja dan senarai rujukan. Pelajar juga perlu menunjukkan keputusan awal penyelidikan. Projek ini akan diteruskan dalam kursus KKEE4154 pada semester berikutnya.

An academic research that related to research field/ specialisation at Department of Electrical, Electronic and Systems Engineering that must be prepared by all final year students as to fulfil the requirements for bachelor degree of engineering awarded. This project is a type of research that involves data analysis, software

or hardware development. Each student are expected to prepare a complete report that at least contains introduction, objectives, literature review, research methodology, project schedule planning and references. The students also are required to attach the research preliminary status. This project will be continued in KKEE4154 in the subsequent semester.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Patten, M. L., Newhart, M. 2017. Understanding Research Methods. Routledge.

Terrell, S. R. 2016. Writing a Proposal for Your Dissertation. Guidelines and Examples. The Guilford Press.

Pusat Pengurusan Siswazah. 2016. Panduan Penulisan Tesis Gaya UKM. Edisi semak ketiga. Penerbit UKM.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	*Berkebolehan menentukan pengetahuan dan kemahiran kejuruteraan yang bersesuaian dalam menangani suatu masalah kejuruteraan yang signifikan;* *Ability to identify suitable engineering knowledge and skills in handling any significant engineering problem;*
2	Berkebolehan mengamalkan pengetahuan, kemahiran dan sikap jurutera profesional; *Ability to practice the knowledge, skills and attitudes of a professional engineer;*
3	Berkebolehan menerangkan hasil kerja/kertas kerja penyelidikan terdahulu yang berkaitan dengan projek; *Ability to describe previous research work/proposal related to project;*
4	*Berkebolehan merekabentuk penyelesaian yang sesuai untuk sesuatu masalah kejuruteraan; Ability to identify solutions suitable for any certain engineering problem;*
5	Berkebolehan menyusun aktiviti projek dengan menyeluruh. *Ability to organize project activities comprehensively.*

KKEE4113 Elektronik Kuasa
Power Electronics

Matlamat kursus ini ialah untuk memberikan pengetahuan, kefahaman dan kemahiran asas sistem elektronik kuasa. Antara isi kandungan kursus ialah pengenalan sistem elektronik kuasa, teknologi, aplikasi dan isu-isu semasa yang berkaitan. Ciri-ciri, penggunaan dan kawalan peranti kuasa dibincangkan. Litar penukar kuasa seperti litar penerus satu dan tiga fasa, litar pemotong serta litar penyongsang satu dan tiga fasa dipelajari. Teknik pensuisan modulasi lebar denyut (PWM) juga akan diperkenalkan. Pemodelan litar elektronik kuasa menggunakan perisian MATLAB Simulink atau Pspice dilakukan. Latihan amali di makmal atau projek mini turut dilaksanakan.

The objective of this course is to give knowledge, comprehension and basic skills of power electronics system. The contents of the course include the introduction to power electronic systems, technology, application, and related current issues. The power devices characteristics, usage and control is discussed. Power converter circuits such as single and three phase rectifiers, choppers and inverters are studied. Pulse width modulation (PWM) switching technique, is also introduced. Power electronics circuit modelling using MATLAB Simulink or Pspice softwares is carried out. A practical experiment in the laboratory or mini project will also be conducted.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Muhammad, H. R. 2018. Power Electronics: Devices, Circuits, and Applications, International Edition. 4th Edition. Pearson Education Limited.

Muhammad, H. R. 2017. Power Electronics Handbook. Elsevier.

Batarseh, I. and Harb, A. 2017. Power Electronics: Circuit Analysis and Design. Elsevier.

**Mohan, N., Undeland, T. M. & Robbins, W. P. 2003. Power Electronics Converters, Applications and Designs. 3rd Edition. John Wiley & Sons, Inc* (versi terkini).

**Hart, D. W. 2011. Power Electronics. McGraw-Hill* (versi terkini).

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan memahami sistem elektronik kuasa dan teknologinya; *Ability to comprehend power electronics and its application;*
2	Berkebolehan mengaplikasi dan mengoperasikan litar-litar penukar kuasa; *Ability to apply and operate power converter circuits;*
3	Berkebolehan mempraktik dan melaksanakan projek makmal berasaskan litar-litar penukar kuasa; *Ability to practice and perform a laboratory project based on power converter circuits;*
4	Berkebolehan memodel dan menyelaku litar penukar kuasa menggunakan alatan komputer; *Ability to model and simulate power converter circuits using computer tool.*

KKEE4103 Mesin Elektrik, Pemacu dan Aplikasi
Electrical Machine, Drives and Application

Kursus ini memberikan pengetahuan dan kefahaman asas mesin elektrik, pemacuan dan aplikasi masing-masing. Mesin AT(motor AT dan penjana AT) membincangkan tentang konsep teori, binaan, prinsip operasian, penukartertiban, pengkelasan, pencirian, litar setara, aliran kuasa, kecekapan dan aplikasi. Manakala Mesin AU (motor aruhan dan motor segerak tiga fasa) pula menerangkan tentang konsep teori, binaan, prinsip operasian, pencirian, litar setara, aliran kuasa, kecekapan dan aplikasi. Pemacuan motor AT dan motorAU pula memperkenalkan tentang konsep teori, rekebentuk litar penukar kuasa, persamaan dinamik, daya kilas dan laju boleh laras dan kaedah kawalan. Kursus ini turut menitikberatkan ujikaji amali secara berpasukan di makmal, di mana pemacuan ringkas motor elektrik direkabentuk, dibina dan diujinilai.

This course delivers knowledge and comprehension on electrical machines fundamental as well as their respective drives and application. DC Machine (DC motor and generator) discusses about theoretical concept, construction, operational principles, commutation, classification, characteristic, equivalent circuit, power flow, efficiency and application. AC Motor (three phase induction and synchronous motors) explains about theoretical concept, construction, operational principles, characteristics, equivalent circuit, power flow, efficiency and application. Furthermore, the DC motor and AC motor drives introduce theoretical concept, power converter circuits design, dynamic equations, adjustable speed and torque, and control method. This course also highlighted a

teamwork practical experiment where a simple drive system of electrical motor is designed, developed and validated.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Ramamoorty, M. & Sekhar, O. C. 2018. Electrical Machines, Eastern Economy Edition. PHI Learning Private Limited.

Gieras, J. F. 2016. Electrical Machines: Fundamentals of Electromechanical Energy Conversion. International Standard Book, CRC Press.

Hughes, A. & Drury, B. 2019. Electric Motors and Drives: Fundamentals, Types and Applications, 5th Edition. Newnes, Elsevier Ltd.

Ryan, W.T. 2016. Design of Electrical Machinery: A Manual for the Use, Primarily, of Students in Electrical Engineering Courses. Bibliolife DBA of Bibilio Bazaar II LLC.

El-Sharkawi, M. A. 2018. Fundamentals of Electric Drives (2nd Edition). Cengage Learning.

**Wildi, T. 2005. Electrical Machines, Drives and Power Systems (6th Edition). Pearson.*

**Fitzgerald, A. E., Kingsley C. J. and Umans, S. D. 2005. Electric Machinery (6th Edition). McGraw-Hill.*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menerangkan konsep teori, prinsip operasian, binaan dan aplikasi mesin elektrik; *Ability to explain the theoretical concept, operational principles, construction and applications of electric machines;*
2	Berkebolehan memodel, menyelaku dan menganalisa mesin elektrik/sistem pemacu menggunakan alatan komputer dan melalui ujikaji makmal; *Ability to model, simulate and analyse electric machine/drive system using computer tool and via laboratory experiment;*

3	Berkebolehan untuk mentafsirkan litar setara mesin elektrik, serta memahami teknologi mesin elektrik terkini; *Ability to interpret the equivalent circuits for electric machines, as well as understanding the recent electric machine technology;*
4	Berkebolehan untuk mengaplikasi dan merekabentuk teknik pemacuan elektrik motor AU atau motor AT; *Ability to apply and design the DC or AC motor electric drive technique.*

KKEC4103 Rekabentuk Sistem Kawalan
Control System Design

Matlamat kursus ini ialah memberikan pengetahuan dan kefahaman dalam merekabentuk sistem kawalan. Ia merupakan lanjutan kepada kursus sistem kawalan yang memberi penekanan terhadap teknik-teknik rekabentuk sistem kawalan moden, kawalan klasik dan rekabentuk sistem kawalan lasak. Turut diajar dalam kursus adalah kaedah rekabentuk sistem kawalan berbantu komputer dengan memanfaatkan alat perisianseperti MATLAB dengan Simulink dan Kotak Alatan Sistem Kawalan.

The objective of this course is to give knowledge and understanding in designing a control system. It is an extension of control system course that emphasizes on the design of modern control system techniques, classical control and the design of robust control system. Design technique with computer assisted control system will also be taught in the course, with the help of commercial software tool like MATLAB with Simulink and Control System Toolbox.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

* *Nise, N. S. 2019. Control Systems Engineering. 8th Edition. John Wiley & Sons Inc.*
* *Dorf, R. C. & Bishop, R. H. 2016. Modern Control Systems. 13th Edition. Pearson Education.*
* *Clark, R. N. 2015. Control Systems Dynamics. Cambridge University Press.*
* *Ogata, K. 2012. Modern Control Engineering. 5th Edition. Pearson Education* (versi terkini).

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkeupayaan menerangkan struktur serta teknik-teknik rekabentuk sistem kawalan secara berkumpulan. *Ability to describe the structure and techniques to design a control system in a group.*
2	Berkeupayaan mentafsir spesifikasi rekabentuk dan memanipulasi strategi sistem kawalan berasaskan objektif kawalan dalam domain masa dan frekuensi. *Ability to interpret design specifications and manipulate the control system strategy based on the control objectives in time domain and frequency domain.*
3	Berkeupayaan menilai dan mewajarkan sistem kawalan yang telah dibangunkan. *Ability to evaluate and justify the developed control system.*
4	Berkeupayaan merekabentuk suatu sistem kawalan lasak. *Ability to design a robust control system.*

KKEC4113 Pemprosesan Imej Digital
Digital Image Processing

Kursus ini memberikan pengenalan kepada konsep asas, metodologi dan algoritma pemprosesan imej digital yang memberi tumpuan kepada dua masalah berikut yang berkaitan dengan imej digital: (1) peningkatan imej dan pemulihan untuk penafsiran gambar yang lebih mudah, dan (2) analisis imej dan pengenalan objek . Beberapa teknik pemprosesan imej terkehadapan (contoh, Wavelet dan pemprosesan multiresolusi) juga akan dipelajari dalam kursus ini. Matlamat utama kursus ini adalah meletakkan asas yang kukuh untuk pelajar mengkaji topik analisis imej terkehadapan seperti sistem penglihatan komputer, analisis imej biomedikal, dan pemprosesan & retrival multimedia.

This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing focusing on the following two major problems concerned with digital images: (1) image enhancement and restoration for easier interpretation of images, and (2) image analysis and object recognition. Some advanced image processing techniques (e.g., wavelet and multiresolution processing) will also be studied in this course. The primary goal of this course is to lay a solid foundation for students to study advanced image analysis topics such as computer vision systems, biomedical image analysis, and multimedia processing & retrieval.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Rafael, C. G., Richard, E. W. 2018. Digital Image Processing. 4th Edition, Pearson

**Mark N. 2015. Feature Extraction and Image Processing for Computer Vision. 3rd Edition, Wiley*

**Wilhelm B., Mark J. B. 2011. Principles of Digital Image Processing: Core Algorithms (Undergraduate Topics in Computer Science). 2nd Edition, Springer*

**Ravishankar, C. S. 2014. Image Processing and Acquisition using Python. 1st Edition, CRC PRESS*

**John, R. J. 2015. Introductory Digital Image Processing: A Remote Sensing Perspective. 4th Edition, Pearson*

**John, C. R., Brent Neal, F. 2015. The Image Processing Handbook. 7th Edition, CRC PRESS*

Stan, B. 2017. Image Processing and Analysis. 1st Edition, Cengage Learning

Kendall, T. 2016. Image Processing with MATLAB. 1st Edition, Pearson

Ashwin, P. 2017. Raspberry Pi Image Processing Programming: Develop Real-Life Examples with Python, Pillow, and SciPy. 1st Edition. APress.

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menghuraikan dan menerangkan prinsip asas pemprosesan imej digital; *Ability to describe and explain basic principles of digital image processing;*
2	Berkebolehan mereka bentuk dan melaksanakan algoritma yang melaksanakan pemprosesan imej asas (contoh, penghapusan bunyi dan peningkatan imej); *Able to design and implement algorithms that perform basic image processing (e.g., noise removal and image enhancement);*
3	Berkebolehan mereka bentuk dan melaksanakan algoritma untuk analisis imej terkehadapan (contoh, pemampatan imej, segmen imej & perwakilan imej); *Ability to design and implement algorithms for advanced image analysis (e.g., image compression, image segmentation & image representation);*
4	Berkebolehan menilai prestasi algoritma dan sistem pemprosesan imej. *Able to assess the performance of image processing algorithms.*

KKEM4103 Rekabentuk VLSI
VLSI Design

Kursus ini bertujuan untuk menerangkan asas dan kaedah merekabentuk litar bersepadu VLSI (Very Large Scale Integration). Kursus ini memberi tumpuan khusus kepada rekabentuk digit di samping menyentuh litar analog. Kuliah akan bertumpu kepada analisa sistematik dan asas rekabentuk litar bersepadu.Pelajar juga akan didedahkan kepada kemahiran perisian komputer yang berkaitan dengan rekabentuk VLSI yang mana pada masa yang sama akan meningkatkan kreativiti yang diperlukan untuk diaplikasikan di dalam bidang Kejuruteraan Elektronik.

The aim of this course is to provide some background and useful methods in designing VLSI (Very Large Scale Integration) integrated circuits. This course will give more emphasis on the digital design with some exposure on analog design. Teaching will focus on the systematic analysis and design of basic integrated circuits. Students will also be exposed to computer skills related toVLSI design which will simultaneously assist them in increasing the creative skills needed to be applied in the field of Electronic Engineering.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic. 2016. Digital Integrated Circuits: A Design Perspective. 2nd edition, Pearson Education India.

**Wayne Wolf. 2015. Modern VLSI Design. 4th edition, Pearson Education India.*

Behzad Razavi. 2016. Design of Analog CMOS Integrated Circuits. 2nd edition, McGraw Hill Education.

**Sung-Mo Kang, Yusuf Leblebici, Chulwoo Kim. 2014. CMOS Digital Integrated Circuits Analysis & Design. 4th edition, McGraw-Hill Education.*

**Neil H.E. Weste, David Harris. 2010. CMOS VLSI Design: A Circuits and Systems Perspective. 4th Edition. USA: Pearson Education.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menunjukkan litar VLSI menggunakan perisian EDA; *Ability to display VLSI circuits using EDA tools;*
2	Berkebolehan untuk mereka bentuk litar VLSI untuk menyelesaikan masalah kejuruteraan; *Ability to design VLSI circuits to solve engineering problems;*
3	Berkebolehan untuk mengenalpasti dan menganalisa masalah/kekangan di dalam litar; *Ability to identify and analyze problems/disturbance in circuits.*
4	Berkebolehan untuk mengintegrasi teknik pengoptimuman litar untuk mencapai objektif tertentu. *Ability to integrate circuit optimization techniques to achieve the required objectives.*

KKEM4113 Teknologi Peranti Termaju
Advanced Devices Technology

Matlamat kursus ini adalah untuk memperkenalkan kepada para pelajar elemen-elemen asas teknologi peranti termaju. Tajuk-tajuk yang dibincangkan adalah kesan elektron panas, peranti gelombang mikro, peranti-peranti frekuensi tinggi, dan lain-lain. Selain itu, teknologi MOSFET submikron, peranti masa transit, peranti paparan, CCD, dan peranti cas magnetik turut dibincangkan.

The aim of this course is to introduce to the students the basic elements of advanced devices technology. The topics covered are hot electron effects, microwave devices, high frequency devices, etc. In addition, technologies on submicron MOSFETs, transit time devices, display devices, CCD, and magnetic charged devices are also discussed.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Grundmann M. 2016. The Physics of Semiconductors: An Introduction Including Nanophysics and Applications. 3rd edition. Springer.
Bolívar N. 2017. Modern Semiconductor Device Physics. Arcler Press.
**Sze S.M. 2015. Semiconductor Devices: Physics And Technology. 2nd edition. Wiley India.*

Rudan, M. 2017. Physics of Semiconductor Devices. 2nd edition. Springer.
**Neamen, D. 2011. Semiconductor Physics And Devices. 4th edition. McGraw-Hill.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menjelaskan prinsip asas peranti semikonduktor termaju serta penyelesaian analitik dan hadnya; *Ability to explain the basic principles of advanced semiconductor devices as well as analytical solutions and the limitation;*
2	Berkebolehan untuk menerangkan kesan sifat bahan dan suhu ke atas prestasi peranti; *Ability to describe the effect of temperature on material properties and devices performance;*
3	Berkebolehan untuk mengenalpasti teori asas semikonduktor dengan penekanan kepada angkutan pembawa dan kelincahan elektron dalam pelbagai aplikasi; Ability identify basic theory of semiconductors with emphasis on carrier transport and mobility of electrons in numerous applications;
4	Berkebolehan untuk memberi pendapat tentang penyelidikan terkini dalam teknologi peranti termaju. *Ability to give own opinion on the latest research in advanced device technologies.*

KKEM4123 Keboleharapan dan Pencirian Litar Bersepadu
Relibility and Characterization of Integrated Circuit

Matlamat kursus ini ialah memberikan pengetahuan, kefahaman dan konsep dalam bidang kejuruteraan keboleharapan dan peranti litar bersepadu. Kursus ini merupakan kursus pengenalan kepada konsep keboleharapan dan pengenalan kepada kaedah pencirian litar bersepadu. Pelajar-pelajar mengaplikasi ilmu matematik dan kejuruteraan terutama dalam bidang kebarangkalian dan statistik. Mereka juga dikehendaki merekabentuk satu sistem, menggunakan komponen atau proses dengan mengambilkira konsep keboleharapan, seterusnya melakukan kerja, menulis laporan dalam kumpulan. Dengan ini juga mereka dapat memahami, mengecam, serta menyelesaikan masalah berkaitan dengan keboleharapan serta pencirian litar bersepadu. Membuat lawatan industry sekurang-kurangnya 3 jam untuk meninjau amalan di dalam industri.

The aim of this course is to give knowledge, understanding and concept in the field of reliability and integrated circuit characterization. This course is an introductory course to the concept of reliability and characterization method in integrated circuit. Students are to apply mathematics and engineering knowledge especially in the area of probability and statistics. Students should

be able to translate the given data using statistics. They are also required to design a system using component or process with the inclusion of reliability concept and then analyze the design and write group report. With this, they should be able to understand, identify and solve problems related to the reliability and integrated circuit characterization. This course will also include at least 3 hours of industrial visit to observe the practice in industry.

Pra-Keperluan (*jika ada*): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Modarres, M.; Kaminskiy, M. and Krivtsov, V. 2016. Reliability and Risk Analysis – A Practical Guide. 3/e, CRC Press.
**Enrico Zio. 2007. An Introduction to the basics of Reliability and Risk Analysis. World Scientific Publishing.*
**Ebeling, C. E. 2009. Reliability and Maintainability Engineering. Mc Graw Hill.*
**Stark,H. and Woods, J. W. 2002. Probability, Random Processes and Estimation Theory for Engineers. Third Edition. Prentice Hall.*
Rykov, V.. 2016. Reliability of Engineering Systems and Technological Risk. ISTE.
**Tortorella, M. 2015. Reliability, Maintainability, and Supportability: Best Practices for Systems Engineers. 1/e, Wiley-Blackwell.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk memahami konsep kualiti, keboleharapan dan keselamatan dalam industri; *Ability to identify the concept of quality, reliability and safety in industry.*
2	Berkebolehan memahami konsep kadar kegagalan tetap bagi model komponen / sistem; *Ability to explain the concept of fixed failure rate model of a component / system;*
3	Berkebolehan mengenalpasti system dengan keboleharapan tinggi dan berkeboleharapan rendah; *Ability to identify a system with high and low reliabilities;*
4	Berkebolehan untuk melakukan kerja penyiasatan secara bersepadu bagi mengenapasti punca kegagalan; iaitu dengan kaedah analisis berkesan mod kegagalan (FMEA) dan analisis pokok kegagalan (FTA). *Ability to construct integrated investigation work to identify the source of failure i.e. with failure mode effective analysis method (FMEA) and failure tree analysis (FTA).*

KKEM4133 Teknologi Fotonik
Photonics Technology

Matlamat kursus ini ialah untuk menyampaikan pengetahuan tentang penggunaan teknologi fotonik dalam berbagai bidang terutamanya komunikasi gentian optik (analog dan digital), sistem penghantaran dan penerimaan isyarat optik, pemprosesan isyarat, industri berkaitan fotonik, pengukuran dan penderiaan berdasarkan prinsip-prinsip optik geometri, sinar, gelombang dan optik kuantum. Pengenalan kepada teknologi laser dan juga peranti seperti diod pengesan cahaya, pengganding optik, pemodulat optik dan sebagainya juga diterapkan. Selain itu, proses fabrikasi peranti-peranti tersebut berdasarkan gentian dan teknologi planar juga disentuh. Pelajar juga akan didedahkan tentang pengendalian peralatan optik seperti OTDR, mesin penyambat gentian optik, penganalisis spektrum optik (OSA) dan sebagainya yang terdapat di Makmal Teknologi Fotonik UKM.

The aim of this course is to convey knowledge about the use of photonics technology in various fields especially optical fiber communications (analog and digital), optical transmitter and receiver systems, signal processing, photonic industry, measurement and sensing system based on principles of geometric optics, light, wave and quantum optics. An introduction on laser technology and optical devices such as photodiode, optical coupler, optical modulator etc is also included. In addition, the fabrication process of these devices based on fiber and planar technologies is also discussed. The students are also exposed to the handling of optical equipment that are provided at the UKM Photonic Laboratory such as OTDR, optical splicer machine, optical spectrum analyzer (OSA) etc.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Saleh, B.E.A. & Teich, M.C. 2019. Fundamentals of Photonics. 3/e. Wiley
Eugene H. 2016. Optics. 5/e. Addison-Wesley
Reider, G. A. 2016. Photonics. Springer.
**Keiser, G. 2014. Optical Fiber Communications. 5/e. Mc Graw Hill Education.*
**Kasap, S. O. 2013. Optoelectronics & Photonics: Principles & Practices. 2/e. Prentice Hall.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menganalisis komponen dan sistem optik berdasarkan pengetahuan teknologi fotonik; *Ability to analyze component and optical system based on photonic technology knowledge;*
2	Berkebolehan mengaplikasi ilmu dan memasang peralatan dan komponen untuk ujikaji yang berkaitan dengan teknologi fotonik; *Ability to apply knowledge and assemble equipment and components for experiment related to photonic technology;*
3	Berkebolehan merekabentuk dan menyelesaikan masalah yang berkaitan dengan teknologi fotonik masa kini; *Ability to design and solve problems associated with the current photonics technology;*
4	Berkebolehan mencadangkan penyelesaian masalah yang berkaitan bidang teknologi fotonik. *Ability to propose solution for problems in areas related to photonics technology.*

KKET4103 Antena dan Litar Berfrekuensi Tinggi
Antenna and High Frequency Circuits

Matlamat kursus ini ialah untuk memberikan pengetahuan, kefahaman dan kebolehan kepada pelajar untuk merekabentuk antenna dan litar-litar berfrekuensi tinggi. Bahagian pertama kursus ini memberi penekanan terhadap konsep asas dan teori antena, diikuti dengan rekabentuk antena dan aplikasi dalam bidang telekomunikasi. Pakej perisian terbantu komputer seperti CST, IE3D, Sonnet atau HFSS diperkenalkan bagi membantu pelajar merekabentuk antena dan juga litar-litar berfrekuensi tinggi. Pelajar juga akan didedahkan kepada penggunaan alatan pengukuran peranti RF dan gelombang mikro seperti penjana isyarat, penganalisa isyarat, meter kuasa dan penganalisa rangkaian untuk tujuan pengujian litar. Bahagian kedua kursus ini memberikan penekanan terhadap rekabentuk dan analisa peranti RF lain seperti rekabentuk penuras RF serta beberapa litar RF lain.

The aim of this course is to import knowledge, understanding and ability of the student to design antenna and high frequency circuits. First part of this course focuses on the basic concept and theory of antenna, followed by the antenna design and applications in telecommunication field. Computer-aided software package such as CST, IE3D, Sonnet or HFSS will be introduced to help students to design antenna and other high frequency circuits. Students are also introduced with the basic RF and microwave circuits measurement tools such as signal generator, signal analyser, power meter and network analyser circuit for testing purposes. The second part of this course focuses on the design and analysis of other RF circuits such as filter design as well as some other RF circuits.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Balanis, C. A. 2016. Antenna Theory: Analysis and Design. 4/e. Wiley-Interscience.
**Grebennikov A. 2015. RF and Microwave Power Amplifier Design. 2/e. McGraw-Hill.*
Chaturvedi, P.K. 2018. Microwave, Radar & RF Engineering. 1/e, Springer.
Boris, L. 2017. Antenna Engineering: Theory and Problems. CRC Press
**Pozar, D. M. 2011. Microwave Engineering. 4/e. Addison-Wesley.*
**Yikai C., & Chao-Fu W. 2015. Characteristic Modes: Theory and Applications in Antenna Engineering. 1/e, Wiley*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk mengenalpasti dan menganalisa berbagai jenis komponen litar RF dan memahami spesifikasi elektrik litar; *Ability to identify and analyse various components of the RF circuit and understanding the electrical specifications of the circuit;*
2	Berkebolehan untuk merekabentuk berbagai jenis komponen litar RF serta menyelesaikan masalah berkaitan dengan rekabentuk; *Ability to design various component of the RF circuit, and solving problems related to the design;*
3	Berkebolehan untuk menggunakan pakej perisian terbantukan komputer untuk merekabentuk antena dan litar HF dan menggunakan alatan pengukuran RF dan gelombang mikro untuk pengujian litar; *Ability to use software computer-aided package for design of HF antennas and circuits, and uses RF and microwave measurement devices for circuit testing;*
4	Berkebolehan untuk menilai prestasi parameter antena dan litar RF bagi sesuatu keadaan khusus yang diberikan; *Ability to evaluate the performance of the antenna and RF circuits parameters for a specific given environment;*

KKET4113 Rangkaian dan Keselamatan
Network and Security

Kursus ini merupakan kursus pelengkap kepada beberapa kursus komunikasi seperti Komunikasi Data dan Telekomunikasi. Berpandukan kepada model 7 lapisan OSI, kursus ini akan lebih menumpukan kepada lapisan rangkaian dan ke atas. Pada lapisan rangkaian ini, kaedah pengalamatan IP dan cara membuat sub-rangkaian akan diperkenalkan. Di samping lPv4, pengalamatan lPv6 juga akan diterangkan. Lapisan berikutnya adalah lapisan pengangkutan yang menghubungkan lapisan rangkaian kepada lapisan applikasi termasuk keselamatan lapisan keselamatan (TLS), keselamatan email dan keselamatan WLAN. Keselamatan rangkaian akan diterangkan pada keperluan keselamatan setiap lapisan, jenis-jenis ancaman keselamatan rangkaian dan kaedah untuk mengatasinya juga akan diterangkan. Ini termasuklah teknik-teknik kriptografi serta teknik pengesanan dan pencegahan ancaman.

This course is a complement course to some communication courses such as Data Communication and Telecommunication. Based on the OSI 7 layer model, this course will give more emphasis on the network layer and the layers above it. In the network layer, methods of IP addressing and subnetwork creation will be introduced for both IPv4 and IPv6. The next layer is the transport layer, which connects the network layer to the application layer which includes transport layer security (TLS), e-mail and wireless LAN security. Network security for the requirements of each layer will be discussed, types of threats in networking security and methods to overcome them will also be described. This includes cryptography techniques, as well as intrusion detection and prevention.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Stallings, W. 2020. Cryptography and Network Security: Principles and Practice. 8th Edition. Pearson.
Stallings, W. 2017. Computer Security: Principles and Practice. 4th Edition. Pearson.
Comer, D. 2018. Computer Networks and Internets. 6th Edition. Pearson.
**Stallings, W. 2014. Data and Computer Communications. 10th Edition. Prentice*

Hall. (Versi terkini)
**Forouzan, B.A. and Fegan, S.C. 2012. Data communication and networking. 5th Edition., McGraw-Hill.* (Versi terkini)
Tanenbaum, A.M. 2010. Computer Networks. 5th edition. New Jersey, Prentice Hall. (Versi terkini)

Hasil Pembelajaran
Course Outcomes

Bil No.	Hasil Pembelajaran Kursus *Course Outcomes (CO)*
1	Kebolehan untuk menerangkan rangkaian data komunikasi menggunakan pengetahuan tentang komponen rangkaian dan mengunakan teknologi terkini berdasarkan IPv4 dan IPv6; *Ability to describe a data communication network using knowledge of standard network components and current technology based on IPv4 and IPv6;*
2	Kebolehan untuk menganalisa masalah dalam sistem rangkaian dan mengenalpasti penyelesaian untuk mengatasi masalah ini; *Ability to analyse the problems in a network and identify solutions to overcome these problems;*
3	Kebolehan untuk menerangkan prestasi dan kekangan rangkaian yang sedia ada; *Ability to describe the performance and constraints of the existing network;*
4	Kebolehan untuk menerangkan ancaman dan teknik untuk rangkaian yang selamat dengan menggunakan teknologi keselamatan terkini; *Able to explain threats and techniques for a secure network using the latest security technology;*

KKEE4123 Ekonomi Kejuruteraan dan Perakaunan Kos
Engineering Economics and Cost Accounting

Kursus ini meliputi prinsip-prinsip asas ekonomi kejuruteraan dan perakaunan. Objektif kursus ini adalah untuk melatih bakal jurutera untuk menganggar kos berpatutan, serta menilai dan mengenalpasti projek-projek kejuruteraan yang dapat memberikan pulangan ekonomi yang optimum. Teknik-teknik anggaran kos, peruntukan kos, penetapan-kos-berdasarkan-aktiviti, dan analisis penetapan kos kitaran-hidup akan diperkenalkan. Analisis ekonomi berkala bagi projek-projek kejuruteraan dalam keadaan ketentuan dan ketidaktentuan juga akan dibincangkan.

This course covers the fundamental principles of engineering economics and accounting. The objective of this course is to train future engineers to estimate appropriate costs, as well as to evaluate and identify engineering projects that can yield optimal economic returns. Techniques of cost estimation, cost allocation, activity-based costing, and life-cycle costing analysis will be introduced. Periodic economic analysis of engineering projects under conditions of certainty and uncertainty will also be discussed.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Blank, L. and Tarquin, A. 2014. Basics of Engineering Economy. 2nd edition. McGraw-Hill.*
Blank, L. and Tarquin, A. 2018. Engineering Economy. 8th edition. McGraw-Hill.
Newman, D., Eschenbach, T., and Lavelle, J. 2017. Engineering Economic Analysis. 13th edition. Oxford University Press.
Marnell, P. 2016. Engineering Economics for the 21st Century. John Wiley & Sons.
**Park, C. 2015. Contemporary Engineering Economics. 6th edition. Pearson.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menyatakan tujuan dan kepentingan melakukan analisis ekonomi ke atas projek-projek kejuruteraan; *Ability to state the purpose and significance of performing economic analysis on engineering projects;*
2	Berkebolehan untuk menilai projek-projek kejuruteraan menggunakan konsep nilai-masa wang, dan teknik-teknik anggaran kos, peruntukan kos, dan kawalan kos; *Ability to evaluate engineering projects by applying the concept of time-value of money, and techniques of cost estimation, cost allocation and control;*
3	Berkebolehan membandingkan alternatif-alternatif menggunakan kriteria ekonomi yang berbeza yang mengambilkira risiki-risiko dan ketidaktentuan; *Ability to compare alternatives based on different economic criterias that incorporate risks and uncertainties;*
4	Berkebolehan untuk menaksir anggaran kos, dan menilai serta memilih projek-projek kejuruteraan yang mempunyai nilai ekonomi paling minimum. *Ability to estimate appropriate costs, as well as to evaluate and select economically optimal engineering projects.*

KKEE4133 Penjanaan Kuasa Elektrik, Penggunaan dan Voltan Tinggi
Electrical Power Generation, Utilization and High Voltage

Matlamat kursus ini adalah untuk memberikan pengetahuan dan kefahaman tentang penjanaan kuasa elektrik, penggunaan dan komposisi voltan tinggi yang terdapat di dalam sistem kuasa. Penekanan diberikan kepada pelbagai cabang komponen dalam penjanaan, penghantaran dan agihan kuasa. Antara tajuk yang dirangkum bagi penjanaan tenaga adalah konsep dan pencirian loji kuasa konvensional dan sumber-sumber tenaga keterbaharuan, dan penghantaran kuasa ekonomik. Bagi penggunaan tenaga pula, topik yang akan disampaikan ialah sistem agihan kuasa dan bekalan elektrik, tarif elektrik dan insentif, dan sistem pengurusan tenaga. Pendedahan asas ditekankan terhadap asas voltan tinggi termasuk keselamatan elektrik voltan tinggi dalam sistem kuasa, kemudian diikuti dengan prinsip-prinsip operasi komponen-komponen voltan tinggi dalam sistem kuasa, penjanaan voltan tinggi, ujian voltan tinggi terhadap perkakas sistem kuasa, pengukuran voltan tinggi, voltan lampau dalam sistem kuasa dan koordinasi penebat.

The course aims to provide knowledge and comprehension on power generation, utilization and high voltage. Emphasis is given to various components in power generation, power transmission and power distribution. Among the topics covered under power generation are concept and characteristics of conventional power plants and renewable resouces, and economic power dispatch. For energy utilization, the topics covered are distribution system and electricity supply, electricity tariff and incentives and energy management system. Basic introduction of high voltage engineering including high voltage electrical safety will be emphasized, followed by several other topics such as operating principle of high voltage apparatus, generation of high voltages, measurement of high voltages, high voltage testing of electrical apparatus, overvoltages in electrical power systems and insulation coordination in electrical power systems.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Rizk, F.A.M. & Trinh, G.N. 2018. High Voltage Engineering. CRC Press. 3 Sep 2018.

Ahmad, M. 2018. Operation and Control of Renewable Energy Systems. 1st ed. John Wiley & Sons. Ltd

Fan, L. 2017. Control and Dynamics in Power Systems and Microgrids. CRC Press.

Luo, F.L. & Hong, Y. 2017. Renewable Energy Systems: Advanced Conversion Technologies and Applications. Reprint Edition, CRC Press, Taylor and Francis.

Glover, J.D. Sarma, M.S. & Overbye, T.J. 2016. Power System Analysis and Design. 6th ed. Cengage Learning.

**Kuffel, P. Zaengl, W.S. & Hammond, P. 2013. High Voltage Engineering: Fundamentals. Pergamon Press.*

** Kreith, F. & Goswami, D.Y. 2008, Energy Management and Conservation Handbook, CRC Press.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk membezakan pelbagai jenis penjanaan kuasa dan menyelesaikan masalah penghantaran kuasa ekonomik; *Ability to distinguish different types of power generations and solve economic power dispatch problems;*
2	Berkebolehan untuk menerangkan sistem pengurusan tenaga, polisi dan audit serta mencadangkan kaedah penjimatan tenaga secara lebih efektif; *Ability to explain on energy management system, policy and audit; and propose energy saving solution in more effective way;*
3	Berkebolehan untuk menerangkan ilmu asas kejuruteraan voltan tinggi; *Ability to explain basic knowledge of high voltage engineering;*
4	Berkebolehan untuk melaksanakan simulasi/pengukuran berbagai komponen voltan tinggi di dalam sistem kuasa; *Ability to accomplish simulation/ measurement of various high voltage components in power systems.*

KKEE4154 Projek Ilmiah II
Project II

Kursus ini merupakan sambungan kepada projek ilmiah, KKKE4142. Hasil kerja projek bersama-sama dengan kerja yang dilakukan dalam projek ilmiah I perlu dilaporkan dalam satu laporan akhir berbentuk disertasi. Format penulisanperlu mengikut format dalam panduan menulis tesis Gaya UKM. Projek ini akandinilai oleh penyelia dan ahli jawatankuasa dalam bentuk pemeriksaan tesis, laporan teknikal dan lisan pada penghujung semester berkenaan.

This course is a continuation of Project I, KKKE4142. Project results together with the work done in Project I have to be documented in a final report in a form of dissertation. The writing format has to follow specifications in the writing guidelines for thesis writing using the UKM style. This project will be evaluated by the supervisor and another assessor in the form of a thesis, technical report and oral assessment at the end of the semester.

Pra-Keperluan (jika ada): KKKE4142 Projek Ilmiah I
Pre-Requisite (if any): *KKKE4142 Project I*

Bacaan Asas:
References:

Pusat Pengurusan Siswazah. 2016. Panduan Penulisan Tesis Gaya UKM. Edisi semak ketiga. Penerbit UKM.

R. Irish, M. Poe, T. Deans. 2016. Writing in Engineering : A Brief Guide (Short Guides to Writing in the Disciplin). Oxford University Press.

**Umberto Eco. 2015. How to Write a Thesis. Massachusetts Institute of Technology (MIT) Press.*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan mencipta penyelesaian yang sesuai untuk sesuatu masalah kejuruteraan; *Ability to create solutions suitable for any certain engineering problem;*
2	Berkebolehan mengatur satu projek penyelidikan dengan jayanya; *Ability to organize a research project successfully;*

3	Berkebolehan merumuskan data/hasil dari eksperimen/projek; *Ability to formulate data/outcomes from experiment/project;*
4	Berkebolehan melaporkan hasil projek dengan berkesan; *Ability to report project output effectively;*
5	Berkebolehan mengamalkan pengetahuan, kemahiran dan sikap jurutera profesional. *Ability to practice the knowledge, skills and attitudes of a professional engineer.*

KKEC4123 Kualiti dan Perlindungan Sistem Kuasa
Power System Protection and Quality

Matlamat kursus ini ialah memberikan pengetahuan, kefahaman dan sintesis dalam bidang kualiti kuasa. Kursus ini memberi penekanan terhadap topik pengenalan kualiti kuasa, jenis gangguan kualiti kuasa, fana, lendut voltan, gelembung voltan, harmonik, voltan lebihan, voltan berkurangan serta herotan bentuk gelombang. Memperkenalkan kaedah pemantauan kualiti kuasa, pemilihan peralatan dan tempat pengawasan serta punca lendut voltan, harmonik dan fana. Peralatan pembaikan kualiti kuasa seperti penapis harmonik, sistem bekalan kuasa tanpa gangguan, pemampas statik, pemulih voltan dinamik turut diajar. Kursus ini juga bermatlamat untuk memberikan pengetahuan dan kefahaman tentang perlindungan sistem kuasa. Ia memberi pengetahuan tentang peranti perlindungan sistem kuasa seperti pengubah arus, pengubah voltan, geganti, fius, pemutus litar dan penutup semula. Membincangkan jenis geganti seperti geganti IDMT, geganti arus lebihan, geganti galangan, geganti jarak, geganti kebezaan juga perbandingan antara geganti digit dan elektromekanikal. Termasuk perlindungan terhadap penjana, pengubah, basbar dan talian. Aplikasi perlindungan sistem kuasa dan penyelarasan geganti turut dipelajari.

Objective of this course is to provide knowledge, understanding and synthesis in power quality field. This course gives emphasis on power quality introduction, types of power quality disturbance, transient, voltage sag, voltage swell, harmonic, over voltage, under voltage as well as waveform distortion. Introducing power quality monitoring technique, instrument selection and monitoring area, PQ benchmarking as well as the cause of voltage sag, harmonic and transient. Rectification instrument for power quality such as harmonic filter, uninterruptable power supply system, static compensator and dynamic voltage restorer will also be taught in this course. This course also aims to provide knowledge and understanding of power system protection. It gives knowledge about the devices of power system protection such as current transformer, voltage transformer, relay, fuse, circuit breaker and recloser. Discussing about types of relays such as

IDMT relay, over current relay, impedance relay, distance relay and differential relay as well as a comparison between digital and electromechanical relays. Generator, transformer, busbar and line protection also included. Power system protection application and relay coordination also being studied.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Cadick, J., Windfield, A., Capelli-Schellpfeffer, M. 2018. Electrical Safety Handbook. Mc Graw Hill.

Donsion, M.P. and Buzdugan, M. I. 2017. Power Quality. Cambridge Scholars Publishing.

Das, J. C. 2017. Power System Protective Relaying. CRC Press.

Sankaran, C. 2017. Power Quality. CRC Press.

Duncan, J. G., Sarma, M. S. and Overbye, T. J. 2016. Power System Analysis and Design. Thomson Learning.

**Masoum, M.A.S. and Fuchs, E.F. 2015. Power Quality in Power Systems and Electrical Machines. Academic Press.*

**Singh, B. Chandra, A. and Al-Haddad, Kamal. 2015. Power Quality: Problems and Mitigation Techniques. Wiley.*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menerangkan dan menganalisis berbagai jenis gangguan kualiti kuasa, punca dan kesannya, serta piawaian kualiti kuasa; *Ability to describe and analyse various types of power quality interruptions, causes and impacts as well as the power quality standards;*
2	Berkebolehan mengenalpasti dan mempersembahkan operasi peranti perlindungan sistem kuasa; *Ability to identify and demonstrate about power system protection devices operation;*
3	Berkebolehan melaksanakan penyelesaian masalah kerosakan elektrik dalam sistem kuasa menggunakan sistem perlindungannya; *Ability to perform solution of electrical faulty problems in power system using its protection system;*
4	Berkebolehan melakukan ujikaji makmal kualiti kuasa dan analisa menggunakan peranti kualiti kuasa; *Ability to conduct a power quality experiment and analysis using PQ devices.*

KKEC4133 Bioisyarat dan Analisis
Biosignals and Analysis

Prinsip instrumentasi perubatan telah diberikan dengan penekanan yang khusus terhadap peralatan elektronik. Secara amnya, kursus ini memberi penekanan kepada topik-topik berikut: kekangan isyarat perubatan, pengaturan peranti perubatan, aktiviti elektrik terhadap sel-sel teruja, electroneurogram, electromyogram, electrocardiogram, electroencephalogram, pengkutuban elektrod dan elektrod model, antaramuka kulit elektrod, model litar mikroelektrod, keperluan penguat biopotensi, electrocardiograph, pemproses biopotensi dan jenisnya, kesan fisiologi terhadap arus elektrik, kejutan mikro dan kejutan makro, pencegahan bahaya, DSP untuk isyarat biologi dan akhir sekali kajian kes dalam isyarat biologi.

Principles of medical instrumentation are reviewed. Special emphasis is put on electronic apparatus. Generalized instrumentation systems. Medical signal constraints. Regulation of medical devices, Electrical activity of excitable cells, The electroneurogram, electromyogram, The electrocardiogram, the electroencephanogram, Polarization of electrodes and electrode models, Requirements of biopotential amplifiers, The electrocardiograph, Other types of biopotential processors. Physiological effects of electrical current, Microshock and Macroshock, Hazard prevention, DSP for biological signals. Case studies in biological signals.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Eugenijus Kaniusas. 2015. Biomedical Signals and Sensors II: Linking Acoustic and Optic Biosignals and Biomedical Sensors. Springer.*
**Joseph D. Bronzino, Donald R. Peterson. 2014. Biomedical Engineering Fundamentals. CRC Press.*
**John G. Webster and Halit Eren. 2014. Measurement, Instrumentation, and Sensors Handbook, Second Edition: Two-Volume Set. CRC Press.*
**Rahul Sarpeshkar. 2010. Ultra Low Power Bioelectronics: Fundamentals,*

Biomedical Applications, and Bio-Inspired Systems. Cambridge University Press

**John G. Webster. 2009. Medical Instrumentation Application and Design. 4th Edition. John Wiley.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan membuat kesimpulan spesifikasi sistem tertentu diperlukan berdasarkan permohonan tertentu dan asal biosignal dalam tubuh manusia; *Ability to infer specifications of particular system required based on the particular application and origin of the biosignal in the human body;*
2	Berkeupayaan untuk menilai kesan fisiologi dan had keselamatan arus elektrik pada tubuh manusia; *Ability to evaluate the physiological effects and safety limits of electric currents on human body. CO2;*
3	Berkeupayaan untuk menggambarkan sumber gangguan utama dan menganalisis kesannya kepada kualiti rakaman isyarat; *Ability to describe the main interference sources and analyze their effect on the quality of signal recording;*
4	Berkebolehan mereka bentuk sistem rakaman isyarat bio-elektrik; *Ability to design a bioelectrical recording system;*

KKEC4143 Sistem Kawalan Pintar
Intelligent Control System

Kursus ini memberikan pengetahuan dan kefahaman mengenai sistem kawalan pintar berasaskan teori pembelajaran mesin. Kursus ini memperkenalkan dua kaedah utama kawalan pintar iaitu kawalan logik kabur dan kawalan rangkaian neural. Pembelajaran secara praktikal melalui perisian simulasi atau eksperimenmakmal juga akan dilakukan di dalam kursus ini.

This course provides knowledge and understanding on intelligent control systems based on machine learning theory. This course introduces two main methods of intelligent control that are fuzzy logic control and neural network control. Practical learning through simulation software or laboratory experiments will also be executed in this course.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Liu, J. 2018. Intelligent Control Design and MATLAB Simulation. Springer.
Rios, J.D., Alanis, A.Y., Arana-Daniel, N. & Lopez-Franco, C. 2019. Neural Networks Modelling and Control: Applications for Unknown Nonlinear Delayed Systems in Discrete-Time. Elsevier Science & Technology.
Ross, T.J. 2016. Fuzzy Logic with Engineering Applications. 4th Edition. John Wiley.
Shin, Y.C. & Xu, C. 2017. Intelligent Systems: Modeling, Optimization, and Control. CRC Press.
Zadeh, L.A. & Aliev, R.A. 2019. Fuzzy Logic Theory and Applications: Part I and Part II. World Scientific.

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkeupayaan memahami konsep asas kawalan pintar bagi sistem tidak lelurus; *Ability to understand the basic concepts of intelligent control for non-linear systems;*
2	Berkeupayaan merekabentuk kawalan logik kabur untuk aplikasi sistem tidak lelurus; *Ability to design fuzzy logic control for linear or non-linear systems;*
3	Berkeupayaan merekabentuk kawalan rangkaian neural untuk aplikasi sistem tidak lelurus; *Ability to design neural network control for linear or non-linear systems;*
4	Berkeupayaan mengadaptasi sistem kawalan pintar menggunakan logik kabur atau rangkaian neural menerusi pembelajaran berasaskan masalah; *Ability to adapt intelligent control systems using fuzzy logic or neural network through problem based learning;*

KKEC4153 Pengkomputeran Selari
Parallel Computing

Kursus ini adalah sambungan kepada kursus Mikropemproses Tahun 3. Kursus ini memperkenalkan pengkomputeran selari dari segi senibina keselarian tahap arahan dan berbilang pemproses kebanyakan komputer moden. Senibina komputer teragih dan heterogen juga akan diperkenalkan. Setelah itu,keselarian perisian dari segi berbilang proses dan bebenang akan dierkenakan kepada pelajar bagi memanfaatkan senibina selari sistem komputer moden.Pada separuh kedua kursus, pelajar akan menggunakan teori yang dipelajari bagi melaksanakan satu penyelesaian sistem pengkomputeran teragih.

This course is a continuation of the microprocessor course in Year 3. This course will introduce parallel computing in terms of the instruction level parallelism and multiprocessor architecture of many modern computers. Distributed and heterogenoous computing architectures will also be introduced. Thereafter, software parallelism in terms of multiprocessing and multhreading will be introduced to students to take advantage of the parallel architectureof modern computing systems. In the second half of the course, students willuse the theory learnt to implement a distributed computing system solution.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Trobec R. et al., 2018. Introduction to Parallel Computing, Springer.
Schmidt B. et al., 2017. Parallel Programming: Concepts and Practice. Morgan Kaufmann.
**Pacheco P. 2011. An Introduction to Parallel Programming. Morgan Kaufmann.*
Silberschatz A. et al. 2018. Operating System Concepts. 10th Edition. Addison Wesley, USA.
**Stallings W., 2015. Computer Organization and Architecture. 10th Edition. Prentice Hall, USA.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk memahami senibina pengkomputeran selari pada tahap arahan dan pemproses sistem komputer moden; *Ability to understand parallel computing architecture at the instruction level and processor level of modern computing systems;*
2	Berkebolehan melaksanakan pemprosesan berbilang atas sistem komputer tunggal dan teragih; *Ability to perform multiprocessing on single and distributed computing systemsl;*
3	Berkebolehan untuk menggunakan keupayaan berbilang bebenang sebuah sistem komputer moden; *Ability to use the multithreading capabilities of modern computing systems;*
4	Kebolehan melaksanakan satu penyelesaian sistem pengkomputeran teragih; *Ability to implement a distributed computing system solution;*

KKEM4143 Mikropemesinan Transduser
Micromachined Transducers

Kursus ini memberi pendedahan kepada pelajar tentang teknologi pemesinan mikro yang membolehkan pengecilan sesebuah peranti dilakukan. Tujuan kursus ini adalah untuk memberi pengetahuan, kefahaman dan kebolehan kepada pelajar untuk merekabentuk transduser berasaskan teknologi pemesinan mikro. Kursus ini dimulakan dengan pengenalan kepada teori asas struktur transduser, bahan dan aplikasinya. Rekabentuk dan fabrikasi proses diperkenalkan termasuk proses pemesinan mikro/nano. Pelbagai kaedah sensor dan aktuator diperkenalkan dan dianalisis. Pelajar juga didedahkan kepada reka bentuk asas transduser termaju seperti sensor bioperubatan.

This course provides students with exposure to micro-machining technology that enables miniaturization of a device. The aim of this courseisto provide students with knowledge, comprehension and ability to design devices using micromachining technology. This course begins with the introduction to basic theory of transducer's structure, materials and applications. The design and fabrication processes are introduced which includes micro/nano machining process. Various sensing and actuation methods are introduced and analyzed. Students are also exposed to basic and advanced design of MEMS sensors such as biomedical sensors.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Nihtianov, S. & Luque, A., 2018. Smart Sensors and MEMS: Intelligent Sensing Devices and Microsystems for Industrial Applications International Edition. 2nd Ed. Duxford: Woodhead.

Lee, Y.C., Cheng, Y. T.& Ramadoss, R. 2018. MEMS Packaging. World Scientific Publishing.

**Castañer, L. 2015 Understanding MEMS: Principles and Applications. 1st Edition. Wiley.*

**Y-L. Lin, C-M. Kyung, H. Yasuura & Y. Liu. 2015/ Smart Sensors and Systems. 1st Edition. Springer International Publishing*

**Clarence W. de Silva 2015. Sensors and Actuators: Engineering System Instrumentation. Second Edition. CRC Press.*

Hasil Pembelajaran
Course Outcomes

Bil No.	Hasil Pembelajaran Kursus *Course Outcomes (CO)*
1	Berkebolehan memerihalkan teori-teori asas dalam teknologi pemesinan mikro, termasuk asas struktur, bahan dan aplikasi; *Ability to demonstrate basic theories in micromachining technology, including basic structures, materials and applicationsl;*
2	Berkebolehan mengenal-pasti dan mengkelaskan setiap teknik pemesinan mikro dalam proses fabrikasi sesebuah transduser; *Ability to distinguish and categorize each micro-machining techniques in fabrication processs for each transduser;*
3	Berkebolehan mengusulkan proses asas mikrofabrikasi untuk membangunkan sesebuah transduser*;* *Ability to propose basic microfabrication process to develop a transducer;*
4	Berkebolehan mengintegrasi pengetahuan teknologi pemesinan mikro dalam penghasilan peranti-peranti termaju. *Ability to integrate knowledge of micmachining technology in producing advanced devices.*

KKEM4153 Rekabentuk Litar Bersepatu Analog CMOS
CMOS Analog Integrated Circuit Design

Kursus ini membincangkan aspek rekabentuk litar analog yang berasaskan pemprosesan teknologi CMOS. Pemahaman konsep asas dan pembangunan model litar analog akan ditekankan untuk mengenalpasti beberapa parameter yang penting bagi sesuatu litar. Beberapa litar asas analog akan dianalisa seperti litar arus tingkap, litar rujukan dan juga litar penguat. Berasaskan kepada pemahaman konsep ini, kursus iniakan diakhiri dengan satu rekabentuk keseluruhan litaranalog.

This course discusses aspects of analogue circuits based on CMOS process technology. Emphasis will be given to the fundamental understanding andmodels development for analogue circuit. Several basic analogue circuits will be analysed such as current mirrors, reference circtuis and analogue amplifiers. Based on this, the course will be directed towards the design and simulation of a complete analogue circuit.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Cilingiroglu, U. 2019. Analog Integrated Circuit Design by Simulation: Techniques, Tools, and Methods. McGraw-Hill Education.*

Razavi B., 2016. Design of Analog CMOS Integrated Circuits. 2nd Edition. McGraw-Hill.

**Rincon-Mora G., 2015. Analog IC Design with Low-Dropout Regulators, 2nd Edition. McGraw-Hill Professional.*

Allen, P.E. 2016. CMOS Analog Circuit Design. Oxford University Press.

Jespers, P.G.A. & Murmann, B. 2017. Systematic Design of Analog CMOS Circuits. Cambridge University Press.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menerangkan model-model yang berkaitan dengan litar analog; *Able to explain the models related to analog circuit;*
2	Berkebolehan menganalisa litar-litar analog dan prestasinya; *Able to analyse analog circuits and its performance;*
3	Berkebolehan merekabentuk litar-litar analog; *Able to design analogue circuits;*
4	Berkebolehan membincangkan keseluruhan rekabentuk litar analog; *Able to discuss a complete analogue circuit design;*

KKEM4163 Sensor Termaju untuk Sistem Pintar
Advanced Sensor for Intelligent System

Matlamat kursus ini ialah untuk menyampaikan pengetahuan tentang teknologi sensor elektronik termaju untuk penggunaan di dalam pelbagai applikasi industri seperti pembuatan, telekomunikasi, industri berat, robotik, perubatan dan internet-pelbagai-benda (IoT). Dalam kursus ini, pelajar akan didedahkan kepada asas dan keperluan sistem pintar berasaskan teknologi sensor. Pelajar kemudiannya akan mempelajari perkara asas berkaitan dengan bahan, struktur dan mekanisma kerja sensor termaju. Antara sensor yang akan dipelajari adalah sensor berasaskan nanoelektronik dan juga sensor yang berasaskan teknologi fotonik. Aplikasi sistem pintar berasaskan sensor termaju dalam bidang industri sebenar akan diterokai.

The aim of this course is to convey knowledge on advaced electronic sensor technology in various industrial application fields such as manufacturing, telecommunication, heavy industry, robotics, medical and Internet-of-Thing (IoT). In this course, students will be exposed to the basics and requirements of intelligent systems based on sensor technology. Students will then learn the basics related to the materials, structure and working mechanisms of advanced sensors. Advanced Nanoelectronic-based sensors and photonics-based sensors will be introduced in this course. Real industrial applications of advanced sensor based intelligent systems will be explored.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Arthur, H. H. 2017. An Introduction to Distributed Optical Fibre Sensors. CRC Press.

** Stoyan, N. 2014. Smart sensors and MEMS: Intelligent devices and microsystems for industrial applications. Woodhead Publishing.*

Edward, S. 2020. Wearable Sensors: Fundamentals, Implementation and Applications (2nd edition). Academic Press.

Reider, G. A. 2016. Photonics. Springer.

**Kasap, S. O., 2013, Optoelectronics & Photonics: Principles & Practices, 2/e. Prentice Hall.*

Hasil Pembelajaran
Course Outcomes

Bil **No.**	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan menganalisis teknologi sensor termaju untuk sistem pintar; *Ability to analyze advanced sensor technology for intelligent systems;*
2	Berkebolehan mengaplikasi ilmu dan mengoperasikan peralatan dan komponen untuk ujikaji yang berkaitan dengan teknologi sensor termaju; *Ability to apply knowledge and operate equipment and components for experiment related to advanced sensor technology;*
3	Berkebolehan merekabentuk dan menyelesaikan masalah yang berkaitan dengan teknologi sensor termaju; *Ability to design and solve problems associated with the current advanced sensor technology;*
4	Berkebolehan mencadangkan penyelesaian masalah/kaedah yang sesuai yang berkaitan bidang teknologi sensor termaju. *Ability to propose solution for problems in areas related to advanced sensor technology.*

KKET4123 Sistem Komunikasi Optik
Optical Communication System

Kursus ini meliputi topik-topik berikut: Sejarah dan latar belakang komunikasi optik, Gentian optik dan kabel-kabel, sumber-sumber dan pengesan-pengesan, Hubungan gentian titik ke titik, Peranti-peranti komunikasi optik, Pemultipleks pembahagi panjang gelombang (WDM), Peranti-peranti WDM, CWDM dan penghantaran jarak jauh, Pengulang dan penguat optik, Gentian optik dalam WAN, metropolitan dan rangkaian agihan, Peranti tambah/gugur dan sambung silang optik, Suis-suis optik, Rangkaian-rangkaian pelanggan dan teknologi FTTH, FTTH dan WDM, PON dan CWDM, CDMA optik, serta Sistem optik tanpa wayar.

This course covers the following topics: History and background of optical communication. Optical fiber and cables, sources and sensors, point-to-point fiber connection, Optical communication devices, Wavelength division multiplexing (WDM), WDM devices, CWDM and long distance transmission, Repeater and optical amplifier, Optical fiber in WAN, metropolitan and distribution networks, Optical add / drop devices and optical cross-links. Optical switches, FTTH's customers and technology networks, FTTH and WDM, PON and CWDM, CDMA optics, as well as Wireless optical system.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

Nathan Blaunstein, Shlomo Engelberg, Evgenii Krouk and Mikhail Sergeev. 2019. Fiber Optic And Atmospheric - Optical Communication. 1 Edition. Wiley-IEEE Press.

Rongqing Hui. 2019. Introduction to Fiber-Optic Communication. 1 Edition. Academic Press.

Murat Uysal et. Al. 2016. Optical Wireless Communications. Springer.

**Eugene H. 2015. Optics, 5/e. Addison-Wesley.*

Fedor M., 2016. Fiber Optics: Physics and Technology. 2/e. Springer

**Keiser, G. 2013. Optical Fiber Communications. 5/e. McGraw-Hill, Toronto.*

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Berkebolehan untuk menganalisis komponen dan aplikasi dalam sistem komunikasi optik. *To be able to analyse component and application in System of Communication Optic.*
2	Berkebolehan untuk mereka bentuk sistem komunikasi optik menggunakan perisian atau secara experimen. *To be able to design System of Communication Optic using software or by experiment.*
3	Berkebolehan untuk mengaplikasi ilmu dan memasangkan komponen dan peralatan untuk ujikasi yang berkaitan dengan komunikasi optik. *To be able to apply knowledge and assemble components and equipment related to optical communurrent technology and issues that are related to Optical Communication..*
4	Berkebolehan untuk membincangkan teknologi dan isu-isu terkini yang berkaitan dengan sistem komunikasi optik. *To be able to discuss current technology and issues that are related to System of Communication Optic.*

KKET4133 Komunikasi Radio dan Satelit
Radio and Satellite Communication

Kursus ini akan mengkaji dua sistem komunikasi iaitu sistem komunikasi radio khususnya radio selular dan peribadi serta sistem komunikasi satelit.Bermula dengan sejarah, perkembangan dan piawaian, seterusnya prinsip asas mengenai sistem tersebut akan diterangkan. Kursus ini juga melibatkan kajian kesan perambatan dan pemudaran, perancangan sel, belanjawan pautan dan trafik, skema capaian dan modulatan serta rekabentuk sistem. Beberapa aplikasi komunikasi radio dan satelit turut dibincangkan.

This course explores two communication systems i.e. radio communication, specifically radio and personal cellular, as well as satellite communication system. This course begins with the history, development and standard; after that, basic principles on the system will be discussed. This course also involves the study on the effects of propagation and fading, cell planning, link budget and traffic, modulation and access scheme as well as system design. The applications of radio and satellite communication are also discussed.

Pra-Keperluan (jika ada): Tiada
Pre-Requisite (if any): None

Bacaan Asas:
References:

**Beard & Stallings. 2015. Wireless Communication Network and Systems. 1/e. Pearson*

Timothy, P. & Jeremy, E. A. 2019. Satellite Communications. 3/e. Wiley and SonsLouis, J.I. 2017. Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance. 2/e. Wiley andSons.

Randy, L.H. 2019. Introduction to Wireless Communications Systems. 1/e. Wileyand Sons

Alejandro Aragón-Zavala. 2017. Indoor Wireless Communications: From Theoryto Implementation. 1/e. Wiley and Sons.

Hasil Pembelajaran
Course Outcomes

Bil No.	**Hasil Pembelajaran Kursus** ***Course Outcomes (CO)***
1	Kebolehan untuk membezakan piawai dan migrasi sistem komunikasi tanpa wayar selular dan menerangkan prinsip-prinsip asas radio selular berdasarkan gangguan sistem; *Ability to distinguish the migration and standard of a communication system for wireless cellular and explain the principle of basic cellular radio based on system interference;*
2	Kebolehan untuk menjangka kepada mekanik orbit, pejejakan satelit, tujuan belanjawan pautan dan jangkaan liputan menggunakan kesan perambatan terhadap rekabentuk sistem komunikasi radio dan satelit dan model kehilangan laluan; *Capability to predict orbital mechanical, satellite tracking, the link budget purpose and the coverage prediction by using propagation effects towards radio and satellite communication system design and path loss model;*
3	Kebolehan untuk mengaplikasikan teknik perancangan saluran, gred perkhidmatan, penambahbaikan kapasiti dan kecekapan spektrum; *Ability to apply channel planning technique, service grade, capacity enhancement and spectrum efficiency;*
4	Kebolehan untuk memanipulasi peralatan dan perisian bagi memantau liputan rangkaian berdasarkan kedudukan; *Ability to manipulate the instruments and software for network coverage monitoring based on location;*