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INSTITUT SEL FUEL
SELFUEL
UNIVERSITI KEBANGSAAN MALAYSIA

PANDUAN SISWAZAH
GRADUATE PROSPECTUS

INSTITUT SEL FUEL *Fuel Cell Institute*

UNIVERSITI KEBANGSAAN MALAYSIA

MENGILHAM HARAPAN, MENCIPTA MASA DEPAN
Inspiring Future, Nurturing Possibilities

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PANDUAN SISWAZAH
INSTITUT SEL FUEL (SELFUEL)

GRADUATE PROSPECTUS
FUEL CELL INSTITUTE (SELFUEL)

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Pihak Pengurusan Universiti sedaya upaya sudah memastikan bahawa bahan Buku Panduan ini adalah tepat pada masa ia diterbitkan. Buku ini bermaksud memberi panduan kepada pelajar untuk memilih program dan kursus pengajian serta kemudahan yang Universiti tawarkan dan bukan pula dimaksudkan sebagai satu ikatan kontrak. Pengurusan Universiti berhak meminda atau menarik tawaran program dan kursus pengajian serta kemudahan tanpa sebarang notis.

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Universiti Kebangsaan ini merupakan puncak dari usaha kita ke arah memenuhi tuntutan dan aspirasi rakyat yang ingin melihat bahawa bahasa ibunda mempunyai kedaulatan dan kedudukan yang sewajarnya di dalam usaha memenuhi keperibadian nasional

(Ucapan Tun Abdul Razak di Konvokesyen Pertama UKM, 1973)

Maksud Logo UKM

Logo UKM ialah sebuah perisai yang berpetak empat. Tiap-tiap petak mengandungi gambar dan membawa maksud-maksud tertentu.

Buku

Buku melambangkan ilmu pengetahuan iaitu peranan utama UKM sebagai pusat pengajian tinggi dan penyelidikan.

Perisai

Perisai bererti keteguhan. Keteguhan yang dimaksudkan ialah kemampuan UKM memainkan peranan sebagai pusat pengajian tinggi di negara ini.

Harimau

Harimau melambangkan keberanian dan kegagahan. Harimau mencerminkan masyarakat Malaysia yang berteraskan kebudayaan Melayu. Harimau garang menggambarkan kesediaan dan keupayaan UKM mara memerangi kejahilan, kejahatan dan kepalsuan.

Atom dan Teknologi

Simbol-simbol atom dan teknologi melambangkan konsep pembangunan negara yang berlandaskan sains dan teknologi moden. UKM sebagai pusat ilmu bertanggungjawab mengeluarkan tenaga-tenaga mahir dalam semua bidang untuk memenuhi keperluan pembangunan negara.

Bunga Raya

Bunga raya adalah bunga kebangsaan Malaysia. Lima helai ranggi melambangkan lima prinsip Rukun Negara yang diamalkan dan sentiasa dipelihara oleh rakyat Malaysia.

Falsafah, Wawasan, Misi dan Matlamat Universiti

Falsafah

Paduan antara iman kepada ALLAH dengan ilmu yang bermanfaat serta gabungan antara teori dan amal adalah dasar utama bagi perkembangan ilmu, proses pembinaan masyarakat terpelajar dan pembangunan Universiti

Wawasan

UKM bertekad menjadi Universiti terkehadapan yang mendahului langkah masyarakat dan zamannnya bagi membentuk masyarakat dinamis, berilmu dan berakhlak mulia.

Misi

Menjadi university terpilih yang memartabatkan Bahasa Melayu serta mensejagatkan ilmu beracuan budaya kebangsaan

Matlamat

Untuk menjadi pusat keilmuan yang terkehadapan, berteknologi dan berdaya saing yang:

Memartabatkan Bahasa Melayu sebagai bahasa ilmu; Membangun masyarakat dinamis dan berakhlak mulia; Mengantarabangsakan citra dan sumbangan UKM bagi masyarakat sejagat; dan

Menjana teknologi yang bermanfaat kepada masyarakat

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Latar Belakang
Universiti Kebangsaan Malaysia

Cetusan pertama gagasan perlunya pendidikan tinggi untuk orang Melayu berlaku dalam Mesyuarat Majlis Raja-raja pada 1903. Za'ba, seorang cendekiawan, menulis berkenaan gagasan tersebut dalam akhbar Lembaga Melayu pada 1917. Gerakan pemikiran, perdebatan serta tekad golongan cendekiawan Melayu untuk menubuhkan sebuah universiti dan menggunakan bahasa Melayu, bahasa ibunda sebagai bahasa pengantar di institusi pengajian tinggi bermula pada 1923 apabila Abdul Kadir Adabi, seorang lagi cendekiawan Melayu mengemukakan memorandum gagasan tersebut kepada DYMM Sultan Kelantan. Namun demikian, pemikiran dan tekad tersebut tidak dapat berkembang dan terlaksana kerana wujudnya berbagai-bagai halangan dan rintangan oleh tekanan kolonialisme.

Mulai 1957 hingga 1967, perjuangan untuk penubuhan universiti kebangsaan menjadi semakin bersemarak sebagai memenuhi tuntutan dan semangat kemerdekaan bangsa dan negara. Sehubungan itu, pada 1968 cendekiawan Melayu telah membentuk sebuah jawatankuasa penaja yang berperanan merancang penubuhan sebuah universiti kebangsaan. Pelbagai forum budaya dan politik diadakan bagi mendapat sokongan kerajaan dan rakyat untuk mewujudkan sebuah institusi pengajian tinggi yang memartabatkan bahasa Melayu sebagai bahasa pengantar dalam semua bidang pangajian dan keilmuan. Perjuangan yang tidak pernah luput itu mencapai kejayaan dengan penubuhan Universiti Kebangsaan Malaysia (UKM) pada 18 Mei 1970 yang memulakan operasi pertamanya di Lembah Pantai Kuala Lumpur. Kumpulan pertama pelajar prasiswazah seramai 190 orang dan seorang pascasiswazah mula mendaftar di tiga buah fakulti iaitu Fakulti Sains, Fakulti Sastera dan Fakulti Pengajian Islam.

Pada 1974, UKM menubuhkan UKM Kampus Sabah di Kebun Kawang, Papar. Nama Kebun Kawang kemudiannya ditukar kepada Limauan oleh Tun Datu Mustapha Datu Harun yang ketika itu sebagai Ketua Menteri Sabah. Kampus yang menempatkan Fakulti Sains dan Sumber Alam ini berpindah ke Bukit Padang, Kota Kinabalu pada 1980. Seterusnya berpindah ke Menggatal, Tuaran pada 1990 bersama Fakulti Sains Pembangunan yang asalnya ditempatkan di Kampus Induk Bangi. Dengan penubuhan Universiti Malaysia Sabah pada 1994, UKM Kampus Sabah ditutup secara rasminya pada 1996 dan kedua-dua fakulti berkenaan dipindahkan ke Kampus Induk Bangi, Selangor.

Universiti ini terus berkembang pesat sebagai sebuah institusi pengajian tinggi awam terkehadapan yang kini mempunyai tiga belas (13) fakulti, sebuah Graduate Schoolof Business (UKM-GSB) dan dua belas (12) institut kecemerlangan penyelidikan. UKM juga mempunyai entiti yang beroperasi secara komersil, iaitu UKM Holdings Sdn. Bhd. dan UKM Technology Sdn Bhd sebagai

satu pendekatan dalam mengkomersilkan dan memasyarakatkan kepakaran yang dimiliki di samping menjana kewangan Universiti.

Kampus induk UKM yang mempunyai keluasan 1,096.29 hektar terletak di Bangi, Selangor Darul Ehsan, kira-kira 35 kilometer dari Bandar raya Kuala Lumpur. Kampus induk terletak di sebuah lembah yang dikelilingi pokok-pokok yang menghijau yang dapat menyediakan suasana nyaman dan tenang untuk para pelajar menimba ilmu. Fakulti dan institut kecemerlangan yang terletak di kampus induk Bangi ialah Fakulti Ekonomi dan

Perniagaan, Fakulti Kejuruteraan dan Alam Bina, Fakulti Pengajian Islam, Fakulti Sains dan Teknologi, Fakulti Sains Sosial dan Kemanusiaan, Fakulti Undang-Undang, Fakulti Pendidikan, Fakulti Teknologi dan Sains Maklumat, Graduate School of Business (UKM-GSB), Institut Alam dan Tamadun Melayu (ATMA), Institut Alam Sekitar dan Pembangunan (LESTARI), Institut Kajian Malaysia dan Antarabangsa (IKMAS), Institut Mikro dan Nanoelektronik (IMEN), Institut Sistem Biologi (INBIOSIS), Institut Penyelidikan Tenaga Suria (SERI), Institut Sel Fuel (SELFUEL), Institut Islam Hadhari (HADHARI), Institut Kajian Etnik (KITA), Institut Infomatik Visual (IVI), Institut Perubahan Iklim (IPI), Pusat Siswazah (PS), Pusat Pengajian Umum (PPU), Pusat

Perkembangan Pelajar dan pusat perkhidmatan lain. Selain itu, UKM juga mempunyai sebuah kampus kesihatan di Jalam Raja Muda Abdul Aziz, Kuala Lumpur yang menempatkan Fakulti Perubatan (Jabatan Praklinikal), Fakulti Sains Kesihatan Bersekutu, Fakulti Pergigian dan Fakulti Farmasi. Manakala Pusat Perubatan UKM (PPUKM) yang mempunyai keluasan 22.3 hektar di Cheras, Kuala Lumpur berupaya memenuhi keperluan semasa dari segi pendidikan, penyelidikan dan perkhidmatan perubatan. PPUKM menempatkan Fakulti Perubatan (Jabatan Klinikal) dan Hospital UKM. Di sini juga ditempatkan Institut Perubatan Molekul (UMBI).

Berasaskan kecemerlangan dalam bidang penyelidikan lebih empat dekad, UKM dipilih sebagai salah sebuah universiti penyelidikan di Malaysia pada 2006. Proses pemantapan bidang penyelidikan disusuli dengan pengwujudan projek tertumpu di bawah lapan (8) nic iaitu Cabaran Membina Negara-bangsa, Pembangunan Lestari Wilayah, Tenaga Keterbaharuan, Teknologi Kesihatan & Perubatan, Perubahan Iklim, Nanoteknologi & Bahan Termaju, Kepelbagaian Biologi dalam Pembangunan Bioteknologi dan ICT: Informatik Isian.

Universiti juga adalah penerima Anugerah Kualiti Perdana Menteri 2006, memperoleh status Swa-Akreditasi pada 2010 dan diberikan status Universiti Autonomi pada Januari 2012. Penganugerahan ini adalah pengiktirafan bagi kecemerlangan UKM dalam bidang akademik dan tadbir urus. UKM melestarikan kecemerlangannya melalui Pelan Strategik UKM 2000-2020 (PS2020) dan Pelan Transformasi ke arah universiti terkemuka dunia menjelang 2018. Kini, UKM

tampil dengan citra baru melalui garis tanda “Mengilham Harapan, Mencipta Masa Depan’. Garis tanda ini memberi keyakinan kepada warganya untuk mengembangkan bakat yang dimiliki, tempat memupuk kebolehan, labuhan untuk berkarya dan berjaya dalam karyaan tersebut, kerana di sini mereka disediakan dengan prasarana untuk memiliki masa depan yang gemilang.

Background
Universiti Kebangsaan Malaysia

The idea for an institution of higher learning for the Malays was first mooted at the 1903 Rulers' Conference, or Durbar. The Malay intellectual Za'ba, wrote about such a need in the newsletter Lembaga Melayu in 1917. A movement, and subsequent debates, among Malay intellectuals, for the setting up a university using the Malay language as the medium of instruction in the institution of higher learning was formed in 1923 when another Malay thinker Abdul Kadir Adabi, submitted a memorandum on the matter to the HRH the Sultan of Kelantan. Howeverthe effort came to nothing due to many obstacles and resistance from the colonial authorities.

Nevertheless, from 1957 until 1967, a resurgence of nationalism revived the idea, and in 1968 Malay scholars formed a steering committee to bring the vision of a national university to reality. A slew of meetings on cultutal and political exchanges eventually secured an agreement from the government of the day. The efforts to realise a Malay language-based institution in all subjects bore fruit and resulted in The National University of Malaysia (UKM), in May 18 1970, which opened it's doors in Lembah Pantai Kuala Lumpur. The first batch of 190 undergraduates and 1 post-graduates registered at 3 faculties; Science, Arts and Islamic Studies.

In 1974, UKM set up a campus in Kebun Kawang, Papar. Later, the place was renamed Limauan by the then Sabah Chief Minister Tun Datu Mustapha Datu Harun. The campus housed the Science and Natuiral Resources faculty, which was moved to Bukit Padang, Kota Kinabalu in 1980. It later relocated to Menggatal, Tuaran in 1990 along with the faculty of Developmental Science which originally was based in the main campus of Bangi. With the formation of of University malaysia Sabah in 1994, UKM's Sabah campus was officially closed in 1996 and the faculties permanently located back tio the main campus in Bangi, Selangor.

UKM has since seen tremendous growth in being able to provide an increasing number of places of learning for the people as well undertaking research in various disciplines and fields of study. It now has 13 faculties, a Graduate School of Business (GSB-UKM), as well as 12 research institutes of excellence in education. UKM has also set up UKM Holdings Sdn. Bhd, operating as a commercial entity to benefit from all the expertise it has while also generating income for the University.

The university's main campus in Bangi, Selangor Darul Ehsan spans an area of 1,096.29 hectares approximately 35 kilometres from Kuala Lumpur. The campus is situated in a valley surrounded by hills and greenery, providing a serene and conducive environment for learning and knowledge exploration. The faculties and institutes housed in the main campus are the Faculty of Economics and Management, Faculty of Engineering and Built Environment, Faculty of Islamic Studies, Faculty of Science and Technology, Faculty of Social Sciences and Humanities, Faculty of

Law, Faculty of Education, Faculty of Information Science and Technology, Graduate School of Business (GSB-UKM), Institute of Malay World and Civilisation (ATMA), Institute of Environment and Development

(LESTARI), Institute of Malaysian and International Studies (IKMAS), Institute of Microengineering and Nanoelectronics (IMEN), Institute of System Biology (INBIOSIS), Institute of Solar Energy Research (SERI), Fuel Cell Institute (SELFUEL), Institute of Islam Hadhari (HADHARI), Institute of Ethnic Studies (KITA), UKM Medical Molecular Biology (UMBI), Institute of Climate Change Studies (IPI), Institute of Visual Informatics (IVI), Graduate Centre (PS), Centre of General Studies (PPU), Students Development Centre and other centres of service.

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UKM was appointed as one of the four research universities of Malaysia in 2006 based on it's excellent record in research for 40 years. That recognition has gained further ground when the Malaysia Genome Institute (MGI) and the International Institute of Global Health, United Nations University were set up at the university. Its areas of research were further consolidated and enhanced with the identification of eight niche areas; Challenges to Nation Building, Sustainable Territorial Development, Renewable Energy, Health and Medical Technology, Climate Change, Nanotechnology and Advanced Materials, Biological Diversity in Biotechnology Development and ICT: Content Informatics.

UKM is also the recipient of the Prime Minister's Quality Award 2006, a recognition of its excellent achievements in the academic and management fields. It has also been conferred the status of an Autonomous University in January 2012, while it looks ahead to a Transformation Pelan by 2018. With these strong foundations, UKM aims at not just sustaining but also enhancing its level of excellence via its 2000-2020 (PS2020) Strategic Plan in line with its slogan, 'Inspiring Futures, Nurturing Possibilities'. All these developments have brought about greater confidence among its staff to continue upgrading their capabilities while enhancing their talents in a conducive, healthy and supportive environment as provided by the university.

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Latar Belakang
Institut Sel Fuel (SELFUEL)

Pengenalan

Institut Sel Fuel telah diluluskan penubuhannya di Universiti Kebangsaan Malaysia oleh Jabatan Pengajian Tinggi, Kementerian Pengajian Tinggi Malaysia pada bulan Julai 2006 sebagai sebuah institut penyelidikan yang pertama di Malaysia melakukan penyelidkan dalam bidang sel fuel. Institut ini mula beroperasi secara rasmi setelah Prof. Dato' Ir. Dr. Hj. Wan Ramli Wan Daud sebagai Pengarah yang telah dilantik oleh Naib Canselor Universiti Kebangsaan Malaysia, YBhg. Prof. Tan Sri Dato' Dr. Sharifah Hapsah binti Syed Hasan Shahabudin pada 1 Januari 2007.

Penubuhan institut ini mencerminkan kekuatan penyelidikan sel fuel dan tenaga hidrogen di Universiti Kebangsaan Malaysia selama 12 tahun yang telah berjaya menarik dana penyelidikan IRPA besar dari Kementerian Sains, Teknologi dan Innovasi (MOSTI); menerbitkan banyak kertas di dalam jurnal antarabangsa berindeks dan berimpak tinggi, dan di dalam pascasidang dan prasidang persidangan antarabangsa dan kebangsaan; dijemput membentang banyak kertas ucap utama antarabangsa dan kebangsaan dan menghasilkan banyak harta intelek sel fuel dan tenaga hidrogen. Penubuhan Institut Sel Fuel di Universiti Kebangsaan Malaysia juga mencerminkan kekuatan penyelidikan tenaga keterbaharuan dalam bidang tenaga hidrogen dan teknologi sel fuel di universiti yang sudah berusia kira-kira 51 tahun.

Visi Institut

Menjadi pusat rujukan teknologi sel fuel dan tenaga hidrogen, serta dasar dan pengurusan tenaga bertaraf dunia.

Misi Institut

- Meneroka sains, kejuruteraan, pengurusan dan ekonomi bagi membangunkan teknologi sel fuel dan tenaga hidrogen pribumi, dan dasar dan pengurusan tenaga.

- Membina modal insan dalam bidang-bidang tersebut.

Matlamat Pembelajaran Institut

Melahirkan graduan peringkat sarjana dan doktor falsafah yang mempunyai pengetahuan yang luas, berkemahiran tinggi dan berkaliber dalam bidang kejuruteraan sel fuel dan tenaga hidrogen, serta pengurusan dan dasar tenaga.

Objektif Institut

- Menjalankan program penyelidikan, pengembangan dan projek demonstrasi (PP&P) untuk menghasilkan teknologi sel fuel pribumi.

- Menggalakkan dan menyokong pembangunan industri sel fuel di Malaysia dengan menyediakan sumber teknologi yang diperolehi daripada program penyelidikan, pengembangan dan projek demonstrasi (PP&P).

- Merancang strategi pembangunan industri sel fuel negara melalui penyediaan instrument governans, termasuk dasar negara, undang-undang dan pengurusan sumber.

- Menjadi pusat tumpuan negara bagi memajukan teknologi sel fuel pribumi.

- Menjadi pusat pengeram teknologi untuk industri sel fuel negara.

- Menghasilkan sumber manusia yang mahir dalam bidang sel fuel bagi menyokong industri sel fuel negara.

Background
Fuel Cell Institute (SELFUEL)

Introduction

Fuel Cell Institute was approved at the National University of Malaysia by the Department of Higher Education, Ministry of Higher Education Malaysia in July 2006 as the first research institute in Malaysia which carries out research in the field of fuel cells. The institute began operation officially with the appointment of Prof. Dato' Ir. Dr. Hj. Wan Ramli Wan Daud as the founding Director by the Vice-Chancellor of the National University of Malaysia, YBhg. Prof. Tan Sri Dato' Dr. Sharifah Hapsah binti Syed Hasan Shahabudin on January 1, 2007.

The establishment of this institute reflects the strength of fuel cell and hydrogen energy research at the National University of Malaysia for 12 years which has attracted large IRPA research funds from the Ministry of Science, Technology and Innovation (MOSTI). Moreover, this institute has published a large number of papers in many indexed and high-impact international journals, in international and national precedings and conferences. Fuel Cell Institute was also invited to present many international and national keynote papers. In addition, this institute has produced many intellectual properties realted to fuel cells and hydrogen energy. The establishment of Fuel Cell Institute at the National University of Malaysia also reflects the strength of renewable energy research in the field of hydrogen energy and fuel cell technology at the university which has aged 51 years.

Vision of Institute

To be a world class reference centre for fuel cell and hydrogen technology; and for energy management and policy.

Mission of Institute

1. To explore the frontiers of knowledge in science, engineering, management and economy for the development of world class indigenous fuel cell and hydrogen technology and sustainable energy management and policy.

2. To develop excellent world class human capital in these areas.

Educational Objective of Institute

To produce excellent postgraduates at Masters and PhD levels who are well equipped with very wide knowledge and skills in fuel cell, hydrogen energy, energy management and policy.

Objectives of Institute

1. To be the national focal centre for advancing indigenous fuel cell and hydrogen energy technology and formulating energy management and policy.
2. To conduct research, development and project demonstration programs for the production of indigenous fuel cell and hydrogen energy technology and the formulation of energy management and policy.
3. To promote and support the development of the fuel cell and hydrogen energy industry in Malaysia by providing indigenous technology.
4. To plan the national fuel cell industry development strategies through the provision of the instrument of governance including national policy, law and resources management.
5. To be the technology incubator centre for the national fuel cell industry.
6. To produce skilled human resources in the fields of fuel cell, hydrogen energy and energy management and policy to support the national fuel cell industry.

Program Pengajian Siswazah
Institut Sel Fuel (SELFUEL)

Institut Sel Fuel (SELFUEL) telah mula menawarkan program pengajian siswazah dengan mod penyelidikan mulai Sesi 2009/2010 bagi program-program berikut:

1. Sarjana Sains
2. Doktor Falsafah

Program Sarjana Sains

Pengenalan

Program Sarjana Sains (Kejuruteraan Sel Fuel) ini bertujuan membekalkan pelajar dengan ilmu lanjutan tentang teknologi sel fuel. Program ini dapat melahirkan graduan dengan pemahaman tentang konsep dan teori asas mengenai sel fuel, aplikasi sel fuel, pencirian/analisis prestasi sel fuel dan berupaya menjalankan penyelidikan dengan baik. Di samping itu, program ini bertujuan melahirkan graduan yang berkaliber dan sesuai untuk memegang jawatan sebagai penyelidik, ahli akademik, jurutera yang menyumbang kepada perkembangan dan pembangunan saintifik di dalam bidang teknologi sel fuel.

Tempoh Pengajian

Sepenuh masa adalah dua (2) hingga empat (4) semester
Separuh masa adalah empat (4) hingga lapan (8) semester

Hasil Pembelajaran Program

1. Berkebolehan mengaplikasi ilmu untuk menjalankan penyelidikan dalam bidang kejuruteraan sel fuel, tenaga hidrogen atau pengurusan dan dasar tenaga secara berterusan.

2. Berkebolehan untuk mengenalpasti peluang penyelidikan yang inovatif dan mengaplikasi kaedah saintifik dan menganalisis secara kritikal untuk mencapai hasil penyelidikan.

3. Berkebolehan membangun dan mengekalkan rangkaian kerjasama dengan penyelia, rakan-rakan penyelidik lain dan komuniti penyelidik institusi lain dari seluruh dunia.

4. Berkebolehan memperoleh pengetahuan yang luas dan kesedaran yang mendalam terhadap isu-isu yang berkaitan dengan harta intelek, hak cipta, etika penyelidikan, pengamalan yang salah dan kehendak Akta Perlindungan Data.

5. Berkebolehan mengurus projek dan bekerja dalam berkumpulan secara berkesan dalam mencapai objektif penyelidikan bidang teras.

6. Berkebolehan untuk mengenal pasti dan melakukan penyelidikan yang boleh dieksploitasi untuk harta intelektual dan pengkomersialan.

7. Berkebolehan mendemonstrasikan dan memahami kaedah menganalisis dan dapat menilai sesuatu penyelidikan dalam bidang kejuruteraan sel fuel, tenaga hydrogen, dan pengurusan dasar dan tenaga.

Program Doktor Falsafah

Pengenalan

Program Doktor Falsafah ini bertujuan membimbing pelajar menjadi seorang graduan yang menunjukkan kefahaman sistematik dan mendalam tentang teknologi sel fuel. Program ini dapat melahirkan graduan yang berkemampuan tinggi dan berkebolehan dalam menjana dan menyampaikan ilmu dalam bidang teknologi sel fuel. Penganugerahan ijazah doktor falsafah mengambil kira pengetahuan pelajar yang luas serta keupayaannya menjalankan penyelidikan secara kendiri dalam bidang penyelidikannya.

Tempoh Pengajian

Sepenuh masa adalah enam (6) himgga dua belas (12) semester
Separuh masa adalah lapan (8) hingga empat belas (14) semester

Hasil Pembelajaran Program

1. Berkebolehan untuk menjana ilmu baru melalui penyelidikan dalam bidang kejuruteraan sel fuel, tenaga hidrogen atau pengurusan dan dasar tenaga secara berterusan.

2. Berkebolehan untuk mengenalpasti peluang penyelidikan, memformulasi masalah penyelidikan dan mengaplikasi kaedah saintifik untuk mencapai hasil penyelidikan yang kredibel.

3. Berkebolehan membangun dan mengekalkan rangkaian kerjasama dengan penyelia, rakan-rakan penyelidik lain dan komuniti penyelidik institusi lain dari seluruh dunia.

4. Berkebolehan memperoleh pengetuhuan yang luas dan kesedaran yang mendalam terhadap isu-isu yang berkaitan dengan harta intelek, hak cipta, etika penyelidikan, pengamalan yang salah dan kehendak Akta Perlindungan Data.

5. Berkebolehan mendemonstrasikan dan memahami kaedah menganalisis secara kritikal dan dapat menilai sesuatu penyelidikan dalam bidang kejuruteraan sel fuel, tenaga hydrogen, dan pengurusan dasar dan tenaga.

6. Berkebolehan mengurus projek dan bekerja dalam berkumpulan secara berkesan dalam mencapai objektif penyelidikan bidang teras.

7. Berkebolehan untuk mengenal pasti dan melakukan penyelidikan yang boleh dieksploitasi untuk harta intelektual dan pengkomersialan.

Syarat Kemasukan

Syarat kemasukan ke Institut Sel Fuel adalah dipertimbangkan berdasarkan kreteria-kreteria yang ditunjukkan dalam jadual di bawah:

<table>
<tr><th rowspan="2">Program</th><th colspan="2">Syarat Minima</th></tr>
<tr><th>Graduan UKM</th><th>Graduan Bukan UKM</th></tr>
<tr><td rowspan="3">Ijazah Sarjana</td><td>1) Ijazah Sarjana Muda dengan PNGK ≥ 2.75; ATAU
2) Ijazah Sarjana Muda dengan PNGK minimum adalah 2.50 (perlu ada pengalaman bekerja)</td><td>1) Ijazah Sarjana Muda dengan PNGK ≥ 3.00; ATAU
2) Ijazah Sarjana Muda dengan PNGK minimum adalah 2.70 (perlu ada pengalaman bekerja)</td></tr>
<tr><td colspan="2">Bagi calon yang tidak melepasi pra-syarat minima</td></tr>
<tr><td colspan="2">Calon akan dilantik sebagai Pembantu Penyelidik (RA) bagi tempoh minima selama 6 Bulan dan pelajar harus menunjukkan prestasi yang baik dan disahkan oleh penyelia sebelum ditawarkan sebagai pelajar siswazah SELFUEL.</td></tr>
<tr><td>Ijazah Doktor Falsafah (PhD)</td><td colspan="2">1) Ijazah Sarjana Muda dengan PNGK ≥ 3.67; ATAU
2) Ijazah Sarjana dalam bidang yang berkaitan</td></tr>
</table>

Keperluan TOEFL/IELTS/MUET

1. Keperluan bahasa Inggeris untuk calon antarabangsa:
   Calon luar negara mesti memenuhi syarat bahasa Inggeris seperti berikut:
   a) Mendapat skor TOEFL minimum 500 dalam ujian berasaskan kertas; ATAU
   b) Mendapat skor TOEFL minimum 46 dalam ujian berasaskan internet; ATAU
   c) Mendapat skor IELTS minimum 5.5; ATAU
   d) Mendapat skor MUET minimum band 3; ATAU
   e) Mendapat markah Pearson Test Bahasa Inggeris minimum 51; ATAU
   f) Mendapat kelayakan minimum Cambridge English dan skor Ujian 160

2. Calon antarabangsa yang tidak memenuhi syarat kecekapan berbahasa Inggeris boleh diberikan tawaran bersyarat berikut:

   a) Pelajar dibenarkan mengikuti Kursus Persediaan Bahasa Inggeris dalaman di UKM dengan jangka masa maksimum dua (2) tahun, tetapi pelajar masih tertakluk kepada peraturan Jabatan Imigresen Malaysia yang berkuatkuasa; DAN
   b) Pelajar antarabangsa yang mengikuti Kursus Persediaan Bahasa Inggeris Dalaman mesti menduduki peperiksaan TOEFL, EILTS, MUET, Pearson Test of English atau Cambridge English Qualification and Test untuk memenuhi syarat kecekapan Bahasa Inggeris seperti yang dinyatakan di atas.

Permohonan Kemasukan

Permohonan kemasukan ke Institut Sel Fuel boleh dilakukan dengan mengisi borang di atas talian (*online)* melalui *Graduate Admission Application System (http://guest.ukm.my/). Semua dokumen sokongan perlu dimuatnaik melalui sistem tersebut. Sila baca panduan permohonan yang dikemaskini dengan teliti.*

Syarat Pengijazahan

1. Pelajar program Sarjana hendaklah mendaftar dan lulus 6 jam kredit kursus terdiri daripada:
   - 4 jam kredit kursus RARA6014 Kaedah Penyelidikan (Sains dan Teknologi); DAN
   - 2 jam kredit kursus (1 daripada kursus di bawah)
     - RARA6022 Tenaga Hidrogen; ATAU
     - RARA6032 Pengurusan dan Dasar Tenaga; ATAU
     - RARA6042 Elektrokimia Sel Fuel; ATAU
     - RARA6052 Sistem dan Aplikasi Sel Fuel

2. Pelajar program Doktor Falsafah hendaklah mendaftar dan lulus 8 jam kredit kursus terdiri daripada:
   - 4 jam kredit kursus RARA6014 Kaedah Penyelidikan (Sains dan Teknologi); DAN
   - 4 jam kredit kursus (2 daripada kursus di bawah)
     - RARA6022 Tenaga Hidrogen; ATAU
     - RARA6032 Pengurusan dan Dasar Tenaga; ATAU
     - RARA6042 Elektrokimia Sel Fuel; ATAU
     - RARA6052 Sistem dan Aplikasi Sel Fuel

Penerbitan Manuskrip Sebagai Syarat Bergraduat

Syarat penerbitan manuskrip sebagai syarat bergraduat bagi program pengajian siswazah di Institut Sel Fuel adalah seperti dalam jadual di bawah:

Institut	**Syarat Penerbitan Manuskrip**	
	Ijazah Sarjana	**Ijazah Doktor Falsafah (PhD)**
Institut Sel Fuel	Sekurang-kurangnya **1 artikel** telah diterima untuk penerbitan dalam jurnal berindeks **WoS.**	Sekurang-kurangnya **2** artikel telah diterima untuk penerbitan dalam jurnal berindeks **WoS.**

Kursus-Kursus yang Ditawarkan di Institut Sel Fuel

RARA6014 Kaedah Penyelidikan (Sains dan Teknologi)

Kursus ini bertujuan memberikan latar belakang dan kaedah menjalankan sesebuah penyelidikan saintifik. Tajuk-tajuk mengenai etika penyelidikan yang dibahas ialah prinsip-prinsip penyelidikan dan peranan penyelidik. Tajuk-tajuk mengenai pengurusan penyelidikan meliputi teknik pencarian maklumat secara manual dan atas talian, reka bentuk eksperimen, memproses, menganalisis dan merumuskan data, penyediaan usulan penyelidikan, teknik persembahan hasil penyelidikan secara lisan dan bertulis, dan pengenalan kepada kegiatan penyelidikan di Institut Sel Fuel, UKM. Aspek peraturan dan perundangan dibahas dalam tajuk harta intelek dan hartabenda intelek, aspek keselamatan di ruang bekerja, dan format menulis tesis mengikut gaya UKM. Sebilangan kuliah dan sesi perbincangan diperuntukkan untuk tajuk-tajuk yang lebih khusus. Penilaian kursus ini adalah berdasarkan kepada mutu usulan penyelidikan bertulis yang disediakan oleh pelajar dan pembentangan usulan tersebut di dalam seminar.

Bacaan Asas

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3. Efron S.E., Ravid R. 2018. Writing the Literature Review: A Practical Guide. First Ed. The Guilford Press.
4. Ramakrishna B., Anil Kumar H.S. 2017. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers. First Ed. Notion Press.

5. Scott, A. G. 2016. Research Methods in Science and Engineering. CRC Press.
6. Roslan Abd Shukor. 2015. Rahsia Kejayaan Menulis Jurnal Berimpak Tinggi Buku dan Tesis. Bangi. UKM.

RARA6022 Tenaga Hidrogen

Matlamat kursus ini adalah untuk memberi pengenalan asas kepada para pelajar tentang tenaga hidrogen. Pelajar-pelajar akan diperkenalkan dengan prinsip asas penggunaan tenaga hidrogen pada peringkat awal. Seterusnya, pelajar-pelajar akan didedahkan dengan pelbagai kaedah dalam pemprosesan fuel, penyimpanan hidrogen dan penggunaan hidrogen sebagai tenaga. Isu-isu sosial dan keselamatan yang berkaitan dengan penggunaan tenaga hidrogen akan dibincangkan.

Bacaan Asas:

1. Veziroğlu, T.N. 2016. Compendium of Hydrogen Energy. Volume 3,4. Amsterdam: Woodhead Publishing-Elsevier.
2. Basile, A., Dalena, F., Tong, J., & Veziroğlu, T.N. 2017. Hydrogen Production, Separation and Purification for Energy. London: The Institution of Engineering & Technology.
3. Mehmet Sankir, M. & Sankir, N.D. 2017. Hydrogen Production Technologies. New Jersey: Scrivener Publishing-Wiley.
4. Sasaki, K., Li, H.-W., Hayashi, A., Yamabe, J., Ogura, T. & Lyth, S.M. 2016. Hydrogen Energy Engineering. Japan: Springer.
5. Stolten, D. & Emonts, B. 2016. Hydrogen Science and Engineering: Materials, Processes, Systems and Technology. Weinheim: Wiley-VCH.

RARA6032 Pengurusan dan Dasar Tenaga

Matlamat kursus ini adalah untuk memberi pengenalan asas kepada para pelajar tentang dasar dan pengurusan tenaga. Pelajar-pelajar akan diperkenalkan dengan sumber-sumber tenaga. Seterusnya, pelajar-pelajar juga akan didedahkan dengan senario tenaga dan keselamatan diikuti dengan undang-undang tenaga dan dasar pengurusan tenaga. Pelajar-pelajar juga akan diperkenalkan dengan isu-isu dan cabaran-cabaran krisis tenaga. Ekonomi dan pengurusan tenaga pula didedahkan supaya pelajar dapat memahami teori ekonomi tenaga. Pelajar-pelajar juga akan didedahkan bagaimana tenaga memainkan peranan terhadap alam sekitar dan perubahan iklim.

Bacaan Asas:

1. Marc Ozawa, Jonathan Chaplin, Michael Pollitt, David Reiner, Paul Warde (Ed.). 2019. In Search of Good Energy Policy. Series: Cambridge Studies on Environment, Energy and Natural Resources Governance. Cambridge University Press. 388 p.

2. Power Trip: The Story of Energy Hardcover. 2019. Michael E. Webber. Basic Books. 304 p.
3. Jeremy Rifkin. The Green New Deal: Why the Fossil Fuel Civilization Will Collapse by 2028, and the Bold Economic Plan to Save Life on Earth. 2019. St. Martin's Press. 292 p.
4. Walter A. Rosenbaum. 2019. Environmental Politics and Policy (11 Ed.). CQ Press. 352 p.
5. IRENA. 2019. Global Energy Transformation: A Roadmap to 2050.

RARA6042 Elektrokimia Sel Fuel

Kursus ini memperkenalkan teori umum elektrokimia, instrumentasi dan kaedah pencirian elektrokimia dalam sel fuel. Di peringkat awal, pelajar akan didedahkan kepada topik pengenalan kepada sel fuel, bahan mangkin/membran sel fuel dan jenis-enis sel fuel. Turut dibincangkan dalam kursus ini adalah topik elektrokimia asas, elektromangkin, termodinamik sel fuel dan tindak balas redoks sel fuel. Kaedah pencirian elektrokimia seperti siklik voltametri, spektroskopi impedans elektrokimia dalam mengukur prestasi mangkin/bio-mangkin serta membran sel fuel juga akan dibincangkan dengan lanjut dalam kursus ini. Akhir sekali, pelajar dikehendaki melakukan projek berkaitan bidang sel fuel dan dinilai berdasarkan pembentangan dan laporan bertulis.

Bacaan Asas:

1. Sorensen, B. & Spazzafumo, G. 2019. Hydrogen and Fuel Cells. 3rd Edition. Elsevier/Academic Press.
2. O'Hayre, R., Cha, S-W., Colella, W. & Prinz, F. B. 2016. Fuel Cell Fundamentals. John Wiley & Sons.
3. Jiang, S. P., Li, Q. 2021. Introduction to Fuel Cells: Electrochemistry and Materials. Springer Singapore.
4. Breitkopf C., Swider-Lyons K. 2016. Handbook of Electrochemical Energy. New York: Springer.
5. Koper, M. & Wieckowski, A. 2019. Fuel Cell Catalysis: A Surface Science Approach. Wiley.

RARA6052 Sistem Sel Fuel dan Aplikasi

Matlamat kursus ini adalah untuk membincangkan topik-topik penting berkaitan dengan teknologi sel fuel dan penerapan sistem sel fuel sebagai penjana tenaga alternatif. Di peringkat awal pelajar akan diberikan pemahaman tentang konsep dan teori asas mengenai sel fuel. Jenis-jenis sel fuel, analisis prestasi, sistem kawalan dan pemantauan sel fuel akan dibincangkan secara meluas dalam kursus ini. Selain itu, pengetahuan mengenai kejuruteraan sistem proses sel fuel turut akan disentuh, yang mana aspek reka-bentuk, keadaan operasi, pengurusan air dan haba serta prestasi

sistem sel fuel akan dibincangkan. Isu-isu terkini, perkembangan teknologi sel fuel dengan penggabungan pelbagai disiplin ilmu juga dibahaskan dalam kursus ini. Peranan sel fuel dalam bidang tenaga keterbaharuan, aplikasi pada bekalan kuasa dan kenderaan akan dibentangkan bersama lawatan makmal. Perkembangan dan pembangunan saintifik di dalam bidang ini dapat memberi kesan terhadap perkembangan sosial, ekonomi dan alam sekitar yang turut ditekankan dalam kursus ini. Akhir sekali, pelajar dikehendaki melakukan projek berkaitan bidang sel fuel dan dinilai berdasarkan pembentangan dan laporan bertulis

Bacaan Asas:

1. Revankar, S.T. & Pradip Majumdar, P. 2014. Fuel Cells: Principles, Design, and Analysis. Boca Raton: CRC Press.
2. Su, H., Gomez, J.C.C., Reddy, H., Sita, C., Pasupathi, S., Bujlo, P. 2016. Recent Advances in High-Temperature PEM Fuel Cells. Academic Press.
3. Hacker, V., Mitsushima, S. 2018. Fuel Cells and Hydrogen: From Fundamentals to Applied Research. Elsevier.
4. Fergus, J., Hui, R., Li, X., Wilkinson, D.P. & Zhang, J. 2016. Solid Oxide Fuel Cells: Materials Properties and Performance. First Ed. Boca Raton: CRC Press.
5. Kendall, K. and Kendall, M. 2016. High-temperature Solid Oxide Fuel Cells for the 21st Century: Fundamentals, Design and Applications. Second Ed. London: Academic Press.

Bidang-Bidang Penyelidikan

1. Kejuruteraan Sistem Proses
2. Bahan dan Pembuatan Plat Sel Fuel
3. Proses Elektrokimia Sel Fuel
4. Sel Fuel Cecair Langsung
5. Sel Fuel Oksida Pepejal
6. Biohidrogen dan Biosel Fuel
7. Pemprosesan Fuel
8. Hidrogen Suria
9. Pengurusan dan dasar tenaga
10. Penyimpanan Tenaga

Penukaran Program Sarjana kepada Program Doktor Falsafah

1. Syarat permohonan adalah seperti berikut:

    a) Pelajar Sarjana (secara tesis) yang mendaftar secara sepenuh masa sahaja adalah layak memohon menukar bentuk pengajian.

b) Pelajar perlu membuat permohonan sebelum semester ke-3 pengajian, agar pertimbangan dapat dilakukan dalam semester ke-3 dan keputusan dapat dikeluarkan sebelum semester ke-4 pengajian bermula.

c) Pelajar yang telah mencapai objektif kajian Sarjana (biasanya akhir semester 3) tidak layak dipertimbangkan dan harus menyelesaikan pengajian Sarjananya.

d) Mempunyai laporan kemajuan yang memuaskan dan mendapat sokongan penyelia.

2. Cara permohonan adalah seperti berikut:

a) Calon menyediakan usulan baru untuk Doktor Falsafah yang merangkumi:
- Tambahan skop penyelidikan
- Signifikan penyelidikan
- Tambahan objektif penyelidikan
- Tambahan masa penyelidikan
- Idea baru dalam penyelidikan tersebut
- Penemuan baru yang mungkin akan diperolehi

b) Permohonan hendaklah dibuat secara bertulis kepada Pengarah, dengan perakuan Penyelia Utama/Pengerusi Jawatankuasa Penyeliaan.

c) Jawatankuasa Pertukaran Status Pengajian Pascasiswazah (JPSPP) akan dibentuk untuk meneliti dan menilai proposal calon.

d) Calon akan membentangkan proposal penyelidikan Doktor Falsafah tersebut dengan kehadiran ahli JPSPP dan pensyarah lain.

e) JPSPP akan menyatakan pandangan dan komen terhadap proposal tersebut.

f) Calon akan membuat pembetulan proposal mengikut cadangan JPSPP.

g) Calon menyerahkan proposal baru kepada Ketua Pentadbiran Institut untuk perakuan Jawatankuasa Akademik Institut dan kelulusan Pengarah Institut.

h) Sebarang keputusan akan dimaklumkan kepada calon.

Penulisan Tesis/Disertasi Kompilasi

1. Syarat-syarat bagi penulisan tesis/disertasi format kompilasi:

a) Penyelia bersetuju bahawa tesis/disertasi penyelidikan yang telah dijalankan ditulis dalam bentuk tesis/disertasi kompilasi

b) Pelajar perlu membuat permohonan secara bertulis kepada Pengarah untuk menulis tesis/disertasi dalam bentuk kompilasi

c) Pelajar telah menerbit makalah atau makalah telah diterima untuk penerbitan dalam jurnal tersohor yang diiktiraf oleh Fakulti/Institut. Namun demikian, setiap disiplin memerlukan tahap impak yang berbeza bagi memastikan kualiti yang setaraf dengan pengajian di peringkat Doktor Falsafah atau Sarjana.

d) Makalah perlu memenuhi skop dan objektif penyelidikan yang dijalankan oleh pelajar. Kertas yang dibentangkan dalam persidangan atau seminar, dan kertas yang diterbitkan dalam prosiding persidangan atau seminar hanya boleh diterima sebagai bahan penerbitan sokongan sahaja.

e) Syarat dan bilangan penerbitan makalah adalah seperti berikut:

- Program Doktor Falsafah:

  i. Sekurang-kurangnya **EMPAT (4)** artikel telah diterbitkan atau diterima untuk penerbitan dalam makalah berindeks **WoS** dan berkuartil ***Q1/Q2***.

  ii. **DUA (2)** daripada artikel-artikel yang diterbitkan atau diterima untuk penerbitan seperti dalam Perkara (i) di atas **WAJIB** berindeks **WoS** dan berkuartil ***Q1*.**

- Program Sarjana:

  i. Sekurang-kurangnya **DUA (2)** artikel telah diterbitkan atau diterima untuk penerbitan dalam makalah berindeks **WoS** dan berkuartil ***Q1/Q2.***

  ii. **SATU (1)** daripada artikel-artikel yang diterbitkan atau diterima untuk penerbitan seperti dalam Pekara (i) di atas **WAJIB** berindeks **WoS** dan berkuartil ***Q1*.**

f) Pelajar perlu mendapatkan kebenaran hak cipta daripada penerbit makalah yang diterbitkan sekiranya tesis/disertasi hendak dibukukan.

g) Pelajar merupakan **pengarang utama** atau **pengarang yang dirujuk** bagi setiap makalah yang dinyatakan dalam Perkara (e) di atas dan ditulis **bersama penyelia**.

h) Pelajar yang mempunyai lebih dari satu afiliasi perlu meletakkan Universiti Kebangsaan Malayisa sebagai afiliasi pertama.

i) Bagi pelajar berstatus warganegara, di mana tesis mesti ditulis dalam Bahasa Melayu kecuali dengan kebenaran Institut, makalah boleh ditulis dalam bahasa ia diterbitkan. Namun, calon perlu menyertakan ringkasan makalah dan maklumat makalah penerbitan di dalam Bahasa Melayu mengikut format seperti dalam Perkara 2 di bawah.

2. Format serta kandungan tesis/disertasi adalah seperti berikut:

a) Pernyataan bahawa tesis/disertasi ditulis mengikut format kompilasi.

b) Senarai penerbitan yang dimasukkan sebagai bab dalam tesis/disertasi.

c) Keseluruhan tesis/disertasi perlu disediakan mengikut format penulisan tesis/disertasi Gaya UKM.

d) Bab Pengenalan – Bab ini memberi pengenalan kepada isu yang dikaji dan menerangkan perkaitan di antara makalah yang telah diterbit bagi memastikan tesis/disertasi dipersembahkan dalam bentuk yang bersepadu.

e) Bab Bahan Penerbitan – Setiap makalah yang telah diterbit perlu dipersembahkan sebagai bab berasingan di dalam tesis/disertasi. Abstrak makalah dan maklumat jurnal penerbitan perlu disertakan bagi tesis/disertasi yang ditulis dalam bahasa yang selain dari bahasa penulisan tesis/disertasi.

f) Bab Kesimpulan – Bab ini mensintesis dapatan kajian dan memberi kesimpulan menyeluruh tentang penyelidikan yang telah dijalankan.

g) Rujukan – Senarai rujukan merangkumi rujukan bagi bab Pengenalan dan Kesimpulan.

Graduate Studies Programmes
Fuel Cell Institute (SELFUEL)

Fuel Cell Institute (SELFUEL) has started to offer research mode graduate programmes beginning from the session of 2009/2010 for the following programmes:

1. Master of Science
2. Doctor of Philosophy

Master of Science

Introduction

Master of Science program is intended to equip student with extended knowledge on fuel cell technology. This program is designed to produce graduates with understanding on concept and theoretical basis of fuel cell, fuel cell application, fuel cell characterization/ performances analysis and is capable of carrying out good research. At the same time, this programme is intended to deliver capable graduate and suitable holding onto post as researcher, academician and engineer which contribute to scientific development in fuel cell technology.

Duration of Studies

The duration on a full-time basis is between two (2) to four (4) semesters
The duration on a part-time basis is between four (4) to eight (8) semesters

Program Learning Outcome

1. Ability to apply knowledge to conduct research in the field of fuel cell engineering, hydrogen energy or energy policy and management.

2. Ability to identify innovative research opportunities, apply scientific method and critically analyzed to achieve research results.

3. Ability to build and maintain cooperation network with supervisors, research colleagues and research community from other institutions around the world.

4. Ability to demonstrate a broad understanding and a deep awareness on issues relating to intellectual property, copyright, research ethics, wrong practice and the requirements of the Data Protection Act.

5. Ability to manage projects and work in the team effectively to achieve core research field objectives.

6. Ability to identify and conduct research that can be exploited for intellectual property and commercialization.

7. Ability to demonstrate and understand the analysis method critically and able to evaluate research that related to fuel cell engineering, hydrogen energy, and energy policy and management.

Doctor of Philosophy

Introduction

The Doctor of Philosophy program is intended to cultivate a graduate with systematic and profound understanding on fuel cell technology. The program will produce graduates who are highly skilled and capable of generating and imparting knowledge in the field of fuel cell technology. The award of a doctorate degree will be taken into account the extensive knowledge and ability of students to conduct research independently in the related field.

Duration of Studies

The duration on a full-time basis is between six (6) to twelve (12) semesters
The duration on a part-time basis is between eight (8) to fourteen (14) semesters

Program Learning Outcome

1. Ability to generate new knowledge through the continuous research in the field of fuel cell engineering, hydrogen energy or energy policy and management.

2. Ability to identify research opportunities, formulate research problems and apply the scientific method to achieve credible research results.

3. Ability to build and maintain cooperation network with supervisors, research colleagues and research community from other institutions around the world.

4. Ability to demonstrate a broad understanding and a deep awareness on issues relating to intellectual property, copyright, research ethics, wrong practice and the requirements of the Data Protection Act.

5. Ability to demonstrate and understand the analysis method critically and able to evaluate research that related to fuel cell engineering, hydrogen energy, and energy policy and management.

6. Ability to manage projects and work in the team effectively to achieve core research field objectives.

7. Ability to identify and conduct research that can be exploited for intellectual property and commercialization.

Entry Requirements

Admission to the Fuel Cell Institute is considered based on the creteria shown in the table below:

<table>
<tr><th rowspan="2">Programme</th><th colspan="2">Minimum requirements</th></tr>
<tr><th>UKM Graduate</th><th>Non-UKM Graduate</th></tr>
<tr><td rowspan="3">Master Degree</td><td>1) Bachelor degree with a CGPA ≥ 2.75; OR
2) Bachelor degree with a minimum CGPA of 2.50 (working experience is required)</td><td>1) Bachelor degree with a CGPA ≥ 3.00; OR
2) Bachelor degree with a minimum CGPA of 2.70 (working experience is required)</td></tr>
<tr><td colspan="2">For candidates who do not meet the minimum requirements</td></tr>
<tr><td colspan="2">The candidate will be appointed as a Research Assistant (RA) for a minimum of 6 months and the appointed RA must show a good performance and verified by the supervisor before being offered as a graduate student of the Fuel Cell Institute.</td></tr>
<tr><td>Doctor of Philosophy (PhD)</td><td colspan="2">1) Bachelor degree with CGPA ≥ 3.67 ; OR
2) Master degree in a related field</td></tr>
</table>

TOEFL/IELTS/ MUET Requirements

1. English language requirements for international candidates:
   Overseas candidates must meet the English language requirement as follows:
   a) Obtain a minimum TOEFL score of 500 in paper based test; OR
   b) Obtain a minimum TOEFL score of 46 in internet based test; OR
   c) Obtain a minimum IELTS score of 5.5; OR
   d) Obtain a minimum MUET score of band 3; OR
   e) Obtain a minimum Pearson Test of English score of 51; OR
   f) Obtain a minimum Cambridge English Qualifications and Test score of 160

2. International candidates who do not meet the English language competency requirements may be given the following Conditional Offers:

   a) Students are allowed to attend the internal English Preparatory Course at UKM with a maximum period of two (2) years, but students are still subject to the rules of the Department of Malaysian Immigration which is in force; AND
   b) International students who take the Internal English Preparation Course must sit for the TOEFL, EILTS, MUET, Pearson Test of English or Cambridge English Qualifications and Test examinations to meet the English Language competency requirements as stated above.

Application for Admission

Application for admission at the Fuel Cell Institute can be done by filling in the online form through the *Graduate Admission Application System* (*http://guest.ukm.my/*). All documents must be uploaded through the system. Please read the updated application guide carefully.

Course Requirements

1. Master's student must register and pass 6 credit hours of the following course:
   - 4 credit hours of RARA6014 Research Methodology (Science and Technology)
   - 2 credit hours of (any of a course)
     - RARA6022 Hydrogen Energy; OR
     - RARA6032 Energy Management and Policy; OR
     - RARA6042 Fuel Cell Electrochemistry; OR
     - RARA6052 Fuel Cell System and Application
2. Doctoral's student must register and pass 8 credit hours of the following courses:
   - 4 credit hours of RARA6014 Research Methodology (Science and Technology)
   - 4 credit hours of (any of 2 courses)
     - RARA6022 Hydrogen Energy; OR
     - RARA6032 Energy Management and Policy; OR
     - RARA6042 Fuel Cell Electrochemistry; OR
     - RARA6052 Fuel Cell System and Application

Manuscript Publication as a Requirement for Graduation

Manuscript publication requirements as a condition of graduation for the graduate studies programmes at the Fuel Cell Institute are shown in the table below:

Institute	**Manuscript Publication Requirements**	
	Master degree	**Doctor of Philosophy (PhD)**
Fuel Cell Institute	At least **1 article** has been accepted for publication in an indexed journal of **WoS.**	At least **2 articles** have been accepted for publication in indexed journals of **WoS.**

Courses Offered at the Fuel Cell Institute

RARA6014 Research Methodology

This course aims to introduce the background and process to conduct a scientific research. Topics related research ethics discussed in this course include research philosophy and role of researcher. On the aspect of research management, the topics covered are manual and online information search techniques, design of experiment, processing, analysing and summarising data, research proposal preparation, results presentation through oral and written format and introduction of researches in institute. The rules and regulations related to research are covered under the topics of intellectual properties, safety at workplace and UKM thesis writing format. Lectures and discussion sessions are allocated for the specific topics. This course adapts continuous assessment and the course evaluation is mainly based on the quality of the written research proposal as well as the proposal presentation during the seminar.

Basic Reading

1. Komuta H.M., Germaine R.W. 2019. A Concise Guide to Writing a Thesis or Dissertation: Educational Research and Beyond. Second Ed. Routledge.
2. Miles, M R., Huberman, A.M. & Saldana, J.M. 2019. Qualitative Data Analysis: A Methods Sourcebook. SAGE Publications Ltd.
3. Efron S.E., Ravid R. 2018. Writing the Literature Review: A Practical Guide. First Ed. The Guilford Press. Ramakrishna B., Anil Kumar H.S. 2017. Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers. First Ed. Notion Press.

4. Scott, A. G. 2016. Research Methods in Science and Engineering. CRC Press.
5. Roslan Abd Shukor. 2015. Rahsia Kejayaan Menulis Jumal Berimpak Tinggi Buku dan Tesis. Bangi. UKM.

RARA6022 Hydrogen Energy

The objective of this course is to give a fundamental introduction to the students on hydrogen energy. Students are introduced with basic overview in utilizing the hydrogen energy during the early stage. Next, the students are also exposed to different methods of fuel processing, hydrogen storage and the use of hydrogen in generating electricity. Social issues and safety issues related to the use of hydrogen energy will be discussed as well.

Basic Reading

1. Veziroğlu, T.N. 2016. Compendium of Hydrogen Energy. Volume 3,4. Amsterdam: Woodhead Publishing-Elsevier.
2. Basile, A., Dalena, F., Tong, J., & Veziroğlu, T.N. 2017. Hydrogen Production, Separation and Purification for Energy. London: The Institution of Engineering & Technology.
3. Mehmet Sankir, M. & Sankir, N.D. 2017. Hydrogen Production Technologies. New Jersey: Scrivener Publishing-Wiley.
4. Sasaki, K., Li, H.-W., Hayashi, A., Yamabe, J., Ogura, T. & Lyth, S.M. 2016. Hydrogen Energy Engineering. Japan: Springer.
5. Stolten, D. & Emonts, B. 2016. Hydrogen Science and Engineering: Materials, Processes, Systems and Technology. Weinheim: Wiley-VCH.

RARA6032 Energy Policy and Management

The objective of this course is to provide basic knowledge on energy policy and management. The course will cover topics on energy supply and demand in global and national scales, the impacts of energy use and the role in climate change mitigation. Energy policy and statistics will be reviewed and analysed through class activities and exercises. The importance of energy policy and management will be introduced not only in terms of global and nation, but also in an organisation, such as in buildings or industries sector.

Basic Reading:

1. Marc Ozawa, Jonathan Chaplin, Michael Pollitt, David Reiner, Paul Warde (Ed.). 2019. In Search of Good Energy Policy. Series: Cambridge

Studies on Environment, Energy and Natural Resources Governance. Cambridge University Press. 388 p.
2. Power Trip: The Story of Energy Hardcover. 2019. Michael E. Webber. Basic Books. 304 p.
3. Jeremy Rifkin. The Green New Deal: Why the Fossil Fuel Civilization Will Collapse by 2028, and the Bold Economic Plan to Save Life on Earth. 2019. St. Martin's Press. 292 p.
4. Walter A. Rosenbaum. 2019. Environmental Politics and Policy (11 Ed.). CQ Press. 352 p.
5. IRENA. 2019. Global Energy Transformation: A Roadmap to 2050.

RARA6042 Fuel Cell Electrochemistry

This course introduces the general theory of electrochemistry, instrumentation and electrochemical characterization methods for fuel cells. At first, students will be exposed to introductory topics of fuel cells, catalytic materials, conducting membranes and types of fuel cell. Also discussed in this course are basic electrochemical topics, electrocatalyst, thermodynamic of fuel cells and fuel cell redox reactions. Electrochemical analysis methods such as cyclic voltammetry, electrochemical impedance spectroscopy in measuring the catalyst/bio-catalyst performance and fuel cell membranes will also be discussed further in this course. Lastly, students are required to conduct a fuel cell related project and will be evaluated based on presentations and written reports.

Basic Reading:

1. Sorensen, B. & Spazzafumo, G. 2019. Hydrogen and Fuel Cells. 3rd Edition.
   Elsevier/Academic Press.
2. O'Hayre, R., Cha, S-W., Colella, W. & Prinz, F. B. 2016. Fuel Cell Fundamentals. John Wiley & Sons.
3. Jiang, S. P., Li, Q. 2021. Introduction to Fuel Cells: Electrochemistry and Materials. Springer Singapore.
4. Breitkopf C., Swider-Lyons K. 2016. Handbook of Electrochemical Energy. New York: Springer.
5. Koper, M. & Wieckowski, A. 2019. Fuel Cell Catalysis: A Surface Science Approach. Wiley.

RARA6052 Fuel Cell System and Application

The goal of this course is to discuss important topics related to fuel cell technology and application of fuel cell systems as an alternative energy generator. In the initial stage, the students will be given an understanding of the

basic concepts and theories about fuel cells. The types of fuel cells, performance analysis, system control and monitoring of fuel cells, will be widely discussed in the course. In addition, knowledge of the fuel cell system engineering process also will be touched, for which aspects of design, operating conditions, water and heat management as well as the performance of fuel cell systems will be discussed. Current issues, the development of fuel cell technology by merging various disciplines are also discussed in this course. The role of fuel cells in the field of Renewable Energy, applications on the power supply and the vehicle will be presented on laboratory visit program.

Basic Reading:

1. Revankar, S.T. & Pradip Majumdar, P. 2014. Fuel Cells: Principles, Design, and Analysis. Boca Raton: CRC Press.
2. Su, H., Gomez, J.C.C., Reddy, H., Sita, C., Pasupathi, S., Bujlo, P. 2016. Recent Advances in High-Temperature PEM Fuel Cells. Academic Press.
3. Hacker, V., Mitsushima, S. 2018. Fuel Cells and Hydrogen: From Fundamentals to Applied Research. Elsevier.
4. Fergus, J., Hui, R., Li, X., Wilkinson, D.P. & Zhang, J. 2016. Solid Oxide Fuel Cells: Materials Properties and Performance. First Ed. Boca Raton: CRC Press.
5. Kendall, K. and Kendall, M. 2016. High-temperature Solid Oxide Fuel Cells for the 21st Century: Fundamentals, Design and Applications. Second Ed. London: Academic Press.

Research Areas

1. Process System Engineering
2. Fuel Cell Plate Material and Manufacture
3. Fuel Cell Electrochemical Process
4. Direct Liquid Fuel Cell
5. Solid Oxide Fuel Cell
6. Biohydrogen and Biofuel Cell
7. Fuel Processing
8. Solar Hydrogen
9. Energy Policy and Management
10. Hydrogen Storage

Conversion from Master Programme to Doctoral Programme

1. Criteria for the application are as follows:

a) Master students by research mode (thesis only), registered in full time basis, are eligible to apply for the conversion to Doctor of Philosophy Program.

b) Application should be made in the third semester of study so that the application can be processed and the result can be announced before the registration date of the fourth semester.

c) Students who have accomplished the research objectives for the Master programme (usually in the end of third semester) are not eligible to apply for conversion and are required to complete the Master programme.

d) Result of the progress report is satisfactory and the conversion is approved by the supervisor.

2. Process for the application of conversion:

a) The applicant prepares a new research proposal for the Doctor of Philosophy programme which includes:
   - Additional research scope
   - The significance of research
   - Additional research objectives
   - Additional time frame of the research
   - New ideas of the new proposed research
   - New findings expected from the research

b) The application should be submitted to the Director, with the recommendation from the Main supervisor/Chairman of the Supervisory Committee for approval.

c) The Postgraduate Status Change Committee (JPSPP) will be formed to examine and evaluate the candidate' proposal.

d) Applicant will have to present the Doctor of Philosophy proposal in front of the JPSPP and lecturers.

e) JPSPP will express views and comments on the proposal.

f) Applicant will have to amend the proposal according to the suggestions given by the committee (JPSPP).

g) Applicant then will have to submit the new amended proposal to the Head of Administrative for the approval of the Institute's Academic Committee and the Director of Institute.

h) Any decision will be notified to the applicant.

Writing Thesis/Dissertation by Compilation

1. Requirements for thesis/dissertation compilation formats:

a) The supervisor agrees that the thesis/dissertation of the conducted research is written in the form of compilation.

b) Students must submit a written application to the Director to write a thesis/dissertation in the form of compilation.

c) Students have published or their papers have been accepted for publication in well-known journals in the areas recognized by the Institute. However, each discipline requires a different degree of impact to ensure that the quality is equivalent to the Doctorate or Masters degree.

d) The paper should cover the scope and objectives of the research conducted by the students. Papers presented in conferences or seminars, and papers published in indexed conference proceedings or seminars may only be accepted as publication support materials only.

e) Requirements and the number of publications are as follows:

- Doctor of Phloshopy program:

  i. At least **FOUR (4)** articles have been published or accepted for publication in the indexed journals of **WoS** with the quartile scores of ***Q1/Q2*.**

  ii. **TWO (2)** of the articles in Item (i) **MUST** be published or accepted for publication in the indexed journals of **WoS** with the quartile scores of ***Q1*.**

- Master degree program:

  i. At least **TWO (2)** articles have been published or accepted for publication in the indexed journals of **WoS** with the quartile scores of ***Q1/Q2*.**

ii. **ONE (1)** of the articles in Item (i) **MUST** be published or accepted for publication in the indexed journals of **WoS** with the quartile scores of ***Q1*.**

f) Students are required to obtain copyright permission from the publisher of the papers if the student wants to publish a book out of the thesis/dissertation.

g) The student is the **first** or **corresponding author** for each of the papers in Item (e) and all the papers were written with the supervisor.

h) Students with more than one affiliation are required to place the Universiti Kebangsaan Malaysia as the first affiliation in their publication.

i) For local students, where the thesis must be written in Bahasa Melayu except with the permission of the Institute, all the papers can be written and published in the form of required language. However, candidates need to include a summary of the papers and publication journal information in Bahasa Melayu according to the format in Article 2.

2. The format and contents of the thesis/dissertation are as follows:

a) A statement that the thesis/dissertation is written according to the compilation format.

b) List of publications is included as a chapter in the thesis/dissertation.

c) The entire thesis/dissertation should be prepared according to the writing format of UKM style.

d) Introduction Chapter - This chapter gives an introduction to the issues studied and describes the relevance of published papers. This is to ensure the thesis/dissertation is presented in an integrated form.

e) Chapter of the published papers - Each published paper is required to be presented as a separate chapter in the thesis/dissertation. Abstract papers and journal publication information should be included for thesis/dissertation written in a language other than the thesis/dissertation language.

f) Conclusions - This chapter syntheses the findings of the study and provides a comprehensive conclusion on the conducted research.

g) References - list of references should include references from the Introduction and Conclusion chapter.

Maklumat Tambahan/ *Additional Information*

Untuk maklumat lanjut boleh didapati di laman web Pusat Siswazah: (http://www.ukm.my/pusatsiswazah/peraturan-ukm/)

For further information can be found on Graduate Center Website: (http://www.ukm.my/pusatsiswazah/peraturan-ukm/)

Future of Energy

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