UNIVERSITI MALAYA

UMPEDAC

STUDENT HANDBOOK

2026
2027

MASTER OF RENEWABLE ENERGY (MRE)

ACCREDITED PROGRAM BY MALAYSIAN QUALIFICATION AGENCY (MQA)

MQA/SWA/10820

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1.0 EXECUTIVE DIRECTOR'S NOTES

Salam Sejahtera and Warm Greetings.

With the mission of empowering Malaysia with the capability to become a regional leader in power energy, UMPEDAC rose through the ranks to emerge as the nationally acclaimed Higher Institution Centre of Excellence (HICoE) in Engineering Research Cluster in 2009.

Being part of the reputable Universiti Malaya (UM), the foremost and premier Research University in Malaysia, UMPEDAC is undoubtedly a suitable place for pursuing postgraduate studies in the field of energy.

In Malaysia, the evolution of renewable energy has been marked by a diverse mix of solar, hydropower, biomass, biofuels, and biogas projects. Starting with hydropower in the early 20th century, Malaysia has now prioritized renewable energy for sustainable development and energy security.

The nation is committed to reducing its reliance on fossil fuels, with renewable energy systems, supported by initiatives like Net Energy Metering (NEM) and Supply Agreement of Renewable Energy (SARE), seeing rapid growth. Policies such as the Renewable Energy Act 2010 and the Malaysia Renewable Energy Roadmap (MyRER) provide incentives and strategic direction for the sector, aiming to achieve national climate goals and a net-zero emissions target by 2050.

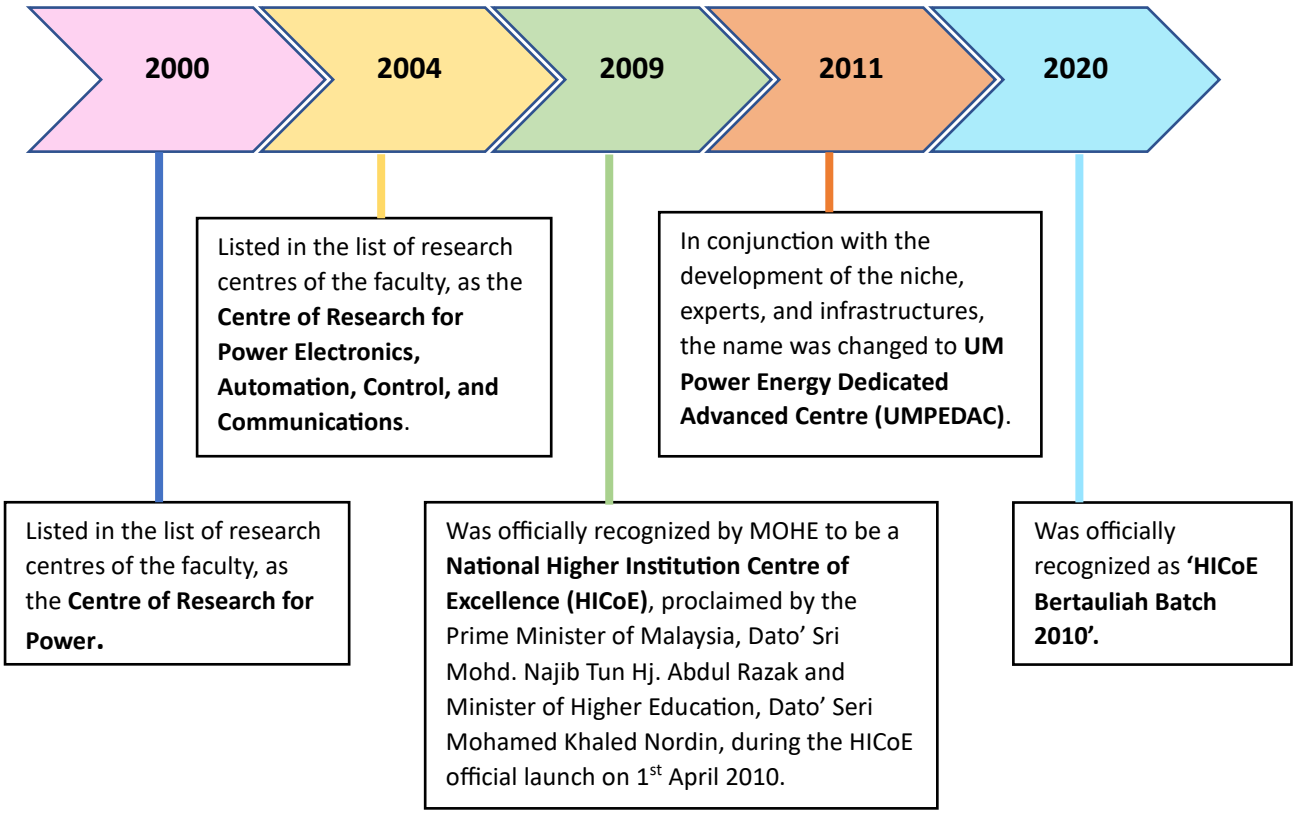
To cater the needs, Master of Renewable Energy (MRE) was designed to produce experts in the field of renewable energy. The programme aims to develop human resources with the knowledge and skills to advance research and development of effective measures to address energy related issues.

I believe the Master of Renewable Energy Programme that you have chosen to pursue will be of great benefit to you in your future career and it will empower you with the capability to contribute to the society. I hope that you find the information in this prospectus useful in guiding you through your time as a student here. I wish you every success in your studies.

Lastly, I again welcome you to UMPEDAC and encourage you to take advantage of all it has to offer.

Professor Ir. Ts. Dr. Jeyraj Selvaraj
Executive Director of UMPEDAC

2.0 UMPEDAC HISTORY



3.0 UMPEDAC VISION, MISSION, AND NICHE AREAS

Vision

Empowering Malaysia with the capability to become a regional leader in power energy.

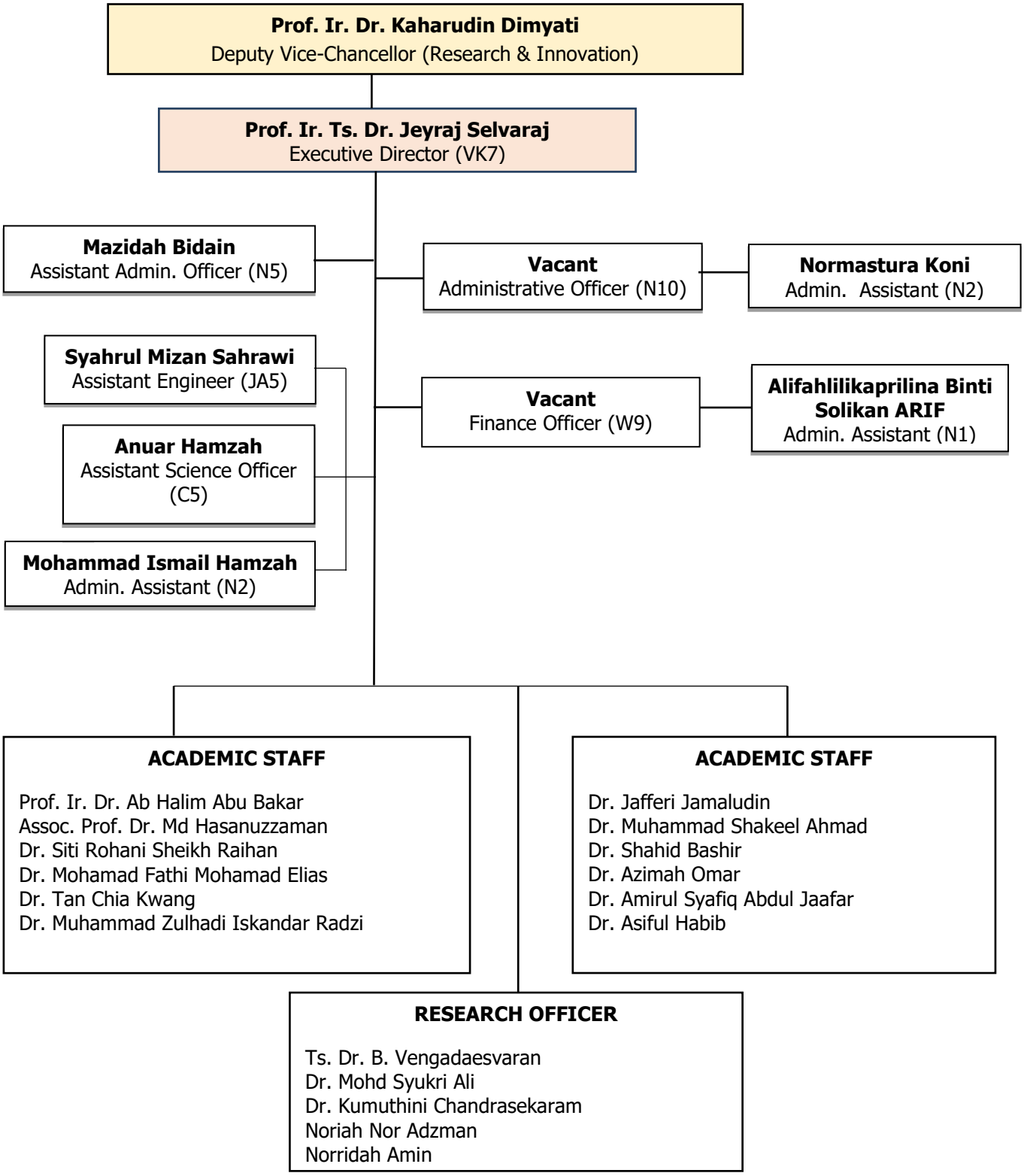
Mission

Reaching innovations that benefit the nation improves the quality of life and raises Malaysia's standard of research in power energy and its related fields.

Niche Areas

Automation and Control
Energy Security
Energy Policy
Hydrogen Technology
Power Electronics
Power System
Power System Protection
Power Quality
Smart Transportation System
Solar Energy
Energy Efficiency
Electrical Motor Drives
Fuel Cell Technology
Machine Design
Power Energy
Power System Stability
Power System Optimization
Renewable Energy
Smart Grid System

4.0 UMPEDAC ORGANISATIONAL CHART



5.0 UMPEDAC EXPERTS

Professor Ts. Dr. Jeyraj Selvaraj
Executive Director
(jeyraj@um.edu.my)

Power Electronic, Solar Energy Systems, and Renewable Energy Connected to Grid

Assoc. Prof. Dr. Tan Chia Kwang
(cktan@um.edu.my)

Power System Study, Power System Protection and

Dr. Siti Rohani Sheikh Raihan
(srohani_sr@um.edu.my)

Power Electronics, Renewable Energy and Embedded Systems

Ts. Dr. Jafferi Jamaludin
(jafferi@um.edu.my)

Power Electronics and Energy Efficiency

Dr. Muhammad Shakeel Ahmad
(muhammadshakeel@um.edu.my)

Hydrogen Technology, Integrated Systems, Third Generation Solar Cells and Structural Micro/Nano Materials

Dr. Azimah Omar
(azimahomar@um.edu.my)

Solar Cell Materials, Carbon Materials, Dye-Sensitized Solar Cell (DSSC), Fabrication and Testing, and Solar PV Module Testing

Dr. Amirul Syafiq Abdul Jaafar (amirul90@um.edu.my)

Nano-Materials, Nanotechnology, Thin-film, Self-Cleaning Coating and Polymer Materials

Assoc. Professor Dr. Md. Hasanuzzaman
(hasan@um.edu.my)

Thermal Engineering, Renewable Energy, Solar Energy, Energy Policy, Energy and Building, Electric Vehicle and Smart Transport

Dr. Mohamad Fathi Mohamad Elias
(fathi@um.edu.my)

Power Electronics and Electrical Drives

Dr. Shahid Bashir
(shahidbashirbaig@um.edu.my)

Polymers, Ceramics, Composites, Nanomaterials (Polymer hydrogels, Polymer Electrolytes, Electrode Materials, MXenes, Supercapacitors, Batteries, Solar Cells, Drug Delivery)

Dr. Zulhadi Iskandar Radzi
(zi.radzi@um.edu.my)

Li/Na-ion batteries; Electrode materials & nanostructures; Electrochemical performance evaluation; Impedance spectroscopy & reaction kinetic

Dr. Asiful Habib
(asifhimu@um.edu.my)

Electric machine design & drive, Electric vehicle, Renewable Energy.

6.0 ACADEMIC CALENDAR

ACADEMIC CALENDAR 2026/2027 ACADEMIC SESSION
(MASTER AND DOCTORATE LEVEL)
AMENDMENT

SEMESTER I					
Orientation *(Week of Welcome) - WOW*	1	week	26.09.2026	-	04.10.2026
Lectures	8	weeks*	05.10.2026	-	29.11.2026
Mid Semester I Break	1	week	30.11.2026	-	06.12.2026
Lectures	6	weeks*	07.12.2026	-	17.01.2027
Revision Week	1	week*	18.01.2027	-	24.01.2027
Semester I Final Examination	2	weeks*	25.01.2027	-	04.02.2027
Semester I Break	3	weeks*	05.02.2027	-	28.02.2027
	22	weeks			
SEMESTER II					
Lectures	7	weeks*	01.03.2027	-	18.04.2027
Mid Semester II Break	1	week	19.04.2027	-	25.04.2027
Lectures	7	weeks*	26.04.2027	-	13.06.2027
UM iFest 2027	*1*	*week*	*08.06.2027*	-	*11.06.2027*
(No teaching and learning (T&L) activities shall be conducted during this period. Participation is mandatory for all final-year students / students undertaking the Final Year Project (FYP).)					
Revision Week	1	week	14.06.2027	-	20.06.2027
Semester II Final Examination	2	weeks	21.06.2027	-	04.07.2027
Semester II Break	3	weeks	05.07.2027	-	25.07.2027
	21	weeks			
SPECIAL SEMESTER					
Lectures	7	weeks*	19.07.2027	-	05.09.2027
Special Semester Final Examination	1	week	06.09.2027	-	12.09.2027
Special Semester Break	1	week*	13.09.2027	-	19.09.2027
	9	weeks			

7.0 PROGRAMME INTRODUCTION

- Master of Renewable Energy (MRE) is a matching programme for Master of Energy Science from Kyoto University, Japan under the University of Malaya - Kyoto University double Master degree agreement.
- It is designed to provide graduate students with advanced understanding in various core areas in Renewable Energy technology and management.
- The main objective of this programme is to offer an education that is directly relevant to the latest advancements in the Renewable-Energy-related industry.

8.0 PROGRAMME INTAKE

9.0 PROGRAMME STRUCTURE

This program consists of 42 credit hours:

- Core courses: 15 credits (3 credits per subject)
- Research project: 12 credits (6 credits per semester)
- Elective courses: 15 credits (Choose 5 subjects, 3 credits per subject)

Minimum duration of study is 2 semesters and maximum is 8 semesters.

10.0 PROGRAMME LEARNING OUTCOME

Students who will successfully obtain Master of Renewable Energy are able to:

PLO1	Demonstrate expertise in the renewable energy field
PLO2	Produce solutions to problems using scientific skills and critical thinking in the field of renewable energy
PLO3	Translate the knowledge learnt into practical skills in renewable energy field
PLO4	Managing information in digital age for lifelong learning in the field of renewable energy
PLO5	Demonstrate ability to communicate and work as a team
PLO6	Demonstrate leadership quality through effective communication among renewable energy partners and agencies
PLO7	Demonstrate entrepreneurial mindset in dealing with energy-related projects
PLO8	Conduct research with minimum supervision and adhere to legal, ethical, and professional practice codes in areas related to renewable energy

11.0 CORE COURSES (COMPULSORY)

Course Code	Course Title	Credit Hours
HQA7001	Research Methodology	3
HQA7022	Research Project	12
HQA7003	Energy and Sustainable Development	3
HQA7004	Energy Policy	3
HQA7005	Energy Efficiency and Management	3
HQA7006	Foundation of Renewable Energy	3

12.0 ELECTIVE COURSES (CHOOSE 5 SUBJECTS)

Course Code	Course Title	Credit Hours
HQA7011	**Smart Grid***	3
HQA7012	**Bioenergy***	3
HQA7014	Energy Storage Technology	3
HQA7015	Low Carbon Buildings	3
HQA7016	Energy Economics	3
HQA7018	**Solar Energy***	3
HQA7019+	**Hydro Energy***	3
HQA7021+	Hydrogen Technology	3

NOTE:

1) For elective courses, minimum number of students must be more than 10 registered students at any time;
2) Course offered are subjected to the availability of lecturer of the specific course;
3) *** Course content may contain highly technical aspects. Please ensure that you are familiar with the fundamentals of the subject matter before selecting these courses. Discuss with the subject lecturer if unsure of the suitability for student.**
4) + Courses are conducted simultaneously.

13.0 OPPORTUNITY TO STUDY IN JAPAN

- This programme is a matching programme for Master of Energy Science from Kyoto University, Japan under the University of Malaya - Kyoto University Double Degree Memorandum of Agreement signed on 16th August 2008.
- Students can be awarded two Master Degrees from Universiti Malaya (UM) and Kyoto University (KU), Japan by means of overseas study programme with credit transfer.

STUDENTS SELECTION PROCEDURE

UMPEDAC will select students per academic session of appropriate ability and academic standard to participate in this programme (subjected to Kyoto University requirement that might be changed from time to time).

Students selected for the program must fulfill the following requirements:

i) A relevant undergraduate specialization
ii) Appropriate English language ability (IELTS or TOEFL)
iii) An appropriate academic performance record
iv) Recommendation letters
v) Interviews

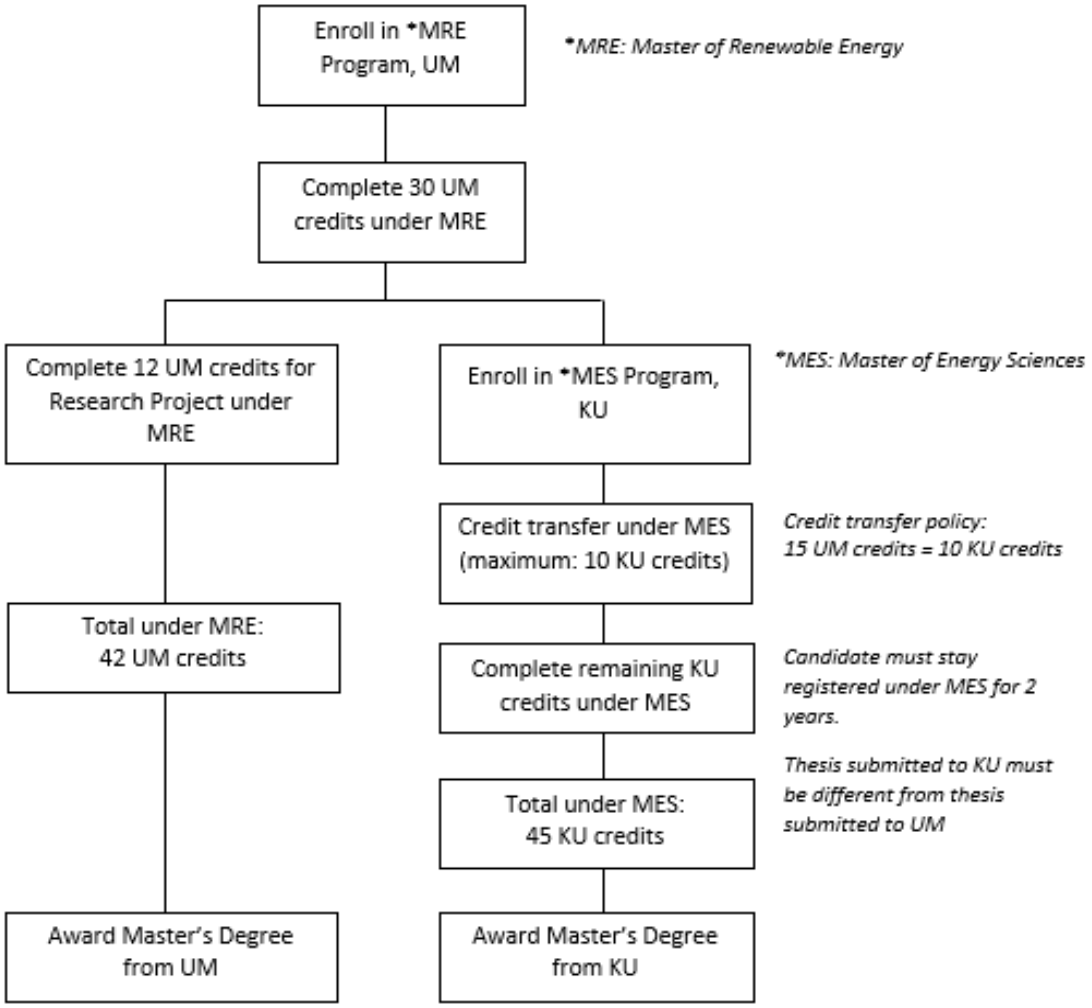
CONFERRAL OF DEGREE

Upon successful completion of the Double Master Degree Programme, students who meet the graduation requirements will be conferred a Master's Degree from Universiti Malaya, Malaysia and a Master's Degree from Kyoto University, Japan.

TUITON & FEES

Each student will pay the required tuition and other fees to the home institution for the duration of their study.

PROCESS FLOW TOWARDS COMPLETION OF DOUBLE MASTER DEGREE PROGRAMME



14.0 ASSESSMENT METHODS

- For Research Methodology and Research Project
  - Continuous Assessment: 100%
  - Final Exam (Alternative Assessment): 0%

- For all other subjects
  - Continuous Assessment: 50%
  - Final Exam (Alternative Assessment): 50%

15.0 SCORING

- Candidates must pass all core courses and 5 elective courses and a minimum grade point 3.0 (Grade B) for each subject and with a grade point average (GPA) of at least 3.0 for each semester.
- Evaluation and scoring used for this program is based on the structural evaluation and scoring system adopted for semester at the Universiti Malaya.

Grade	Scores	Grade Point	Purpose
A	80-100	4.0	Brilliant
A-	75-79	3.7	Brilliant
B +	70-74	3.3	Pass
B	65-69	3.0	Pass
B-	60-64	2.7	Failed
C +	55-59	2.3	Failed
C	50-54	2.0	Failed
C-	45-49	1.7	Failed
D +	40-44	1.5	Failed
D	35-39	1.0	Failed
F	0-34	0.0	Failed
U			Not satisfactory
R			Registered for audit
UW			Unofficial withdrawal
W			Official withdrawal
P			Progress
S			Satisfy
K			Notional
I			Unfinished

16.0 STUDY PLAN

TIMETABLE FOR SEMESTER 1					
COORDINATOR: Dr. Siti Rohani Sheikh Raihan					
DAY	**TIME**	**COURSE CODE**	**COURSE TITLE**	**LECTURER**	**VENUE**
Saturday	9.00 am - 12.00 noon	HQA7014	Energy Storage Technology	Dr. Mohamad Fathi Mohamad Elias	Lecture Room, Level 20, Wisma R&D
	12.00 noon - 3.00 pm	HQA7006	Foundation of Renewable Energy	Dr. Azimah Omar	
	3.00 pm - 6.00 pm	HQA7001	Research Methodology	Dr. Siti Rohani Sheikh Raihan	
Sunday	9.00 am - 12.00 noon	HQA7003	Energy and Sustainable Development	Dr. Shahid Bashir	Lecture Room, Level 20, Wisma R&D
	12.00 noon - 3.00 pm	HQA7015	Low Carbon Buildings	Dr. Thibeorchews Prasankumar	
	3.00 pm - 6.00 pm	HQA7005	Energy Efficiency and Management	Ts. Dr. Jafferi Jamaludin	

TIMETABLE FOR SEMESTER 2					
COORDINATOR: Dr. Siti Rohani Sheikh Raihan					
DAY	**TIME**	**COURSE CODE**	**COURSE TITLE**	**LECTURER**	**VENUE**
Saturday	9.00 am - 12.00 noon	HQA7018	Solar Energy	Prof. Ir. Ts. Dr. Jeyraj Selvaraj	Lecture Room, Level 20, Wisma R&D
	12.00 noon - 3.00 pm	HQA7011	Smart Grid	Dr. Tan Chia Kwang	
	3.00 pm - 6.00 pm	HQA7004	Energy Policy	Assoc. Prof. Dr. Md. Hasanuzzaman	
Sunday	9.00 am - 12.00 noon	HQA7019	Hydro Energy	Dr. Asiful Habib	Seminar Room, Level 15, Wisma R&D
		HQA7021	Hydrogen Technology	Dr. Muhammad Shakeel Ahmad	Lecture Room, Level 20, Wisma R&D
	12.00 noon - 3.00 pm	HQA7012	Bioenergy	Assoc. Prof. Dr. Lee Hwei Voon / Prof. Dr. Juan Joon Ching	
	3.00 pm - 6.00 pm	HQA7016	Energy Economics	Dr Muhammad Zulhadi Iskandar Radzi	

17.0 RESEARCH PROJECT FOR MASTER OF RENEWABLE ENERGY

- Research Project is **12 credit hours, constituting 28.6% of the credit hours in this program**. The course comprised of Research Project 1 and Research Project 2, distributed over 2 semesters.
- The topic titles for the Research Project course should be relevant to the field of Renewable Energy and Energy related fields including the following:
  - Mathematical Modelling
  - Hardware Development
  - Experimental Work
  - Simulation and Modeling Using Matlab etc.
  - Measurement and Monitoring
  - Energy Audit and Management
  - Energy Economics and Policy
  - Energy Conversion
- Candidates can also come up with their own topic, but they should comply with the above conditions.
- Students can request for the list of available research project titles from the PROGRAM COORDINATOR at any time. They can then select the titles and discuss with the potential supervisors before registering for the research project.
- Once a student registers for research project, the first two weeks of the first semester are for the candidates to submit the form:

  - *CONFIRMATION OF RESEARCH PROJECT TITLE FOR MASTER OF RENEWABLE ENERGY (FORM 1)*. **Students can be disqualified from sitting for final project presentation if this step is not completed on time.**
- This research project must be completed in 2 consecutive semesters back-to-back. Students will be given a Fail Grade for failing to complete the research project in 2 consecutive semesters.
- It is highly recommended for students to conduct a thorough planning before registering for research project. Discussions with potential supervisors and identifying the topic of research before registering for research project are highly recommended.
- Candidates must meet a minimum of six (6) discussion sessions with supervisors per semester and the meeting sessions must be documented in RESEARCH PROJECT SUPERVISOR-SUPERVISEE MEETING RECORD (PROGRESSIVE 1) form – FORM 2 for Research Project 1; and RESEARCH PROJECT SUPERVISOR-SUPERVISEE MEETING RECORD (PROGRESSIVE 2) form – FORM 4 for Research Project 2.

- At the end of Research Project 1, candidates are required to submit a 10-page report for assessment by the examiner (The same examiner will assess the candidate for Research Project 2) through PERFORMANCE EVALUATION FORM OF P1 (FORM 3).
- At the end of Research Project 2, candidates are required to submit a dissertation report together with SUBMISSION OF RESEARCH PROJECT FOR SUPERVISOR EXAMINATION (FORM 6). Candidates are also required to conduct a 20 minutes presentation, followed by question and answer session.
- The guideline for dissertation report writing can be accessed from the Downloadable Form page of Institute for Advanced Studies (IAS) website under Thesis Submission / Examination tab or using the URL below:

  https://ias.um.edu.my/downloadable-form#thesis-submission-examination
- The UMPEDAC Higher Degree Committee will have a meeting to decide on the examiners for each of the students.
- Candidates are not allowed to change supervisors and examiners, once it has been decided by the UMPEDAC Higher Degree Committee (*JIT*). The *JIT* committee can decide otherwise under special circumstances.

18.0 LIST OF COURSES

This section provides information for each of the subjects. This information will facilitate students in selecting elective courses.

Some elective courses may contain highly technical content. Refer to Section 12.0 for the list of these subjects. Please ensure that you are familiar with the fundamentals of these subject matter before selecting these elective courses. Discuss with the subject lecturer if unsure of the suitability for you.

* Some course information may vary from semester to semester.

18.1 HQA7001 Research Methodology

Kredit* Credit*	3
Student Learning Time (SLT)	120 hours
Course Pre-requisite(s) / Minimum Requirement(s)	-
Course Learning Outcomes*	At the end of the course, students are able to: 1. Formulate a problem statement and research questions 2. Analyse critically the literature review based on authoritative resources in their respective fields of research. 3. Write a research proposal / report. 4. Perform oral presentation of the research proposal.
Synopsis of Course Contents	This course begins with introduction to research methodology, literature review and scientific research method. Next, research proposal, paper and report writing techniques will be introduced, including Endnote/Mendeley software training. Ethical issues and university research police will be discussed next. Finally, a presentation on research proposal will be conducted at the end of the course.
Assessment Weightage*	Continuous Assessment: 100% Final Examination: 0%
Methodologies for Feedback on Performance	Results will be notified through internet / student portal.
Criteria in Summative Assessment	Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.
Bahasa Pengantar Medium of Instruction	Bahasa Inggeris / English
Rujukan Utama Main Reference	1. R. Kumar (2018) Research Methodology: A Step-by-Step Guide for Beginners, Publisher: SAGE Publications Ltd; Fifth Edition. 2. J.W. Crewell (2018), Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, Publisher: SAGE Publications, Inc; Fifth Edition

	3. Willie Chee Keong Tan (2017), Research Methods: A Practical Guide for Students and Researchers: World Scientific 4. Guide to the Preparation of Research Reports, Dissertations & Theses, Institute for Advanced Studies (IAS), University of Malaya, Kuala Lumpur, Malaysia 5. End note user guide, EndNote, Version X4 for Macintosh and Windows, http://software.um.edu.my/file/EndNote/EndNote_X4/ENX4_GettingStartedGuide_WinMac.pdf, 90 pages
Strategi Pembelajaran Learning Strategies	Kuliah, pembelajaran atas talian, seminar pembentangan Lectures, online learning, presentation seminar
Masa Pembelajaran Pelajar Student Learning Time	Bersemuka / Face to face: 36 jam / 36 hours *Tidak Bersemuka* / Non-Face to face: *6 jam* / 6 hours *Masa Persediaan Pelajar* / Student Preparation Time: *78 jam* / 78 hours
Kemahiran Boleh Pindah Transferable Skills	Kemahiran pengurusan maklumat Information management skill
Pensyarah / Lecturer Bilik / Room Telefon / e-mel Telephone / e-mail	Dr. Siti Rohani Sheikh Raihan Room 18-1, Level 18, Wisma R&D UM 03-22463418 / srohani_sr@um.edu.my
Sesi Kuliah / Lecture Session:	Sila rujuk myum.um.edu.my Please refer myum.um.edu.my
Sesi Tutorial / Amali: Tutorial / Practical Session:	Tiada / None
Perincian Pemberatan Penilaian Detail of Assessment Weightage	Penilaian Berterusan / Continuous Assessment: 100% Peperiksaan akhir / Final Examination: 0%

Jadual Pengajaran / *Teaching Schedule*

Minggu **Week**	Topik & Aktiviti **Topic & Activities**	Rujukan **References**
1	Pengenalan kepada metodologi penyelidikan. Introduction to research methodology.	Rujukan utama 1 Main Reference 1
2	Kaedah penyelidikan saintifik Scientific research methods	Rujukan utama 2 Main Reference 2
3	Kajian literatur Literature review	Rujukan utama 1, 3 Main Reference 1, 3
4	Rekabentuk penyelidikan Research design	Rujukan utama 2, 3 Main Reference 2, 3
5	Aktivit NF2F Menulis kertas cadangan - Master, PhD, Geran Penyelidikan NF2F Activity Proposal writing - Master, PhD, Research grant	Rujukan utama 1, 3 Main Reference 1, 3
6	Latihan perisian – Endnote / Mendeley, Turnitin Software training – Endnote / Mendeley, Turnitin	Rujukan utama 5 Main Reference 5
7	Aktiviti NF2F Kajian literatur NF2F Activity Literature review	Rujukan utama 1, 3 Main Reference 1, 3
8	Polisi penyelidikan universiti, isu etika dan plagiarisme University research policy, ethical issues and plagiarism	Rujukan utama 4 Main Reference 4
9	Penulisan jurnal dan laporan projek penyelidikan Journal writing and report writing	Slaid kuliah Lecture slides
10	Penyediaan pembentangan persidangan, pembentangan lisan, pembentangan poster. Preparing conference presentation, oral presentation, poster presentation	Slaid kuliah Lecture slides
11	Pembentangan Pelajar, Seminar Student Presentation, seminar	-
12	Pembentangan Pelajar, Seminar Student Presentation, Seminar	-
13	Pembentangan Pelajar, Seminar Student Presentation, Seminar	-
14	Pembentangan Pelajar, Seminar Student Presentation, Seminar	-

18.2 HQA7002 / 7022 Research Project

Kredit* Credit*	12
Masa Pembelajaran Pelajar (SLT) Student Learning Time (SLT)	480
Prasyarat / Keperluan Minimum Kursus Course Pre-requisite(s) / Minimum Requirement(s)	-
Hasil Pembelajaran Kursus* Course Learning Outcomes*	At the end of the course, students are able to: 1. Perform literature review on research topics 2. Manage a methodology to carry out research 3. Evaluate data from the experiment /survey 4. Write a scientific report based on the research results 5. Present the scientific report based on the research results
Sinopsis Kandungan Kursus Synopsis of Course Contents	This course starts with reviewing literature on a specific research topic. A research methodology plan will be developed next. Data collection, data interpretation and report writing are carried out to complete the project before presenting the results at the end of the course.
Pemberatan Penilaian* Assessment Weightage*	Continuous Assessment: 100% Final Examination: 0%
Kaedah Maklum Balas Tentang Prestasi Methodologies for Feedback on Performance	Online feedback
Kriteria Dalam Penilaian Sumatif Criteria in Summative Assessment	Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.
Bahasa Pengantar Medium of Instruction	Bahasa Inggeris English
Rujukan Utama Main Reference	Jurnal-jurnal penyelidikan, Maklumat di laman web, Buku-buku (bergantung kepada tajuk penyelidikan) Research journals, information on websites, books (depending on research topic)
Strategi Pembelajaran Learning Strategies	Tugasan, Perbincangan Assignments, Discussion

Masa Pembelajaran Pelajar Student Learning Time	Bersemuka / Face to face: 29 jam / 29 hours Tidak Bersemuka / Non Face to face: 0 jam / 0 hours Masa Persediaan Pelajar / Student Preparation Time: 451 jam / 451 hours
Kemahiran Boleh Pindah Transferable Skills	1. Endnote / Mendeley 2. Turnitin
Pensyarah / Lecturer Bilik / Room Telefon / e-mel Telephone / e-mail	Program Coordinator Level 18, UMPEDAC, Wisma R&D UM
Sesi Kuliah / Lecture Session: Hari / Masa Day / Time Tempat / Venue	Tiada / None
Sesi Tutorial/Amali: Tutorial / Practical Session: Hari / Masa Day / Time Tempat / Venue	Tiada / None
Perincian Pemberatan Penilaian Detail of Assessment Weightage	Penilaian Berterusan / Continuous Assessment:100% Peperiksaan akhir / Final exam: 0%

Jadual Pengajaran / Teaching Schedule

Semester 1

Minggu **Week**	Topik & Aktiviti **Topic & Activities**	Rujukan **References**
1 - 7	Kajian literature / Literature review	Sila lihat rujukan utama See main reference
8 - 11	Perancangan projek / Project planning	Sila lihat rujukan utama See main reference
12 - 14	Pengumpulan data / Data collection	Sila lihat rujukan utama See main reference

Semester 2

Minggu **Week**	Topik & Aktiviti **Topic & Activities**	Rujukan **References**
1 - 6	Pengumpulan data, analisa data / Data collection, data analysis	Sila lihat rujukan utama See main reference
7 - 12	Penulisan laporan akhir / Final report writing	Sila lihat rujukan utama See main reference
13	Penghantaran laporan akhir / Final report submission	Sila lihat rujukan utama See main reference
14	Pembentangan / Presentation	Tiada None

18.3 HQA7003 Energy and Sustainable Development

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat / Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* *1. Use the concept of sustainable development in daily life and policy making* *2. Assess the performance of energy systems using Life Cycle Assessment* *3. Analyze the feasibility of different low carbon energy technologies.*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course presents the development of energy technology, energy resources, and energy technologies available today, and of some emerging technologies for the future. The concept of sustainable energy which is defined as a living harmony between the equitable of energy services to all people and preservation of the earth for future generations will analysed. Life cycle assessment of energy systems and infrastructure configurations for energy delivery is one of the aspects that this course is going to emphasis. This course will examine the broader aspects of energy use from the viewpoints of sustainability, resource availability, technical performance, environmental effects, economics and a system perspective. Finally, policies involved in sustainable energy and issues related to energy in developing countries will be discussed.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment:50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through internet / student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	English

Rujukan Utama *Main Reference*	1. *Jingzheng Ren, Sara Toniolo (2019) Life Cycle Sustainability Assessment for Decision-Making: Methodologies and Case Studies, Elsevier Science.* 2. *Xiangwan Du, Dadi Zhou, Qingchen Chao, Zongguo Wen, Taoli Huhe, Qiang Liu (2019) Overview of Low-Carbon Development, Springer Nature.* 3. *Emanuela Colombo, Diego Masera and Stefano Bologna (2013) Renewable Energy for Unleashing Sustainable Development, Springer* 4. *Mohammad Aslam Uqaili and Khanji Harijan (2012) Energy, Environment and Sustainable Development, Springer*
Strategi Pembelajaran *Learning Strategies*	Lecture, assignment and presentations
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face* :44 hours Tidak Bersemuka / *Non Face to face*: 0 hours Masa Persediaan Pelajar / *Student Preparation Time*: 76 hours
Kemahiran Boleh Pindah Transferable Skills	Performing Life Cycle Assessment using software tools
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	Dr. Shahid Bashir Room 18-3, Level 18, Wisma R&D UM 03-2246 3416 / shahidbashirbaig@um.edu.my
Sesi Kuliah / *Lecture Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	Please refer to the current timetable
Sesi Tutorial/Amali: *Tutorial / Practical Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	Tiada / None
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada tenaga dan pembangunan mampan *Introduction to energy and sustainable development*	Main References 3,4
2	Status Tenaga Dunia, potensi dan kesan alam sekitar *World Energy status, potential and environmental impact*	Main References 3,4
3	Konsep pembangunan dan kemapanan yang mampan *Sustainable development and sustainability concepts*	Main References 3,4
4	Rangka kerja kemapanan *Sustainability frameworks*	Main References 3,4
5	Pembentangan *Presentation*	N/A
6	Penilaian kitaran hayat sistem tenaga *Life cycle assessment of energy systems*	Main Reference 1
7	Penilaian kitaran hayat sistem tenaga dengan Open LCA *Life cycle assessment of energy systems using Open LCA*	N/A
8	Ujian, Perbincangan Tugasan *Test, Discussion on Assignment*	N/A
9	Ceramah daripada Penceramah Jemputan / Pembentangan *Talk from invited speaker / Presentation*	N/A
10	Kelestarian melalui teknologi tenaga rendah karbon & konsep Tenaga dan pengurusan persekitaran *Sustainability through low-carbon energy technologies & Energy and environment management concept*	Main References 2
11	Halangan dan pemboleh bagi teknologi tenaga lestari *Barriers and enablers for sustainable energy technologies*	Main References 3,4
12	Perbincangan Tugasan *Discussion on Assignment*	N/A
13	Membuat keputusan dalam kelestarian & Menilai prestasi amalan pengurusan tenaga dan alam sekitar *Decision making in sustainability & Evaluating the performance of energy and environment management practice*	Main References 3,4
14	Pembentangan *Presentation*	N/A

18.4 HQA7004 Energy Policy

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* 1. *Interpret concepts of policy for renewable energy.* 2. *Analyse the policy to implement renewable energy project.* 3. *Justify impacts of energy policy in social, economic and environmental issues.* 4. *Interpret the energy policy in current practice.*
Kemahiran Insaniah *Soft Skills*	● *Communication Skills (CS1, 2, 3, 5)* ● *Critical Thinking and Problem-Solving Skills (CT1, 2, 3, 5)* ● *Life Long Learning and Information Management (LL1, 2)* ● *Ethics and Moral (EM1, 2)*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course consists of energy supply, demand and forecasting. The renewable energy policies in Malaysia and others countries in term of feed-in-tariffs, renewable energy target, pricing law and quota, incentives rebate/tax exemption and awareness are going to be covered and emphasis. This course also focuses on the institutional structure, regulatory framework as well as international standard*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment:50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through the internet / student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	Bahasa Inggeris / *English*
Rujukan Utama *Main Reference*	1. *Roy L. Nersesian. (2016) Energy Economics: Markets, History and Policy, 1st Edition* 2. *Carol Dahl. (2015) International Energy Markets: Understanding Pricing, Policies, and Profits, 2nd Edition*

	3. *Kenneth J. Skipka, Louis Theodore. (2014) Energy Resources: Availability, Management, and Environmental Impacts, April 22, 2014 by CRC Press, 485 Pages* 4. *Hasanuzzaman, M., Nasrudin, N.A (2019) Energy for Sustainable Development, Demand, Supply, Conversion and Management, 1st Edition* 5. *Charles H. Eccleston, Frederic March & Timothy Cohen. (2017) Inside Energy: Developing and Managing an ISO 50001 Energy Management System, CRC Press, 319 Pages* 6. *National Energy Statistic Handbook (2019), Energy Commission, Malaysia.* 7. *Online journal (Energy Policy, Energy, etc)*
Strategi Pembelajaran *Learning Strategies*	Kuliah, Perbincangan, Pembentangan, Peperiksaan Akhir *Lectures, Discussion, Presentations, Final examination*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 44 jam / *44 hours* Tidak Bersemuka / *Non-Face to face*: 0 jam / *0 hours* Masa Persediaan Pelajar / *Student Preparation Time*: 76 jam / *76 hours*
Kemahiran Boleh Pindah Transferable Skills	Analisa Tenaga *Energy Analysis*
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Associate Prof. Dr. Md. Hasanuzzaman* *Room 18-16, Level 18, Wisma R&D UM* *03-22463405 / hasan@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk jadual terkini. *Please refer to the current timetable.*
Sesi Tutorial / Amali *Tutorial / Practical Session* Hari / Masa *Day / Time* Tempat / *Venue*	Tiada / None
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Bekalan tenaga *Energy supply*	Rujukan Utama 1, 2 *Main Reference 1,2*
2	Permintaan tenaga *Energy demand*	‘’
3	Ramalan bekalan tenaga dan permintaan *Forecast of energy supply and demand*	‘’
4	Polisi tenaga di Malaysia, Sasaran tenaga boleh diperbaharu *Energy policies in Malaysia, renewable energy target*	‘’
5	Dasar tenaga di negara-negara utama yang lain *Energy policies in other major countries*	‘’
6	Harga tenaga, *feed-in-tari* *Energy price, feed-in-tariffs*	‘’
7	Ujian, perbincangan atas tugasan *Test, discussion on assignment*	‘’
8	Insentif, rebat / pengecualian cukai, subsidi dan kesedaran untuk tenaga boleh diperbaharu *Incentives, rebate/tax exemption, subsidies and awareness for renewable energy*	Persembahan slaid Slide presentation
9	Kuliah tetamu / bengkel *Guest Lecture / workshop*	Persembahan slaid Slide presentation
10	Struktur institusi tadbir urus dan rangka kerja pengawalseliaan untuk tenaga, Piawaian antarabangsa *Institutional structure of governance and regulatory framework for energy, International standards*	Rujukan Utama 2 - 5 *Main Reference* *2- 5*
11	Mekanisme Pembangunan Bersih *Clean Development Mechanism*	‘’
12	Ujian, perbincangan atas kesan polisi *Test, discussion on impacts of policy*	‘’
13	Rembentanagn hasil kajian kes "polisi tenaga". *Present the findings of the case study “energy policy”.*	‘’
14	Rembentangan hasil kajian kes "polisi tenaga". *Present the findings of the case study “energy policy”.*	‘’

18.5 HQA7005 Energy Efficiency and Management

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	-
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* 1. *Relate energy management and conservation to societal and environmental issues* 2. *Integrate skills and knowledge in designing approaches for energy management system implementation* 3. *Adapt the use of energy-efficient technologies*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course introduces the students to the basic principles and key elements of energy management including how to conduct energy analysis. The students will learn about the various energy efficient technologies and energy conservation measures. The students will also be exposed to the good practices to achieve energy savings.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Online feedback and oral comments after presentation of assignments* *Results will be notified through internet/student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to the University of Malaya (Masters Degree) Rules 2019 and University of Malaya (Masters Degree) Regulations 2019*
Bahasa Pengantar *Medium of Instruction*	Bahasa Inggeris / *English*
Rujukan Utama *Main Reference*	1. *Frank Kreith & D. Yogi Goswami, 2016. Energy Management and Conservation Handbook, 2nd edition, CRC Press.* 2. *Frank Kreith & D. Yogi Goswami, 2016. Energy Efficiency and Renewable Energy Handbook, 2nd edition, CRC Press.* 3. *Nikolai V. Khartchenko & Vadym M. Khartchenko, 2014. Advanced Energy Systems, 2nd edition, CRC Press.* 4. *Barney L. Capehart, Wayne C. Turner & William J. Kennedy, 2016. Guide to Energy Management, 8th edition, The Fairmont Press.*

	5. *Stephan A. Roosa, Wayne C. Turner & Steve Doty, 2018. Energy Management Handbook, 9th edition, Taylor & Francis.* 6. *Clive Beggs, 2009. Energy Management, Supply and Conservation by, 2nd edition, Elsevier Ltd.* 7. *Frank (Xin X.) Zhu, 2014. Energy and Process Optimization for the Process Industries, AIChE Wiley.*
Strategi Pembelajaran *Learning Strategies*	Kuliah, perbincangan, kajian kes, pembentangan seminar *Lecture, discussion, case study, seminar presentation*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face-to-Face*: 43 Tidak Bersemuka / *Non-Face-to-Face*: 1 Masa Persediaan Pelajar / *Student Preparation Time*: 76
Kemahiran Boleh Pindah Transferable Skills	Kemahiran perisian analisis tenaga, kemahiran pemikiran kritis dalam penilaian prestasi tenaga *Energy analysis software skills, critical thinking skills in energy performance evaluation*
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	Ts. Dr. Jafferi Jamaludin *Room 18-12, Level 18, Wisma R&D UM* *03-2246 3407 / jafferi@um.edu.my*
Sesi Kuliah / *Lecture Session* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk jadual terkini. *Please refer to the current timetable.*
Sesi Tutorial / Amali *Tutorial / Practical Session* Hari / Masa *Day / Time* Tempat / *Venue*	Tiada / None
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir/ *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Senario Tenaga, Polisi dan Perundangan berkaitan Pengurusan Tenaga *Energy Scenario, Energy Management related Policies and Legislation*	Rujukan Utama / *Main References* 1, 2, 3, 6
2	Sistem Pengurusan Tenaga yang Cekap, Perbincangan (Bersemuka) *Efficient Energy Management System, Discussion (Face-to-Face)*	Rujukan Utama / *Main References* 4, 5
3	Audit Tenaga *Energy Audit*	Rujukan Utama / *Main References* 4, 5, 6
4	Perancangan Tenaga *Energy Planning*	Rujukan Utama / *Main References* 4, 5, 6
5	Pelaksanaan Pelan Tenaga, Pemeriksaan dan Semakan, Standard Pengurusan Tenaga *Energy Plan Implementation, Checking and Review, Energy Management Standards*	Rujukan Utama / *Main References* 4, 5, 6
6	Penghantaran, Pembentangan dan Sesi Soal Jawab Tugasan 1 *Submission, Presentation and Q&A of Assignment 1*	
7	Ujian Pertengahan Semester, Perbincangan (Tidak Bersemuka) *Mid-Semester Test, Discussion (Non-Face to Face)*	
8	Pemantauan, Penyasaran dan Ramalan Tenaga *Energy Monitoring, Targeting and Forecasting*	Rujukan Utama / *Main References* 4, 5, 6
9	Analisis Prestasi Tenaga, Perbincangan Kajian Kes, Pembiayaan Projek Kecekapan Tenaga *Energy Performance Analysis, Case Study Discussion, Energy Efficiency Project Funding*	Rujukan Utama / *Main References* 4, 5, 6, 7
10	Kecekapan Tenaga dalam Sistem Elektrik: Penghawa Dingin & Pengudaraan Mekanikal, Penyejuk, Kawalan Permintaan, Transformer, Motor Elektrik Penghantaran Tugasan 2 *Energy Efficiency in Electrical Systems: Air-Conditioning & Mechanical Ventilation (ACMV), Chillers, Demand Control, Transformers, Electric Motors* *Assignment 2 Submission*	Rujukan Utama / *Main References* 2, 3, 4, 5
11	Kecekapan Tenaga dalam Sistem Elektrik: Pam, Kipas & Peniup, Menara Penyejukan, Pemampat Udara, Pencahayaan *Energy Efficiency in Electrical Systems: Pumps, Fans & Blowers, Cooling Towers, Air Compressors, Lighting*	Rujukan Utama / *Main References* 2, 3, 4, 5

12	Kecekapan Tenaga dalam Sistem Haba: Bahan Api dan Pembakaran, Dandang dan Pemanas Minyak Haba, Relau, Sistem Wap *Energy Efficiency in Thermal Systems: Fuels and Combustion, Boilers & Thermal Oil Heaters, Furnaces, Steam Systems*	Rujukan Utama / *Main References* 2, 3, 4, 5
13	Kecekapan Tenaga dalam Sistem Haba: Pemulihan Sisa Haba, Sistem Penjanaan Bersama *Energy Efficiency in Thermal Systems: Waste Heat Recovery, Trigeneration Systems*	Rujukan Utama / *Main References* 2, 3, 5, 6
14	Pengoptimuman Proses Guna Tenaga, Teknologi Kecekapan Tenaga Baru Muncul, Perbincangan Kajian Kes Penghantaran Tugasan 3 *Energy-Consuming Process Optimization, Emerging Energy Efficiency Technologies, Case Study Discussion* *Assignment 3 Submission*	Rujukan Utama / *Main References* 7

18.6 HQA7006 Foundation of Renewable Energy

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* 1. *Interpret concepts of thermodynamics for renewable energy.* 2. *Design the renewable energy system for real application.* 3. *Analyse the energy conversion for renewable energy application.* 4. *Explain the findings of the project "Foundation of Renewable Energy".*
Kemahiran Insaniah *Soft Skills*	● *Communication Skills (CS1, 2, 3, 5)* ● *Critical Thinking and Problem-Solving Skills (CT1, 2, 3, 5)* ● *Life Long Learning and Information Management (LL1, 2)*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course presents the renewable energy resources and concept of energy conversion. The students will learn about the concept of temperature, pressure, properties of substances, energy conversion, power cycle and performance analysis of different renewable energy systems. This course covers solar, bioenergy, wind, fuel cells, hydropower, ocean, wave and tidal power, as well as geothermal energy.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment:50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through the internet / student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	Bahasa Inggeris / *English*
Rujukan Utama *Main Reference*	1. *Felix A. Farret, M. Godoy Simoes. 2017. Integration of Renewable Sources of Energy, 2nd Edition.* 2. *Olindo Isabella, Klaus Jäger, Arno Smets, René van Swaaij, Miro Zeman (2016) Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems, UIT Cambridge Ltd., 488 pages*

	3. *John Twidell and Tony Weir. 2015. Renewable Energy Resources, 3rd Edition* 4. *Çengel A.Y. and Boles A.M. 2019. Thermodynamics: An Engineering Approach. McGraw-Hill, 9 Edition* 5. *Online journal (Energy Conversion and Management, Energy, Solar Energy. Applied Energy, etc.)*
Strategi Pembelajaran *Learning Strategies*	Kuliah, Perbincangan, Pembentangan, Peperiksaan Akhir *Lectures, Discussion, Presentations, Final examination*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 44 jam / *44 hours* Tidak Bersemuka / *Non-Face to face*: 0 jam */ 0 hours* Masa Persediaan Pelajar / *Student Preparation Time*: 76 jam / *76 hours*
Kemahiran Boleh Pindah Transferable Skills	Analisa Tenaga Energy Analysis
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Dr. Azimah Omar / Dr. Amirul Syafiq Abdul Jaafar* *Level 18, Wisma R&D UM* *03-22463454 / azimahomar@um.edu.my / amirul90@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk jadual terkini. *Please refer to the current timetable.*
Sesi Tutorial/Amali: *Tutorial / Practical Session:*	Tiada / None
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada tenaga, sumber tenaga boleh diperbaharu dan tidak boleh diperbaharu, Penukaran tenaga *Introduction to energy, renewable and non-renewable energy resources, energy conversion.*	Rujukan Utama 2,4 *Main Reference 2,4*
2	Potensi sumber tenaga boleh diperbaharu dan kesannya, analisis tenaga umum *Basic concept of temperature and pressure, general energy analysis*	Rujukan Utama 1,2 *Main Reference 1, 2*
3	Asas bagi pemuliharaan tenaga, proses tak boleh balik, kebolehbalikan dan ketersediaan. *Properties of pure substances and energy analysis*	‘’
4	*Kitaran kuasa gabungan, kogenerasi* *Combined power cycle, cogeneration*	“
5	Penukaran tenaga sistem solar *Energy conversion of solar system*	“
6	Penukaran tenaga biotenaga *Energy conversion of bioenergy*	Rujukan Utama 2,5 *Main Reference 2,2*
7	Ujian, perbincangan atas tugasan *Test, discussion on assignment*	“
8	*Kuliah tetamu / bengkel* *Guest Lecture / workshop*	Persembahan slaid Slide presentation
9	Penukaran tenaga kuasa hidro *Energy conversion of hydropower*	Rujukan Utama 2,5 *Main Reference 2,5*
10	Penukaran tenaga kuasa angina, geoterma *Energy conversion of wind power and geothermal*	“
11	Penukaran tenaga gelombang Lautan, dan kuasa pasang surut. *Energy conversion of ocean, wave and tidal power*	‘’
12	Ujian 2, perbincangan atas persembahan *Test 2, discussion on presentation*	‘’
13	Persembahan projek *Project presentation*	
14	Persembahan projek *Project presentation*	

18.7 HQA7011 Smart Grid

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat / Keperluan Minimum Kursus *Course Pre-requisite(s) / Minimum Requirement(s)*	*No*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of this course, students are able to:* *1. Apply the fundamentals of electrical system in smart grid* *2. Design of electrical grid based on smart grid concept* *3. Analyze the system operation in a smart grid*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course is designed to offer fundamental insights into the smart electrical grid technologies, mainly derived from the application of renewable energy into the conventional electrical power grid. The course will cover electrical circuit theory, conventional electrical grid topologies and operation, problems that can be addressed through smart grid technologies, areas of concern during the applications of smart grid technologies and improved grid management under renewable energy integrated grid environments. This course is suitable for electrical grid operators, policy makers and building managers. Higher emphasis on electrical content is to be expected.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through notice board and internet*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	Bahasa Inggeris *English*
Rujukan Utama *Main Reference*	*1. Sundararajan J., Introductory Circuit Theory, 2020, Springer International Publishing* *2. Hadi Saadat, Power System Analysis, 3rd Edition, 2010, PSA Publishing.* *3. Salman K. Salman, Introduction to the Smart Grid: Concepts, Technologies and Evolution, 2017, IET. ISBN: 978-1-78561-119-3* *4. Buchholz, B.M., Styczynski, Z.A., Smart Grids: Fundamentals and Technologies in Electric Power Systems of the Future, 2020, Springer*

	5. *Manoj K.S., Smart Grid: Concepts to Design, 2020, Notion Press*
Strategi Pembelajaran *Learning Strategies*	Kuliah, presentasi *Lecture, presentation*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face* : 44 Tidak Bersemuka / *Non Face to face*: 0 Masa Persediaan Pelajar / *Student Preparation Time*: 76
Kemahiran Boleh Pindah *Transferable Skills*	Computer simulation skills
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Dr. Tan Chia Kwang* *Room 18-18, Level 18, Wisma R&D UM* *03-2246 3408 / cktan@um.edu.my*
Sesi Kuliah / *Lecture Session* Hari / Masa *Day / Time* Tempat / *Venue*	Rujuk jadual kuliah semasa *Refer to the latest lecture schedule*
Sesi Tutorial/Amali: *Tutorial/Practical Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Rujuk jadual kuliah semasa *Refer to the latest lecture schedule*
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Komponen-komponen dan Operasi Sistem Kuasa Elektrik Semasa dan Pengenalan Grid Pintar *Components and Operation of Present Electrical Power Systems* and *Introduction to Smart Grid*	Rujukan utama *Main references*
2	Pengenalan kepada Theori Litar dan Sistem Kuasa Tiga Fasa *Induction to circuit Theories and Three-phase power systems*	Rujukan utama *Main references*
3	Kompensasi Faktor Kuasa dalam Grid Pintar *Power Factor Compensation in Smart Grid*	Rujukan utama *Main references*
4	Integrasi Tenaga Boleh Diperbaharui *Renewable Energy Integration*	Rujukan utama *Main references*
5	Grid Pintar Sebagai Grid Sembuh-Sendiri dengan Integrasi Tenaga Boleh Diperbaharui *Smart Grid as Self-Healing Grid with Renewable Energy Integration*	Rujukan utama *Main references*
6	Infrastruktur meter lanjutan *Advanced Metering Infrastructure*	Rujukan utama *Main references*
7	Sistem Pengurusan Kuasa Pintar - Penjadualan Masa Nyata *Intelligent Power Management System – Real Time Scheduling*	Rujukan utama *Main references*
8	Ujian *Test*	Rujukan utama *Main references*
9	Keselamatan Grid Pintar - Keselamatan Tenaga dan Keselamatan Siber *Smart Grid Security – Energy Security and Cyber Security*	Rujukan utama *Main references*
10	Pasaran Tenaga dan Polisi Grid Pintar *Energy Market and Smart Grid Policy*	Rujukan utama *Main references*
11	Simulasi Grid Pintar - Penjadualan Masa Nyata dalam Sistem Grid *Smart Grid Simulation - Real Time Scheduling in Grid-Connected Mode*	Rujukan utama *Main references*
12	Simulasi Grid Pintar - Penjadualan Masa Nyata dalam Sistem Mandiri dengan Sistem Simpanan Tenaga *Smart Grid Simulation – Real Time Scheduling in Standalone System with Energy Storage System*	Rujukan utama *Main references*
13	Impak Integrasi Tenaga Boleh Diperbaharui terhadap Grid Pintar *Impacts of Renewable Energies Integration on Smart Grid*	Rujukan utama *Main references*
14	*Presentasi Tugasan* *Presentation of Assignment*	Rujukan utama *Main references*

18.8 HQA7012 Bioenergy

Kredit* *Credit**	3
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	120 hours
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	At the end of the course, students are able to: 1. Execute the concepts and production principles of bioenergy. 2. Analyse the applications and economic impact of bioenergy. 3. Evaluate the environmental impacts of bioenergy. 4. Resolve the findings of the project bioenergy.
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	An important goal of the extended use of natural resources is replacing fossil fuels. Potentially, all global energy needs can be covered with natural resources (e.g. biomass) if the utilization is efficient enough. This course provides the introduction of bioenergy, state of the art in the field of efficient conversion of biomass, covering most technical, economical and, environmental issues such as combustion, gasification, pyrolysis, pelletizing and biogas production technologies.
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	Online feedback and oral comments after presentation of assignments. Grades will be given for the final examination.
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	Please refer to the University of Malaya (Masters Degree) Rules 2019 and University of Malaya (Masters Degree) Regulations 2019.
Bahasa Pengantar *Medium of Instruction*	Bahasa Inggeris *English*
Rujukan Utama *Main Reference*	1. *Anju Dahiya (Ed.). (2020). Bioenergy, 2nd Edition, Biomass to Biofuels and Waste to Energy. Elsevier.* 2. *Kumar, R. P., Bharathiraja, B., Kataki, R., & Moholkar, V. S. (Eds.). (2020). Biomass Valorization to Bioenergy. Springer.* 3. *Dalena, F., Basile, A., & Rossi, C. (Eds.). (2017). Bioenergy systems for the future: prospects for biofuels and biohydrogen. Woodhead Publishing.* 4. *Pandey, A., Lee, D. J., Chang, J. S., Chisti, Y., & Soccol, C. R. (Eds.). (2018). Biomass, biofuels, biochemicals: biofuels from algae. Elsevier.*

	5. *Rai, M., & Ingle, A. P. (Eds.). (2019). Sustainable Bioenergy: Advances and Impacts. Elsevier.*
Strategi Pembelajaran *Learning Strategies*	Kuliah, pembelajaran berasaskan scenario *Lecture, scenario-based Learning*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 40 jam / *40 hours* Tidak Bersemuka / *Non Face to face*: 4 jam / 4 *hours* Masa Persediaan Pelajar / *Student Preparation Time*: 76 jam / 76 *hours*
Kemahiran Boleh Pindah Transferable Skills	Kursus ini dapat membangunkan kemahiran komunikasi pelajar, ia juga memperkukuhkan pemikiran kritis, kemahiran penyelesaian masalah dalam bidang tenaga bio. *The course able to develop communication skill among the students, enhance critical thinking, problem solving skill in the field of bioenergy.*
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Assoc. Prof. Dr. Lee Hwei Voon / Prof. Dr. Juan Joon Ching* *Nanotechnology and Catalysis Research Centre (NANOCAT)* *03-6797 6959 / leehweivoon@um.edu.my / jcjuan@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk kepada jadual belajar terkini *Please refer the current timetable*
Sesi Tutorial / Amali: *Tutorial / Practical Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk kepada jadual belajar terkini *Please refer the current timetable*
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada Bioenergy *Introduction to Bioenergy* Aktiviti F2F Kuliah (3 jam)	Rujukan Utama 1 *Main Reference 1*
2	Ciri-ciri dan Pembakaran Bahan Bakar Biojisim *Biomass Fuel Properties and Combustion* Aktiviti F2F Kuliah (3 jam)	‘’
3	Peralatan Pembakaran Biomas *Biomass Combustion Equipment* Aktiviti F2F Kuliah (3 jam)	‘’
4	Taklimat penugasan dan Pembelajaran Berasaskan Senario (SBL1 & 2) *Assignment briefing and Scenario-based Learning (SBL 1 & 2)* Aktiviti F2F Kuliah (2 jam) Aktiviti NF2F Perbincangan atas talian (1 jam)	Rujukan Utama 2,3 *Main Reference 2.3*
5	Penukaran Tenaga Biomas *Biomass Energy Conversion* Aktiviti F2F Kuliah (3 jam)	‘’
6	Penyimpanan dan Pengendalian Bahan Bakar Biomas/ Taklimat dan Ulang kaji Ujian 1 *Biomass Fuel Storage and Handling/ Test 1 briefing and revision* Aktiviti F2F Kuliah (2 jam) Aktiviti NF2F Perbincangan atas talian (1 jam)	‘’
7	Generasi Kuasa Biomas/Ujian 1 *Biomass based Power Generation/Test 1* Aktiviti F2F Kuliah (3 jam)	‘’
8	Alga sebagai biofuel *Algae as biofuel* Aktiviti F2F Kuliah (3 jam)	Rujukan Utama 4 *Main Reference 4*
9	Biogas, pengeluaran Biogas *Biogas, Biogas production.* Aktiviti F2F Kuliah (3 jam)	Rujukan Utama 1,3 *Main Reference 1,3*

10	Biogas, pengeluaran Biogas *Biogas, Biogas production.* Aktiviti F2F Kuliah (3 jam)	‘’
11	Pembentangan dan Penilaian Pembelajaran Berasaskan Senario (SBL) *Presentation and evaluation of Scenario-based Learning (SBL)* Aktiviti F2F Kuliah (3 jam)	Rujukan Utama 2,3 *Main Reference 2.3*
12	Pelepasan dan Kawalan, Peraturan Keselamatan dan Peraturan Alam Sekitar/ Test 2 briefing and revision *Emissions and Control, Environmental Safety Rule and Regulation/ Taklimat dan ulang kaji Ujian 2* Aktiviti F2F Kuliah (2 jam) Aktiviti NF2F Perbincangan atas talian (1 jam)	Rujukan Utama 5 *Main Reference 5*
13	Analisis Ekonomi Pembakaran Bahan Bakar Biojisim/Ujian 2 *Economic Analysis of Biomass Fuel Combustion/Test 2* Aktiviti F2F Kuliah (3 jam)	‘’
14	Analisis Kos Bahan Bakar Biomas untuk Penjanaan Kuasa/ Taklimat dan Ulang kaji peperiksaan akhir *Cost Analysis of Biomass Fuel for Power Generation/ Final exam briefing and revision* Aktiviti F2F Kuliah (2 jam) Aktiviti NF2F Perbincangan atas talian (1 jam)	-

18.9 HQA7014 Energy Storage Technology

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* *1. Explain energy storage technologies based on its operating principles.* *2. Solve problems related to energy storage systems.* *3. Analyze the operation of energy storage systems.*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	This course covers various aspects of energy storage systems from conventional to latest technologies. Higher penetration levels of renewable energy to power system pose a great challenge in energy security since its sources are mostly intermittent. Thus, energy storage systems play vital roles in stabilizing and providing sufficient energy when needed. Among the topics covered are thermal energy storage, electrochemical energy storage, flywheel storage, compressed air energy storage, pumped-hydro storage, superconducting magnetic energy storage, etc. Main elements and operation principles of each energy storage technology will be discussed. These include advantages and disadvantages, capabilities and performance as well as their typical applications.
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment:50.00 %* *Final Examination: 50.00 %*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through internet/student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	English
Rujukan Utama *Main Reference*	1. A. G. Ter-Gazarian, 2020. Energy Storage for Power Systems, Third Edition, The Institution of Engineering and Technology. 2. F. S. Barnes, 2011. Large Energy Storage Systems Handbook, CRC Press, Taylor & Francis Group. 3. R. A. Huggins, 2010. Energy Storage, Springer.

Strategi Pembelajaran *Learning Strategies*	Kuliah, Perbincangan *Lecture, Discussion*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 44 hours Tidak Bersemuka / *Non Face to face*: 0 hours Masa Persediaan Pelajar / *Student Preparation Time*: 76 hours
Kemahiran Boleh Pindah Transferable Skills	Pengaturcaraan Matlab Simulink *Matlab Simulink Programming*
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Dr. Mohamad Fathi Mohamad Elias* *Room 18-13, Level 18, Wisma R&D UM* *03-2246 3410 / fathi@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Rujuk kepada myum.um.edu.my *Refer to myum.um.edu.my*
Sesi Tutorial/Amali: *Tutorial / Practical Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Rujuk jadual waktu *Refer to timetable*
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada Sistem Simpanan Tenaga *Introduction to Energy Storage Systems*	Rujukan Utama / Main References
2	Simpanan Tenaga Haba *Thermal Energy Storage*	Rujukan Utama / Main References
3	Simpanan Roda Tenaga *Flywheel Energy Storage*	Rujukan Utama / Main References
4	Simpanan Tenaga Pam Hidroelektrik *Pumped Hydroelectric Energy Storage*	Rujukan Utama / Main References
5	Simpanan Tenaga Udara Termampat *Compressed Air Energy Storage*	Rujukan Utama / Main References
6	Simpanan Tenaga Magnet Mengalir Lampau *Superconducting Magnetic Energy Storage*	Rujukan Utama / Main References
7	Simpanan Tenaga Elektrokimia I *Electrochemical Energy Storage I*	Rujukan Utama / Main References
8	Simpanan Tenaga Elektrokimia II *Electrochemical Energy Storage II*	Rujukan Utama / Main References
9	Teknologi Kapasitor Super *Supercapacitor Technology* Ujian Pertengahan Semester *Mid Semester Test*	Rujukan Utama / Main References
10	Simpanan Bateri Berskala Utiliti Utility Scale Battery Storage Perbincangan Berkumpulan *Group Discussion*	Rujukan Utama / Main References
11	Simpanan Hidrogen and Teknologi Sel Bahan Api *Hydrogen Storage and Fuel Cell Technology*	Rujukan Utama / Main References
12	Analisis Sistem Simpanan Tenaga dengan Perisian Matlab Simulink *Analysis of Energy Storage System using Matlab Simulink Software*	Rujukan Utama / Main References
13	Kemajuan Terkini Teknologi Simpanan Tenaga *Recent Advances in Energy Storage Technology*	Rujukan Utama / Main References
14	Seminar Pembentangan *Presentation Seminar* Penyerahan Tugasan *Assignment Submission*	-

18.10 HQA7015 Low Carbon Buildings

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*N/A*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* 1. *Identify the technical means by which energy demand within buildings may be reduced.* 2. *Apply renewable energy sources to buildings.* 3. *Relate how human factors and financial implications influence the choice of both demand reduction and renewable energy strategies.* 4. *Propose appropriate demand reduction strategies for specified buildings, including the assessment of cost implications.*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course will expose students to:* ▪ *Principles of low carbon buildings;* ▪ *Environmental issues that lead to the advent of low carbon buildings;* ▪ *Technical aspect of low carbon buildings;* ▪ *Incorporation of renewable energy into building system;* ▪ *Performance monitoring and life cycle assessment of low carbon buildings.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through notice board and internet.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	English

Rujukan Utama *Main Reference*	1. *Dejan Mumovic, & Mat Santamouris. (Eds.) (2019). A Handbook of Sustainable Building Design and Engineering: An Integrated Approach to Energy, Health and Operational Performance. Second Edition. Abingdon, Oxon; New York, NY: Routledge.* 2. *Bruce King. (2017). The New Carbon Architecture: Building to Cool the Climate. Gabriola island, BC: New Society Publishers.* 3. *Charles Eley. (2016). Design Professional's Guide to Zero Net Energy Buildings. Washington, DC: Island Press.* 4. *Francis D.K. Ching, & Ian M. Shapiro. (2014). Green Building Illustrated. Hoboken, New Jersey: John Wiley & Sons, Inc.* 5. *William Maclay, & Maclay Architects. (2014). The New Net Zero: Leading-Edge Design and Construction of Homes and Buildings for a Renewable Energy Future. White River Junction, VT: Chelsea Green Publishing.* 6. *Ali Sayigh. (Ed.) (2014). Sustainability, Energy and Architecture: Case Studies in Realizing Green Buildings. Oxford; Waltham, MA: Elsevier Inc.*
Strategi Pembelajaran *Learning Strategies*	Kuliah, Perbincangan *Lecture, Discussion*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 42 hours Tidak Bersemuka / *Non Face to face*: 2 hours Masa Persediaan Pelajar / *Student Preparation Time*: 76 hours
Kemahiran Boleh Pindah Transferable Skills	Penilaian dan cadangan bangunan hijau *Green building assessment and proposal*
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	Dr. Thibeorchews Prasankumar Institute for Advanced Studies, Universiti Malaya prasankumar@um.edu.my
Sesi Kuliah / *Lecture Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk jadual waktu kuliah yang terkini *Refer to current lecture timetable*
Sesi Tutorial / Amali: *Tutorial / Practical Session:* Hari / Masa *Day / Time* Tempat / *Venue*	Sila rujuk jadual waktu kuliah yang terkini *Refer to current lecture timetable*
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment : 50%* Peperiksaan Akhir / *Final Examination : 50%*

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada sistem persekitaran bangunan, bangunan rendah karbon *Introduction to building environment systems, low carbon buildings*	Rujukan Utama 1-6 *Main Reference 1-6*
2	Degradasi alam sekitar dan alam Bina *Environmental degradation and the built environment* - Pengedaran arahan tugasan - *Distribution of assignment instruction*	Rujukan Utama 1-6 *Main References 1-6*
3	Penggunaan tenaga bangunan dan audit tenaga *Building energy consumption and energy audit*	‘’
4	Perubahan iklim dan reka bentuk bangunan *Climate change and building design*	‘’
5	Tingkah laku penghuni bangunan dan prestasi bangunan *Building occupant behavior and building performance*	‘’
6	Strategi penyejukan mapan *Sustainable cooling strategies*	Rujukan Utama 1-6 *Main Reference 1-6*
7	Pemantauan dan penanda aras pelepasan karbon bangunan *Building carbon emission monitoring and benchmarking*	‘’
8	Ujian pertengahan *Midterm test* Tutorial tugasan / perbincangan *Assignment tutorial / discussion*	Laptop persendirian pelajar, komputer, projektor, skrin *Students’ own laptop, computer, projector, projector screen*
9	Tutorial tugasan / perbincangan *Assignment tutorial / discussion*	Rujukan Utama 1-6 *Main Reference 1-6*
10	Pembentangan *Presentation* - Penyerahan tugasan - *Submission of assignment*	Komputer, projektor, skrin *Computer, projector, projection screen*
11	Pemantauan tenaga, pelabelan dan pemodelan *Energy Monitoring, Labelling and Modelling* - *Wiki presentation*	Rujukan Utama 1-6 *Main Reference 1-6*
12	Keselesaan terma, kualiti udara dalaman dan pemodelan pengudaraan *Thermal comfort, indoor air quality and ventilation modelling* - *Wiki presentation*	‘’
13	Tenaga boleh diperbaharui dan sistem bangunan *Renewable energy and building system* - *Wiki presentation*	‘’

14	Penilaian kitaran hayat bangunan dan analisis ekonomi *Life cycle assessment of buildings and economic analysis* - *Wiki presentation*	‘’

18.11 HQA7016 Energy Economics

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* *1. Analyse economics of energy system.* *2. Compare the cost benefit of energy system.* *3. Evaluate the findings of the case study “Energy Economics”.*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course presents the concept of economic analysis for the decision making of projects. The students will learn about project planning, cost estimating and control, decision making, project financing and investment issues in the energy sector. This course covers economic analysis techniques that include present and future worth, rate of return, cash flow, benefit-cost ratio, payback period, taxes, inflation, replacement and depreciation.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Online feedback and oral comments after presentation of assignments* *Results will be notified through internet/student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to the University of Malaya (Masters Degree) Rules 2019 and University of Malaya (Masters Degree) Regulations 2019*
Bahasa Pengantar Medium of Instruction	*Bahasa Inggeris / English*

Rujukan Utama Main Reference	1. *Donald G. Newnan, Ted G. Eschenbach & Jerome P. Lavelle, 2017. Engineering Economic Analysis, 13th edition, Oxford University Press.* 2. Leland Blank & Anthony Tarquin, 2018. Engineering Economics, 8th edition, McGraw-Hill Publishing 3. Harold Kerzner, 2017. Project Management: A Systems Approach to Planning, Scheduling and Control, 12th edition, John Wiley & Sons, Inc. 4. Subhes C. Bhattacharyya, 2019. Energy Economics: Concepts, Issues, Markets and Governance, 2nd edition, Springer-Verlag London 5. Andre Dorsman, John L. Simpson & Wim Westerman, 2013. Energy Economics and Financial Markets, Springer-Verlag Berlin Heidelberg
Strategi Pembelajaran Learning Strategies	*Kuliah, perbincangan, kajian kes, pembentangan seminar* *Lecture, discussion, case study, seminar presentation*
Masa Pembelajaran Pelajar Student Learning Time	*Bersemuka / Face to face: 43* *Tidak Bersemuka / Non-Face to face: 1* *Masa Persediaan Pelajar / Student Preparation Time: 76*
Kemahiran Boleh Pindah Transferable Skills	*Kemahiran pemikiran kritis dalam penilaian hasil ekonomi, kemahiran numerasi* *Critical thinking skills in economic outcome evaluation, numeracy skills*
Pensyarah / Lecturer Bilik / Room Telefon / e-mel Telephone / e-mail	*Ts. Dr. Jafferi Jamaludin* *Room 18-15, Level 18, Wisma R&D UM* *03-2246 3407 / jafferi@um.edu.my*
Sesi Kuliah / Lecture Session: Hari/Masa / Day/Time Tempat / Venue	*Sila rujuk jadual terkini.* *Please refer the current timetable.*
Sesi Tutorial/Amali: Tutorial/Practical Session: Hari/Masa / Day/Time Tempat / Venue	*Tiada / none*
Perincian Pemberatan Penilaian Detail of Assessment Weightage	*Penilaian Berterusan / Continuous Assessment: 50%* *Peperiksaan Akhir/ Final Examination: 50%*

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada Ekonomi Tenaga, Kekurangan, Faktor Pengeluaran, Perbincangan (Bersemuka) *Introduction to Energy Economics, Scarcity, Factors of Production, Discussion (Face-to-Face)*	Rujukan Utama 1,2,3 *Main Reference 1,2,3*
2	Pengurusan Projek, Konsep Kos *Project Management, Cost Concept*	Rujukan Utama 1,2,5 *Main Reference 1,2,5*
3	Nilai Masa Wang, Kesamaan, Faedah *Time Value of Money, Equivalence, Interests*	Rujukan Utama 1,2 *Main Reference 1,2*
4	Analisa Nilai Sekarang *Present Worth Analysis*	Rujukan Utama 1,2 *Main Reference 1,2*
5	Analisis Aliran Tunai *Cash Flow Analysis*	Rujukan Utama 1,2 *Main Reference 1,2*
6	Analisis Kadar Pulangan *Rate of Return Analysis*	Rujukan Utama 1,2 *Main Reference 1,2*
7	Analisis Nilai Masa Depan, Nisbah Kos-Faedah, Tempoh Bayaran Balik, Analisis Kepekaan dan Pulang Modal, Perbincangan Kajian Kes *Future Worth Analysis, Benefit-Cost Ratio, Payback Period, Sensitivity and Breakeven Analysis, Case Study Discussion*	Rujukan Utama 1,2 *Main Reference 1,2*
8	Ujian Pertengahan Semester, Perbincangan (Tidak Bersemuka) Penghantaran Tugasan 1 *Mid-Semester Test, Discussion (Non-Face-to-Face)* *Assignment 1 Submission*	
9	Ketidakpastian dan Risiko dalam Analisis Ekonomi *Uncertainty and Risks in Economic Analysis*	Rujukan Utama 1,2 *Main Reference 1,2*
10	Penyusutan Nilai dan Percukaian *Depreciation and Taxes*	Rujukan Utama 1,2 *Main Reference 1,2*
11	Inflasi, Perubahan Harga, Kadar Pulangan Menarik Minimum Penghantaran Tugasan 2 *Inflation, Price Change, Minimum Attractive Rate of Return* *Assignment 2 Submission*	Rujukan Utama 1,2 *Main Reference 1,2*
12	Pelaburan Tenaga, Perbincangan Kajian Kes, Pembiayaan Projek dan Ciri-Ciri Bukan Ekonomi *Energy Investment, Case Study Discussion, Project Financing and Noneconomic Attributes*	Rujukan Utama 1,2,4 *Main Reference 1,2,4*
13	Ekonomi Tenaga Elektrik, Tenaga Boleh Diperbaharu dan Keselamatan Tenaga *Economics of Electricity, Renewable Energy and Energy Security*	Rujukan Utama 4 *Main Reference 4*

14	Penghantaran, Pembentangan dan Sesi Soal Jawab Tugasan 3 *Submission, Presentation and Q&A of Assignment 3*	

18.12 HQA7018 Solar Energy

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* *1. Illustrate solar energy system and its benefit to mankind* *2. Compare the performance of various solar energy system* *3. Evaluate and solve problems related to solar energy system*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*Sun is a source of one of renewable energy, known as solar energy. It is intermittent in nature, eco-friendly and nonpolluting energy. This course will discuss the solar energy resources and solar radiation. Besides that, the concept of solar PV and cells will be introduced. Students should be able to design a basic solar system. This course will also cover the application of solar energy, solar thermal and solar collector. It will provide a platform to disseminate the knowledge regarding the fundamental of solar energy namely basic economics of solar system particularly the cost benefit analysis. Finally, project technologies related to solar energy will be discussed as well as environment impact to world.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50 %* *Final Examination: 50 %*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through the internet / student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*
Bahasa Pengantar *Medium of Instruction*	English

Rujukan Utama *Main Reference*	1. *Olindo Isabella, Klaus Jäger, Arno Smets, René van Swaaij,* Miro Zeman (2016) Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems, UIT Cambridge *Ltd.* 2. *Michael Boxwell (2017) Solar Electricity Handbook: 2017 Edition: A simple, practical guide to solar energy? designing and installing solar photovoltaic systems. Greenstream Publishing; 2017 edition* 3. Ibrahim Moukhtar, Adel Z. El Dein, Adel A. Elbaset, Yasunori Mitani (2020), Solar Energy: Technologies, Design, Modelling and Economics, Springer International Publication. 4. *Konrad Mertens, 2013. Photovoltaics: Fundamentals, Technology and Practice, Wiley* 5. *Soteris A. Kalogirou, 2013. Solar Energy Engineering: Processes and Systems, Academic Press* 6. *Godfrey Boyle, 2012, Renewable Energy: Power for A Sustainable Future, Oxford University Press.*
Strategi Pembelajaran *Learning Strategies*	Kuliah, Presentasi Video dan Perbincangan, Pembentangan Seminar *Lecture, Video Presentation and Discussion, Seminar Presentation*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 34 hours Tidak Bersemuka / *Non-Face to face*: 10 hours Masa Persediaan Pelajar / *Student Preparation Time*: 76 hours
Kemahiran Boleh Pindah *Transferable Skills*	
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Dr. Muhammad Zulhadi Iskandar Radzi* *Room 18-7, Level 18, Wisma R&D UM* *03-22463417 / zi.radzi@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	*Please Refer to the current timetable*
Sesi Tutorial/Amali: *Tutorial/Practical Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	Tiada / None

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada tenaga solar *Introduction to solar energy* Aktiviti Semuka Kuliah (3 jam) *Activity F2F Lecture (3 hours)*	*Main Reference 1*
2	Sumber tenaga solar *Solar energy resources* Aktiviti Semuka Kuliah (3 jam) *Activity F2F Lecture (3 hours)*	‘’
3	Sinaran suria *Solar radiation* Aktiviti Semuka Kuliah (3 jam) *Activity F2F Lecture (3 hours)*	‘’
4	Optik solar *Solar optics* Aktiviti Semuka Kuliah (3 jam) *Activity F2F Lecture (3 hours)*	‘’
5	PV / sel solar *Solar PV/cell* Aktiviti Semuka Kuliah (2 jam) *Activity F2F Lecture (2 hours)* Aktiviti Tidak Semuka -Perbincangan tentang pembentangan projek (1 jam) *Activity NF2F - Discussion on project presentation (1 hour)*	‘’
6	Penggunaan tenaga Suria *Application of Solar energy* Aktiviti Semuka Kuliah (3 jam) *Activity F2F Lecture (3 hours)* Aktiviti Tidak Semuka -Presentasi Video dan perbincangan (1 jam) *Activity NF2F - Video Presentation and discussion (1 hour)*	*Main Reference 2*
7	Ujian *Test* Aktiviti Semuka Ujian (2 jam) *Activity F2F Test (2 hours)*	-

	Aktiviti Tidak Semuka -Perbincangan tentang Ujian kelas (1 jam) *Activity NF2F - Discussion on class test (1 hour)*	
8	Terma dan aplikasi solar *Solar thermal and application* Aktiviti Semuka Kuliah (3 jam) *Activity F2F Lecture (3 hours)*	*Main Reference 2*
9	Pemungut Suria Vakum *Evacuated Solar Collector* Aktiviti Semuka Kuliah (1 jam) *Activity F2F Lecture (1 hours)* Aktiviti Tidak Semuka -Presentasi Video dan perbincangan (2 jam) *Activity NF2F - Video Presentation and discussion (2 hour)*	*Main References 3, 4*
10	Penumpuan Solar *Solar Concentrators* Aktiviti Semuka Kuliah (1 jam) *Activity F2F Lecture (1 hours)* Aktiviti Tidak Semuka -Presentasi Video dan perbincangan (2 jam) *Activity NF2F - Video Presentation and discussion (2 hour)*	‘’
11	Prestasi sistem *System performance* Kuiz *Quiz* Aktiviti Semuka Kuliah (2 jam) *Activity F2F Lecture (2 hours)* Aktiviti Tidak Semuka -Kuiz (1 jam) *Activity NF2F - Quiz (1 hour)*	*Main Reference 2*
12	Kesan alam sekitar *Environmental impact* Aktiviti Semuka Kuliah (2 jam) *Activity F2F Lecture (2 hours)* Aktiviti Tidak Semuka -Perbincangan tentang pembentangan projek (1 jam) *Activity NF2F - Discussion on project presentation (1 hour)*	‘’
13	Kos faedah *Cost benefit* Aktiviti Semuka Kuliah (2 jam) *Activity F2F Lecture (2 hours)*	‘’

	Aktiviti Tidak Semuka -Perbincangan tentang pembentangan projek (1 jam) *Activity NF2F - Discussion on project presentation (1 hour)*	
14	Pembentangan *Presentation* Aktiviti Semuka Pembentangan (3 jam) *Activity F2F Presentation (3 hours)*	-

18.13 HQA7019 Hydro Energy

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	None
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of this course, students are able to:* *1. Design of hydropower system.* *2. Compare the cost benefit of hydro energy system.* *3. Explain the findings of the "hydro energy" case study assignment.*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*This course provides an introduction to hydro energy, which includes mini- and micro-/pico- hydro energy systems. Topics covered will include site selection, system design and installation, environmental impacts, as well as regulation and economics of hydro energy. Case study on hydro energy will be used to further strengthen the understanding on the topic.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment:50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through notice board and internet (Spectrum)*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master's Degree) Regulations 2019 and University of Malaya (Master's Degree) Rules 2019.*

Bahasa Pengantar *Medium of Instruction*	Bahasa Inggeris *English*
Rujukan Utama *Main Reference*	1. *Laymen's Guidebook on How to Develop a Small Hydro Site, European Small Hydro Association* 2. *Luis Rodriguez, Teodoro Sanchez, Designing and Building Mini and Micro Hydro Power Schemes: A Practical Guide, 2011, Publisher: Practical Action (June 2011), pp320* 3. *Scott Davis, Serious Microhydro: Water Power Solutions from the Experts, 2010, New Society Publishers, pp 336.* 4. *Bryan Leyland, Small Hydroelectric Engineering Practice, 2014, CRC Press, pp 254.*
Strategi Pembelajaran *Learning Strategies*	Kuliah, Tugasan, Presentasi *Lecture, Assignment, Presentation*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face* : 51 Tidak Bersemuka / *Non Face to face*: 0 Masa Persediaan Pelajar / *Student Preparation Time*: 69
Kemahiran Boleh Pindah Transferable Skills	Simulation softwares such as Matlab
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Dr. Asiful Habib* *Room 18-14, Level 18, Wisma R&D UM* *03-22463403 / asifhimu@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	Rujuk jadual kuliah semasa *Refer to current lecture timetable*
Sesi Tutorial/Amali: *Tutorial/Practical Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	Rujuk jadual pemeriksaan semasa *Refer to current examination time table*
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment* : 50% Peperiksaan Akhir / *Final Examination* : 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan kepada tenaga Mini/Hidro *Introduction to Mini/Hydro Energy*	Rujukan Utama 1
2	Asas Kejuruteraan Hidraulik *Fundamental of hydraulic Engineering*	‘’
3	Sumber air dan potensinya - Penilaian aliran-aliran dengan cara ukuran pelepasan *The water resource and its potential* *- Evaluating stream flows by discharge measurements*	‘’
4	Sumber air dan potensinya - Ciri-ciri aliran-aliran *The water resource and its potential* *- Stream flow characteristics*	‘’
5	Sumber air dan potensinya - Anggaran kapasiti loji and pengeluaran tenaga *The water resource and its potential* *- Estimation of plant capacity and energy output*	‘’
6	Struktur hidraulik -Saluran terbuka *Hydraulic Structures* *- Open channel*	Rujukan Utama 1
7	Struktur hidraulik - Penstock *Hydraulic Structures* *- Penstocks*	‘’
8	Ujian pertengahan semester, *Mid semester test*	
9	Peralatan elektromekanikal - Turbin hidraulik *Electromechnical equipment* *- Hydraulic turbines*	Rujukan Utama 1
10	Peralatanf elektromekanikal - Kawalan turbin *Electromechnical equipment* *- Turbine control*	‘’
11	Peralatan elektromekanikal - Penjana *Electromechanical equipment* *- Generators*	‘’
12	Kesan alam sekitar logi kuasa hidro *Environmental impact of hydro energy plant*	‘’

13	Ekonomi tenaga hidro *The economics of hydro energy*	‘’
14	Persembahan kajian kes bagi kuasa hidro *Presentation on hydro energy case study*	‘’

18.14 HQA7021 Hydrogen Technology

Kredit* *Credit**	*3*
Masa Pembelajaran Pelajar (SLT) *Student Learning Time (SLT)*	*120 hours*
Prasyarat/Keperluan Minimum Kursus *Course Pre-requisite(s)/Minimum Requirement(s)*	*None*
Hasil Pembelajaran Kursus* *Course Learning Outcomes**	*At the end of the course, students are able to:* *1. Apprise Hydrogen based systems from production to end use* *2. Evaluate appropriate hydrogen technology according to market needs* *3. Devise solutions related to hydrogen technology*
Sinopsis Kandungan Kursus *Synopsis of Course Contents*	*Hydrogen as energy carrier has been deemed as one of the most suitable alternatives to fossil fuels for deep decarburization of society. This course will discuss hydrogen technology from production to end use. Besides that, the concept of green hydrogen and other hydrogen production routes will be introduced. Students should be able to size a basic green hydrogen system. This course will also cover the combustion application of hydrogen along with the production of electricity using hydrogen-based fuel cells. It will provide a platform to disseminate the knowledge regarding the fundamental of hydrogen technology namely basic economics of hydrogen system particularly the cost benefit analysis. Finally, project technologies related to hydrogen technology will be discussed as well as environment impact to world.*
Pemberatan Penilaian* *Assessment Weightage**	*Continuous Assessment: 50%* *Final Examination: 50%*
Kaedah Maklum Balas Tentang Prestasi *Methodologies for Feedback on Performance*	*Results will be notified through internet/student portal.*
Kriteria Dalam Penilaian Sumatif *Criteria in Summative Assessment*	*Please refer to University of Malaya (Master’s Degree) Regulations 2019 and University of Malaya (Master’s Degree) Rules 2019.*

Bahasa Pengantar *Medium of Instruction*	English
Rujukan Utama *Main Reference*	1. *Santhanam, K. S., Press, R. J., Miri, M. J., Bailey, A. V., & Takacs, G. A. (2017). Introduction to hydrogen technology. John Wiley & Sons.* 2. *Gandia, L. M., Arzamendi, G., & Diéguez, P. M. (Eds.). (2013). Renewable hydrogen technologies: production, purification, storage, applications and safety. Newnes.* 3. *de Miranda, P. E. V. (2019). Science and engineering of hydrogen-based energy technologies. Federal University of Rio de Janeiro, Rio de Janeiro, Brazil.* 4. *Klebanoff, L. (Ed.). (2012). Hydrogen storage technology: materials and applications. CRC Press.* 5. *Sorensen, B., & Spazzafumo, G. (2018). Hydrogen and fuel cells: emerging technologies and applications.* 6. *Barbir, F. (1991). Hydrogen aircraft technology: By G. Daniel Brewer. CRC Press, Boca Raton, 1991; 430 pages, including references and index; clothbound, price $169.95.*
Strategi Pembelajaran *Learning Strategies*	Kuliah, pembelajaran atas talian, tugasan, tugsan kumpulan & pembentangan *Lecture, online learning, assignment, group assignments & presentation*
Masa Pembelajaran Pelajar *Student Learning Time*	Bersemuka / *Face to face*: 37 hours Tidak Bersemuka / *Non Face to face*: 7 hours Masa Persediaan Pelajar / *Student Preparation Time*: 76 hours
Kemahiran Boleh Pindah Transferable Skills	
Pensyarah / *Lecturer* Bilik / *Room* Telefon / e-mel *Telephone / e-mail*	*Dr. Muhammad Shakeel Ahmad* *Room 18-2, Level 18, Wisma R&D UM* *03-22463422 / muhammadshakeel@um.edu.my*
Sesi Kuliah / *Lecture Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	*Please Refer to the current timetable*
Sesi Tutorial/Amali: *Tutorial/Practical Session:* Hari/Masa / *Day/Time* Tempat / *Venue*	*Tiada / None*
Perincian Pemberatan Penilaian *Detail of Assessment Weightage*	Penilaian Berterusan / *Continuous Assessment*: 50% Peperiksaan Akhir / *Final Examination*: 50%

Jadual Pengajaran / *Teaching Schedule*

Minggu ***Week***	Topik & Aktiviti ***Topic & Activities***	Rujukan ***References***
1	Pengenalan *Introduction*	*Main Reference 1,2*
2	Laluan pengeluaran hidrogen *Hydrogen production routes*	‘’
3	Reka bentuk dan pemilihan elektrolisis *Design and selection of electrolyzer* (Assignment 1)	‘’
4	Sains bahan elektrolisis *Materials science of electrolyzers*	‘’
5	Penyimpanan dan keselamatan hidrogen *Hydrogen storage and safety*	‘’
6	Aplikasi Hidrogen (Kuiz 1) *Applications of Hydrogen* (*Quiz 1)*	‘’
7	Ciri-ciri pembakaran hidrogen *Combustion characteristics of hydrogen*	*Main Reference 3*
8	Sel bahan api hidrogen *Hydrogen fuel cells* (Assignment 2)	-
9	Kejuruteraan integrasi *Integration engineering*	*Main Reference 6*
10	Prestasi sistem (Kuiz 2) *System performance Quiz 2*	*Main References 4, 5*
11	Penukaran biojisim kepada hidrogen *Interaction of hydrogen with metallic storage containers*	‘’
12	Reaktor pembelahan/pelaburan nuklear dan teknologi hidrogen *Nuclear fission/fusion reactors and hydrogen technology*	*Main Reference 2*
13	Kesan alam sekitar *Environmental impact*	‘’
14	Pembentangan *Presentation*	-

Higher Institution Centre of Excellence (HICOE)
UM Power Energy Dedicated Advanced Centre (UMPEDAC)
Level 4, Wisma R&D Universiti Malaya
Jalan Pantai Baharu
59990 Kuala Lumpur, Malaysia

+603 2246 3246 / 3397
umpedac.um.edu.my

@umpedac

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