University Grants Commission

Application for Approval of Master of Science in Clean Energy Technologies

Check List for Proponent								
	Date		**Month**		**Year**			
New Proposal								
Submission of a new Proposal	1	1	0	4	2	0	1	8
Submission of a Revised Proposal	0	2	1	1	2	0	1	8
Complete original application submission to UGC								
Hard copy	1	1	0	4	2	0	1	8
Soft copy	1	1	0	4	2	0	1	8

Type of Proposal (Please mark √ accordingly) – by Proponent

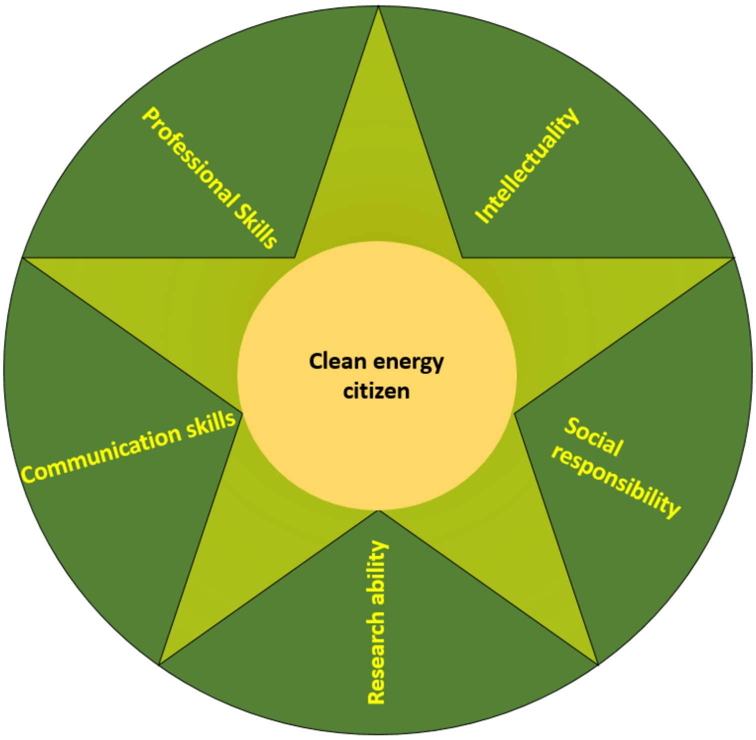
Postgraduate Proposals		
a	Type of Degree/Diploma	
	➢ Postgraduate Degree	**√**
	➢ Postgraduate Diploma	-
b	Proposal to introduce a new Postgraduate Program	**√**
c	Proposal to rename an existing program	-
d	Proposal to restructure the existing curriculum	-
e	Others (Specify)	-

Optional								
	Date		**Month**		**Year**			
Recommendation of Board of Study in Physical Science	0	9	0	1	2	0	1	8
Recommendation of the Faculty of Graduate Studies (Final)	1	1	0	1	2	0	1	8
Concurrence of Senate sub-committee on curriculum development and revision	1	2	0	2	2	0	1	8
Approval of the Senate, University of Jaffna	2	0	0	2	2	0	1	8
Approval of the Council, University of Jaffna	2	4	0	2	2	0	1	8
Approval of QAA, UGC								
Approval of UGC								

Application form					
1	**1.1**	Name of Degree / Diploma programme in all three languages	(English)	Master of Science in Clean Energy Technologies	
			(Sinhala)	පිරිසිදු බලශක්ති තාක්ෂණය පිළිබද පර්යේෂණ සංරචකය හා ඉගැන්වීම් පාඨමාලාවක් සහිත ශාස්ත්‍රපති උපාධිය	
			(Tamil)	தூய சக்தித் தொழில்நுட்பத்தில் விஞ்ஞான முதுமானி	
	1.2	Name of Qualification in all three languages	(English)	Master of Science in Clean Energy Technologies	
			(Sinhala)	පිරිසිදු බලශක්ති තාක්ෂණය පිළිබද පර්යේෂණ සංරචකය හා ඉගැන්වීම් පාඨමාලාවක් සහිත ශාස්ත්‍රපති උපාධිය	
			(Tamil)	தூய சக்தித் தொழில்நுட்பங்களில் விஞ்ஞான முதுமாணி	
	1.3	Abbreviated qualification	(English)	MSc (CET) / MSc (Clean Energy Technologies)	
2	**Programme Offering Entity**				
	2.1	University	University of Jaffna		
	2.2	Faculty/Faculties Institute/s	Faculty of Graduate Studies		
	2.3	Department/Board of Study (if applicable)	Board of Study in Physical Sciences		
	2.4	Mandate Availability			
		Corporate Plan of the University	Reference Number: C/420/2.2.11	Date: 29/07/2017	Evidence ☒ **Please refer Annex XI**
		Final Council Approval	Reference Number: C/426/14.21	Date: 24/02/2018	Evidence ☒ **Please refer Annex XII**
3	**Details of the Degree / Diploma Programme**				
	3.1	Background to the programme **Please see Annex I**			
	3.2	Justification			
		3.2. a Major stakeholder groups from whom views were obtained **Please see Annex II**			
		3.2. b Survey/Questionnaire/Interview (Give details) – When conducted, Number of persons in sample **Please see Annex II**			
		3.2. c Results of Survey/ Questionnaire/Interview **Please see Annex II**			
	3.3	**Objectives of the Degree /Programme Outcomes/Graduate Profile**			
		3.3 a Objectives of the Degree • Get familiarized with different sources of clean energy			

- Apply the relevant concepts in physics, chemistry, engineering and other relevant fields in developing appropriate clean energy technologies
- Learn the most efficient and proper ways of energy production
- Develop competency on applications of fundamental science and operating principles related to clean energy systems to authentic problems prevailing in the clean energy area
- Produce highly skilled Research and development workforce who could offer technical advice and assistance in Clean Energy Technologies

3.3 b (i) Graduate Profile



The desired profile of the MSc holder is depicted in the above figure, which encompasses intellectuality, research ability, social responsibility, professional, intra and inter specific skills with the following Generic and Subject specific attributes:

Generic Attributes

- conduct applied research, demonstrating a sound grasp of research methodology
- communicate effectively orally and in writing at an appropriate level to stakeholders
- plan and manage projects and work in international multidisciplinary teams reflecting on self and giving effective feedback to others
- stay abreast of relevant (inter)national developments in society, policy, and professional practice and to translate, develop and introduce these in an innovative manner to improve professional practice
- collaborate with interdisciplinary teams of research experts
- innovate and commercialize technology adhering to the Intellectual property rights policy of the university

Subject Specific Attributes

- apply the principles of clean energy technologies such as solar, biomass, wind, hydro energy to solve real life problems

- analyze clean energy technologies
- integrate clean energy into a flexible, distributed energy system
- analyze the social, environmental and economic effects of clean energy technologies
- incorporate socio-economic energy policy into clean energy systems development
- integrate technical knowledge and skills with strategic, and socio-economic issues
- analyze and improve the energy efficiency of production chains (implement innovations)
- use appropriate (mathematical) tools for modeling and analyzing problems relevant to clean energy systems
- perceive complexity associated with the energy transition

3.3 b (ii) Programme Learning Outcomes

Intended Learning Outcomes of this programme is categorized into Academic, Application-oriented, Context-oriented, Integrative, Communication and Professional development learning outcomes as follows:

Academic learning outcomes

- define the problem, employ specific research analysis methods and plan and conduct research on real-life non-routine problems
- translate a practical problem into questions in terms of a conceptual model, collect relevant data and translate the outcomes of the model into answers to the original problem.
- apply appropriate scientific methods and techniques, mathematics, economics and other sciences in energy systems design
- justify the ethical concerns in conducting research
- communicate findings in both written and oral form to the relevant stakeholders.
- Innovate and commercialize the output of the research and be a holder of intellectual property rights
- display a reflective attitude towards the possibilities and limitations of the scientific methods used and the development of a body of knowledge and, based on that make meaningful contributions to the energy debate

Application-oriented learning outcomes

- integrate clean energy sources (wind, solar [photovoltaic, thermal], hydro, biomass energy) into a flexible, distributed energy system
- apply the principles of integrated energy storage techniques to solve real life problems
- analyze and improve the energy efficiency of production chains (implement innovations)

Context-oriented learning outcomes

- apply knowledge and insights of the principles of a range of clean energy systems for optimal energy conversion
- design a (range of) clean energy system(s) for optimal energy conversion at a given location and for particular applications
- critically appraise codes of practice relevant to clean energy systems
- analyze economic and sustainability aspects of clean energy systems as well as

technological considerations

- statistically assess clean energy resources at a specific location given appropriate data

Integrative learning outcomes:

- use appropriate mathematical methods for modeling and analyzing engineering problems relevant to clean energy systems
- use knowledge and understanding of the socio-economic impacts when introducing and using relevant technologies
- evaluate the profitability and competitiveness of clean energy projects in economic context

Professional and Communication development learning outcomes

- carry out tasks in a project environment
- participate effectively in an international, multidisciplinary team
- communicate effectively orally, visually and in writing at an appropriate level to stakeholders.
- elaborate the link between technological projects and strategic objectives to the management and other relevant stakeholders
- stay abreast of relevant (inter)national developments, trends and ideas in society, policy, and professional practice and its innovative improvement
- manage his / her own learning process and share expertise with peers and other experts during professional practice

	3.4	**Eligibility requirement (Entry Qualifications)**	Applicants seeking admission to this programme must have one of the following degrees / qualifications from a UGC recognized university: • BSc Honours degree • BSc degree in Engineering • BTech Honours degree • BSc General Degree and at least one year of proven research / professional experience in science / technology stream • Any other equivalent qualifications acceptable to the Board of Study in Physical Sciences of Faculty of Graduate Studies, University of Jaffna.	
	3.5	**Admission process**	i. Written paper Yes ☒ No ☐ ii. Interview Yes ☒ No ☐	
	3.6	**Proposed Student Intake**	30 students/Academic year	
	3.7	**Programme Duration, Type of Degree and Credit Load**		
		3.7 c	Master's degree	**Duration: Two years** **Course work: 40 credits** **Thesis Research: 20 credits** **Total Credits: 60**
	3.8	Programme Structure: This should give details as below		

PROGRAMME STRUCTURE

The proposed MSc programme meets level 10 of the Sri Lanka Qualification Frame Work (SLQF, 2015); a 60 credits programme consisting of course work and a research project of 20 credits. It will be conducted over a period of twenty-four months (during weekends and/or weekdays), inclusive of minimum 08 months for the research project, with provision to exit at the end of second semester with taught master degree equivalent to level 9 of the SLQF.

The Course codes

A four-letter prefix followed by a 5-digit number is used to identify the course unit. The first digit of the five-digit number indicates the year of study. The next two digits indicate the course unit. The last two digits indicate the credit value of the course unit.

List of course units

Table I – Course units to be offered in the First Year

No.	Course code	Course Title	Contact hours		Notional hrs	No. of Credits
			Theory	Practical		
Semester 1						
1.	MCET 101 03	Essential science for Energy Technologies	45	-	150	03
2.	MCET 102 03	Wind Energy Technologies	30	-	100	02
3.	MCET 103 02	Instrumentation and Characterization Techniques	45	-	150	03
4.	MCET 104 03	Solar Energy Technologies	45	-	150	03
5.	MCET 105 03	Hydrogen Energy Technologies	45	-	150	03
6.	MCET 106 02	Lab based short projects [1,2]	-	-	200	02
Semester 2						
7.	MCET 107 02	Energy Storage Technologies	30	-	100	02
8.	MCET 108 02	Marine and Hydro Energy Technologies	30	-	100	02
9.	MCET 109 02	Bioenergy Technologies	30	-	100	02
10.	MCET 110 03	Grid Integration of Clean Energy System	30	45	150	03
11.	MCET 111 02	Project Development and Management	30	-	100	02
12.	MCET 112 01	Industrial training in clean energy plants[2]	-	-	100	01
13.	MCET 113 02	Group research project [2]	-	-	200	02
Total						**30**

[1] to be conducted during first and second semester, [2] Independent learning

Table II – Course units to be offered in the Second Year

No.	Course code	Course Title	Contact hours		Notional hrs	No. of Credits
			Theory	Practical		
Semester 3						
14.	MCET 214 03	Nanomaterials for Energy Harvest and Storage	30	45	150	03
15.	MCET 215 03	Mathematical modelling for Clean energy technologies	15	90	150	03
16.	MCET 216 02	Critical review on a research topic	15	45	100	02
17.	MCET 217 02	Research Ethics, Proposal Writing and presentation	15	45	150	02
Semester 3 & 4						
18.	MCET 216 20	Research project [2]	-	-	2000	20
Sub-total						**30**
Total						**60**

[2] Independent learning

As per SLQF, one credit is considered equivalent to 50 notional learning hours for a taught course, laboratory studies course or field studies. In case of project and industrial training, including time allocated for assessments and in case of research, including time allocated for literature survey, one credit is considered equivalent to a minimum of 100 notional hours.

3.9 **a** Targeted Sri Lanka Qualification Framework (SLQF) Level **(Please tick √)**

SLQF Level	7	8	9	10	11	12
				√		

b Minimum requirements of SLQF fulfilled Yes ☒ No ☐

3.10 Programme Content

Please refer Annex III

4 Programme Delivery and Learner Support System

Note: Blended, student centered teaching with judicious use of ICT teaching and learning tools is a requirement.

Please see Annex IV

5 Programme Assessment Procedure /Rules

Describe in detail the Programme Assessment Procedure/Rules:

Please refer Annex V

6		Resources Requirement

		Existing	Additional Requirement (Estimated)			
			Year 1	Year 2	Year 3	Year 4
Physical Resources#						
Land extent (Acre)		0.25				
Office Space (m^2)		225				
No. of Lecture Theatres		10				
No. of Laboratories		06				
No. of Computers with Internet Facilities		40				
Reading Rooms/Halls		03				
Staff Common Rooms/Amenities		02				
Student Common Rooms/Amenities		02				
Other						
Financial Resources						
Capital Expenditure (million rupees)		2.0				
Recurrent Expenditure (million rupees)		6.0				
Human Resources#						
No. of Academic Staff	Lecturers	25				
	Instructors	06				
No. of Academic Support Staff						
No. of Non Academic Staff	Executive Grades	01				
	Technical Grades	06				
	Management	02				
	Minor Staff	02				

Resources of the Faculties of Science and Engineering will be utilized.

7		Panel of Teachers/ Internal Resource Persons/External Resource Persons **Please refer Annex VI**	
8		Does the Faculty have resources to commence operation of new degree/diploma programme, pending allocation of resources requested?	Yes ☒ No ☐
9		**a.** Does the programme have exit at other postgraduate qualification levels	Yes ☒ No ☐
		b. If yes, state qualification at exit points (Ensure approval is obtained separately for all exit point qualifications)	Master of Clean Energy Technologies

10		Does the programme have any collaboration with another Department / Faculty or Institute outside universities?	Yes ☒ No ☐ If yes, give details: Other faculties – Faculties of Science and Engineering
11		Access to facilities outside the university. If yes, copy of the relevant agreement / MOU with the appropriate authority should be attached.	Yes ☒ No ☐ MOU and MOA are signed with Western Norway University of Applied Sciences attached for Higher Education and Research Collaboration in Clean Energy Technologies. **Please refer Annex XIII**
12		Do the graduates need membership in the professional body after completion of the Degree / Diploma? If Yes copy of the document on recognition/provisional recognition of the degree by the professional body should be attached.	Yes ☐ No ☒
13		Fee structure	**Please refer Annex VII**
	13.1	Tuition fees	First year - LKR 150,000.00 Second year - LKR 50,000.00
	13.2	Other fees if any (specify)	First year - LKR 50,000.00 Second year - LKR 100,000.00
14		Total estimated budget	**Please refer Annex VIII**
15		Reviewers Report	**Please refer Annex IX**
	15.1	Names of the two Reviewers	Professor Lakshman Dissanayake (Physics) Professor Gamini Rajapakshe (Chemistry) Professor J.B. Ekanayake (Engineering)
	15.2	Nomination by Senate	Date: 20/02/2018 Evidence: Yes ☒ No ☐ (Date of Senate meeting and evidence) **Please refer Annex X**
	15.3	Report of Reviewers attached	Yes ☒ No ☐
	15.4	Recommendation of Reviewers comments incorporated	Yes ☒ No ☐ (If yes please highlight such in the whole document)
16		Any other relevant information not stated above	None

17		Recommendation and Signature of IQAU Director of the University	DIRECTOR / IQAU University of Jaffna
18		Signature of Dean of the Faculty/Director of Institute and official stamp	Dean/Graduate Studies University of Jaffna
19		Signature of Vice Chancellor and official stamp	VICE CHANCELLOR University of Jaffna Jaffna, Sri Lanka
20		Date	02/11/2018

Annex I: 3.1 Background to the programme

Mandate of the Institute/Faculty/Department/Board of Study in offering the degree/diploma programme

- Enriching graduates updated with the advanced theoretical and applied knowledge on the subject areas at postgraduate level
- Providing adequate knowledge to specialize on the subject specific areas at postgraduate level
- Widening the understanding on the selected subjects at postgraduate level to enable them to apply at their work
- Guiding the students to organize, plan, materialize and execute the activities as scheduled.
- Developing research and dissemination skills among graduates through presentations and submission of dissertation/thesis
- Assisting the graduate's career development thorough learning more on the selected subjects at postgraduate level.

Details as regard to the current status of the faculty – existing Board of Study and degree / diploma programmes offered

Faculty: Graduate studies							
	Board of Study	**Offered Degree/Diploma Programme**	**Abbreviation**	**Student Intake**	**Staff cadres**	**Educational facilities**	**Common facilities**
1	Education	Master of Education	MEd	100	12 (Visiting)	Lecture halls,	Library, Computer lab
2	Education	Postgraduate Diploma in Education	PGDE	75	10 (visiting)	Lecture halls,	Library , Computer facilities
3	Languages and Cultural Studies	Master of Arts in Tamil	MA (Tamil)	50	10 (Visiting)	Lecture halls,	Library, Computer facilities
4	Religious and Philosophical studies	Master of Arts in Saiva Siddhanta	MA (Saiva Siddhanta)	50	08 (Visiting)	Lecture halls,	Library, Computer facilities
5	Earth Sciences and Environmental Studies	Master of Science in Environmental Management	MSc (EM)	30	15 (Visiting)	Lecture hall	Library, Computer facilities
6	Management and Commerce	Master of Science in Health Management	MSc (HM)	30	15 (Visiting)	Lecture hall	Library, Computer facilities
7	Languages and Cultural Studies	Master of Arts in Cultural Studies	MA (Cultural Studies)	50	6 (Visiting)	Lecture hall	Library
8	Languages and Cultural studies	PG Diploma in Testing English as a Second Language	PGD TESL	30	10 (Vising)	Lecture hall	Library
9	Development studies	PG Dip in Lib and information Sciences	PGDLIS	30	6 (Visiting Staff)	Lecture hall	Library, Computer facilities

Proposal must give general description of the benefits that will be accrued by the students who will pursue degree/diploma level training and the sector (s)/employment markets to which the graduate(s) could look for gainful employment

In line with the national policy of Sri Lanka to meet 20 % of the total power generation by the year 2020 through clean energy resources other than hydro energy, the proposed MSc programme in Clean Energy Technologies is aimed at producing technically sound postgraduates to meet the growing demand in the field of Clean Energy Technologies, such as solar photovoltaic (PV), solar thermal, hydro energy, wind, bioenergy, etc.

This programme enables graduates to get familiarized with different sources of clean energy and apply the relevant concepts in physics, chemistry, engineering and other relevant fields in developing appropriate clean energy technologies. Students shall learn the most efficient and proper ways of energy production as they explore the relationships among work, power and energy and would be engaged in a wide variety of individual and group projects and laboratory activities that illustrate the inter-relationship between various forms of clean energy.

The proposed multidisciplinary programme will produce Master degree holders who are competent on applications of fundamental science and operating principles related to clean energy systems to authentic problems prevailing in the clean energy area, such as wind turbines, bioreactors and biofuel generation, fuel cells, solar thermal and solar PV systems. Moreover, they can develop solutions for these authentic problems using engineering design process. The proposed master degree programme shall produce highly skilled Research and Development workforce who could offer technical advice and assistance in Clean Energy Technologies. The industries in the field of Energy Technologies and Professionals in Energy / Environment / Technology stream will be benefited.

Annex II: 3.2 Justification

3.2 a Major stakeholder groups from whom views were obtained

- Final Year Undergraduates pursuing BSc degree in Engineering, BSc degree in Agriculture and BSc Honours degree in Physics and Chemistry
- Graduates of Science, Engineering and Technology
- Other Stakeholders, such as relevant Industries and Schools where Technology stream exists

3.2 b Survey/Questionnaire/Interview

When Conducted	Number of persons in sample
February – March 2018	73 Final Year Undergraduates
February – March 2018	25 Graduates
February – March 2018	05 Other Stakeholders

3.2 c Result of Survey/Questionnaire/Interview

A questionnaire-based survey was carried out among 73 final year undergraduates, of whom 59% and 36% were pursuing BSc (Engineering) and BSc (Honours) degrees respectively during the survey period. Among the respondents,

- many desire academic (33%) and engineering (32%) professions.
- 40%, 27% and 23% prefer to be employed in education, energy and management sectors respectively.
- 81% are interested to follow a Master degree programme to attain a postgraduate qualification (44%)

and for better job opportunities (32%).

- Of the interested respondents, 67% prefer MSc in CETs of two years duration and 27% are prepared to pay the course fee.
- 84% want to upgrade to MPhil/PhD degree while pursuing the Master degree programme, if a chance is given.

A similar questionnaire-based survey was conducted among 25 graduates, of whom 75% and 15% possess BSc (Honours) and BSc (Engineering) degrees respectively. Among the respondents,

- 47% are unemployed.
- Of the 25 graduates, 70%, 20% and 10% are either employed or preferred to be employed in education, management and energy sectors respectively.
- 95% are interested to follow a Master degree programme to attain a postgraduate qualification (68%) and for better job opportunities (16%).
- Of the interested respondents, 85% prefer to enroll for MSc in CETs of two years duration and 16% are prepared to pay the course fee.
- 95% want to upgrade to MPhil/PhD degree while pursuing the Master degree programme, if a chance is given.

An industry in the field of clean energy technologies states the proposed Master degree programme on CETs possesses high relevance to its institutional scope and it will encourage its employees to pursue the above programme for knowledge enhancement and skill development by providing financial assistance.

Annex III: 3.10 Programme Content (Attach as a separate document for each semester in the program)

Programme Content
Semester 1

List of course units

Table I – Course units to be offered in the First Year

No.	Course code	Course Title	Contact hours		Notional hrs	No. of Credits
			Lecture	Practical		
Semester 1						
1.	MCET 101 03	Essential science for Energy Technologies	45	-	150	03
2.	MCET 102 02	Wind Energy Technologies	30	-	70	02
3.	MCET 103 03	Instrumentation and Characterization Techniques	45	-	105	03
4.	MCET 104 03	Solar Energy Technologies	45	-	150	03
5.	MCET 105 03	Hydrogen Energy Technologies	45	-	150	03
6.	MCET 106 02	Lab based short projects [1,2]	-	-	200	02

[1] to be conducted during first and second semester, [2] Independent learning

Semester 1			
Course Title	**Essential science for Energy Technologies**		
Course Code	MCET 101 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	45	-	105
Objectives	• Introduce crystal structures and interatomic forces • Outline the fundamentals of semiconductors • Introduce generator technologies and back emf • Introduce basic concepts of thermodynamics related to energy conversion • Familiarize with fluid dynamics • Acquaint with heat transfer process • Provide fundamentals of catalysis • Familiarize with biological basics relevant to conversion of biomass to energy		
Intended Learning Outcomes	• Infer fundamentals of thermodynamics with respect to energy conversion • Explain fundamentals of semiconductors • Discuss generator technologies and back emf • Comprehend principles of energy flow and fluid dynamics • Identify different modes of heat transfer process • Analyze thermal resistance for multimode heat transfer		

	• Show mechanism of catalysis • Discuss metabolism of microbes in bioenergy production	
Contents	**Crystal structure and Interatomic forces** Types of crystals, crystal structures, unit cells, FCC, BCC and HCP structures, crystal defects. Inter-atomic forces: Molecules and binding forces, Van der Waals, ionic, covalent and metallic bonds.	
	Fundamentals of Semiconductors Valance band, conduction band, bandgap, Density of States, intrinsic carrier concentration, Fermi level, extrinsic semiconductors, p-n junction, depletion region, semiconducting polymers, HOMO and LUMO levels, doping.	
	Basics of generator technology, back emf	
	Thermodynamics Basic concepts, zeroth law and temperature, energy interaction, first law, flow processes, second law, entropy and availability, combined first and second laws, gas power cycles: Carnot, Stirling, Brayton, Otto, diesel and duel cycles, vapour power cycles: Rankine cycle and improvements, refrigeration, psychrometry, role of thermodynamics in energy conversion	
	Fluid dynamics Equation of continuity, conservation of energy and momentum, energy flow, viscosity, forces on fluid element, uniform and non-uniform flow, flow patterns and Reynolds number, friction in the pipe flow and head lost, jet engine	
	Heat transfer process Modes of heat transfer, thermal resistance and circuit analysis for multimode heat transfer, properties of transparent materials, heat transfer by mass transport	
	Catalysis Heterogeneous and homogenous catalysis, mechanism for production of hydrogen, ammonia and methane, water splitting, carbon dioxide reduction	
	Metabolism of Microbes Microbial diversity, cell nutrients, enzymes, metabolic pathways, cell functions, stoichiometry of microbial growth and product formation	
Teaching and Learning Methods / Activities	Lectures Quizzes Assignments	
Evaluation	In-course assessments	30 %
	End of course examination	70 %
Recommended References	• Essentials of Energy Technology: Sources, Transport, Storage, Conservation, Jochen Fricke and Walter L. Borst, Wiley-VCH, 2013 (ISBN: 9783527334162) • Catalysis for Sustainable Energy Production, Pierluigi Barbaro, Claudio Bianchini (Eds.), Wiley-VCH, 2009 (ISBN: 9783527320950) • Catalysis for Alternative Energy Generation, László Guczi and András Erdôhelyi (Eds.), Springer, 2012 (ISBN: 9781461403432) • Bioprocess Engineering: Basic Concepts, Michael L. Shuler, Fikret Kargi and Matthew DeLisa, Prentice Hall, 2017 (ISBN: 9780137062706)	

Semester 1			
Course Title	**Wind Energy Technologies**		
Course Code	MCET 102 02		
Credit value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70
Objective/s	• Introduce basic wind power calculations using fundamental physics concepts • Familiarize with wind energy technologies • Provide basics of generator technologies • Introduce reliability and quality of wind power generation • Introduce basic design of wind energy generation components • Provide civil engineering design aspects of wind tower		
Intended Learning Outcomes	• Calculate wind energy production from wind turbine • Describe types of wind energy generation technologies • Distinguish between technologies and rationale behind their evolution • Discuss about the quality of electric power produced from wind turbines • Design wind energy generation components • Explain the civil structural requirements and construction of a wind tower		
Contents	**History** Early wind power, technical development, advantages and disadvantages		
	Winds Physical background, energy content, variation in time and in space, geographical resource distribution, influence of terrain, measurement methods, statistical analysis		
	Turbine theory Free flow, principles of drag and lift, aerodynamics, design of turbine blades, horizontal and vertical axis wind turbines, Betz' and Glauert's turbine theories, the BEM method		
	Power reliability/ quality, Grid-code (Wind energy related)		
	Wind power generation technologies Fixed-Speed Induction Generator (FSIG), Variable Speed Wind Turbine (VST), Doubly-Fed Induction Generator (DFIG) and Full Converter Based		
	Blade profile design, Computational Fluid Dynamics (CFD)		
	Tower and foundation design		
Teaching and Learning Methods / Activities	Lectures Mini-project Video-lectures Flipped classes		
Evaluation	In-course assessments	50 %	
	End of course examination	50 %	
Recommended References	• Distributed Generation, N Jenkins, J.B. Ekanayake and G. Strbac, Institution of Engineering and Technology, 2010 (ISBN: 0863419585) • Wind Energy Generation: Modelling and Control, Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright and Mike Hughes, Wiley, 2009 (ISBN 978-0-470-71433-1)		

Semester 1			
Course Title	**Instrumentation and Characterization techniques**		
Course Code	MCET 103 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	45	-	105
Objectives	• Introduce basic principles of materials characterization • Familiarize with selected materials characterization techniques • Acquaint with available methods for analyzing the data obtained using the above techniques		
Intended Learning Outcomes	• Explain principles of optical, microscopic, thermal and electrical techniques used in characterization of materials and devices • Identify appropriate technique for characterization of materials and devices for different applications • Solve practical problems in materials characterization utilizing appropriate techniques, skills, and modern analytical tools		
Contents	• **Introduction** Introduction to different material characterization techniques • **Optical analysis** Principle, Instrumentation, and Applications of - UV-Visible (UV) spectroscopy, - Fourier Transform-Infra Red (FT-IR), - Raman, - Photoluminescence (PL), and - Transient Absorption Spectroscopy (TAS) • **Microscopic analysis** Principle, Instrumentation, and Applications of - Scanning Electron Microscopy (SEM), - Field Emission Scanning Electron Microscopy (FE-SEM), - Transmission Electron Microscopy (TEM), and - Atomic Force Microscopy (AFM) • **Structure analysis tools** Basic principle, instrumentation configuration, data interpretation, and quantification of - X-ray difractometer (XRD) - Energy-dispersive X-ray spectroscopy (EDX) - Neutron Powder Diffractometer - X-ray fluorescence spectrometer (XRF) - X-ray photon spectroscopy (XPS) and - Ultraviolet photon spectroscopy (UVPS) • **Thermal analysis** Principles and applications of - Differential thermal analysis (DTA), - Differential Scanning Calorimetry (DSC), and - Thermo-gravimetric analysis (TGA)		

	• **Electrical analysis** Principles and applications of - Two and four probe - Kelvin probe - Hall Effect and - Magnetoresistance measurements.	
Teaching and Learning Methods / Activities	• Lectures • Lab visit and demonstration • In-class Assignments	
Evaluation	In-course assessments	30 %
	End of course examination	70 %
Recommended References	• Materials Characterization: Introduction to Microscopic and Spectroscopic Methods (2^{nd} Ed.), Yang, L., Wiley, 2013 (ISBN: 978-3-527-33463-6) • Surface analysis: The principal techniques (2^{nd} Ed.), Vickerman, J.C. and Gilmore, I., Wiley , 2009 (ISBN: 978-0-470-01764-7) • Characterization of materials, Kaufmann, E. N., Hoboken and N. J., John Wiley & Sons, 2003 (ISBN: 978-0-471-26882-6) • Thermal analysis of materials (1^{st} Ed.), Speyer, R., CRC press, 1993 (ISBN 13: 978-0824789633, ISBN 10: 0824789636) • Materials Science and Technology: A Comprehensive Treatment/ Characterization of Materials (Materials Science & Technology), Cahn, R. W., Haasan and P., Kramer, E. J., Wiley-VCH, 1992 (ISBN 10: 3527268154, ISBN 13: 978-3527268153)	

Semester 1			
Course Title	**Solar Energy Technologies**		
Course Code	MCET 104 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	45	-	105
Objectives	• Introduce basic concepts of solar energy technologies • Describe existing solar energy strategies and frontier technology updates • Familiarize with different types of solar Photovoltaic (PV) and thermal systems.		
Intended Learning Outcomes	• Recognize the necessity for solar energy technologies in the context of world energy demand • Apply fundamental concepts of various solar energy technologies • Discuss challenges in developing and operating different solar energy technologies • Describe shading effect on the performance of solar cells • Critically compare different solar energy technologies		

<table>
<tr><td></td><td>• Distinguish between different PV technologies
• Evaluate solar Photovoltaic (PV) and thermal systems</td></tr>
<tr><td rowspan="11">Contents</td><td>Solar spectrum
Electromagnetic spectrum, basic laws of radiation, Physics of the Sun, energy flux, solar constant for earth, Solar radiation on the earth surface, spectral energy distribution of solar radiation, Measurement of solar radiation: Pyranometer, Pyrheliometer.</td></tr>
<tr><td>Solar cell performance
I-V characteristics of a solar cells, maximum power point, cell efficiency, fill factor, effect of irradiation and temperature, panel construction and power transmission</td></tr>
<tr><td>Crystalline silicon solar cells
Working principle, fabrication process of crystalline and polycrystalline silicon solar cell, future research trends in silicon solar cell</td></tr>
<tr><td>Thin film solar cells
Operational principles of a-Si, CdTe, CIGS and GaAs solar cells, Advantageous of CdTe solar cells over other thin film solar cells</td></tr>
<tr><td>Nanostructured solar cells
Structure and operating principle organic solar cells, Plasmonic solar cell, Intermediate bandgap solar cell, Quantum dot sensitized solar cell, Up conversion & down conversion</td></tr>
<tr><td>Effect of shading and remedial measures</td></tr>
<tr><td>Computational modeling of solar cells: Optical & electrical stimulation of solar cell using commercial software (eg: VASP , PC1D, Lumerical FDTD, G-solver etc..)</td></tr>
<tr><td>Advances in Solar Cell Manufacturing</td></tr>
<tr><td>Concentrating solar power technology (CSP)
Optical properties of concentrated light systems, Function and build-up of a CSP system, Overview of the different components and their functions. Examples of CSP-systems throughout the world.</td></tr>
<tr><td>Solar thermal energy storage systems
Design aspects of solar thermal energy harvesting and storage systems. Selection criteria of storage materials for heating and cooling applications, selection of heat transfer fluid for heating and cooling applications.</td></tr>
<tr><td>Future Challenges in solar energy technologies</td></tr>
<tr><td>Teaching and Learning Methods / Activities</td><td>In – class Lectures
Seminar presentation</td></tr>
</table>

<table>
<tr><td rowspan="2">Evaluation</td><td>In-course assessments</td><td>30 %</td></tr>
<tr><td>End of course examination</td><td>70 %</td></tr>
</table>

<table>
<tr><td>Recommended References</td><td>• Solar Cells: Operating Principles, Technology, and System Applications, Green, M. A., Prentice Hall, 1981 (ISBN: 9780138222703)
• Semiconductor Material and Device Characterization (2nd Ed.), Schroder, D., Wiley-Interscience, 1998 (ISBN: 9780471241393)
• The Physics of Solar Cells. Nelson, J., Imperial College Press, 2003 (ISBN:</td></tr>
</table>

	9781860943409) - Handbook of Photovoltaic Science and Engineering, Luque, A., and S. Hegedus (Eds.), John Wiley & Sons Ltd, 2003 (ISBN: 9780471491965). - Applied Photovoltaics. 2nd Ed., Routledge, Wenham, S., M. Green, et al. (Eds.), 2006 (ISBN: 9781844074013) - Fundamentals of Semiconductors: Physics and Materials Properties (3rd Ed.), Yu, P., and M. Cardona, Springer, 2004 (ISBN: 9783540413233) - Solar Energy Engineering, J. S. Hsieh, Prentice Hall - Solar Energy Engineering: Processes and Systems, Soteris A. Kalogirou, Academic Press, 2009

Semester 1			
Course Title	**Hydrogen Energy Technologies**		
Course Code	MCET 105 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	45	-	105
Objectives	- Summarize the principles of electrochemistry and thermodynamics behind the operation of a Fuel Cell - Analyze different kinds of Fuel Cells and their respective applications - Explain the functions of each components in a PEM (Proton Exchange Membrane) Fuel Cell and their design - Assess the performance of a PEM Fuel Cell and the parameters influencing its degradation - Establish a knowledge of hydrogen systems, storage, production and its application in fuel cells.		
Intended Learning Outcomes	- Compare different types of fuel cells in relation to specific applications and costs - Identify the thermodynamic and electrochemical requirements for the operation of a fuel cell - Discuss the performance evaluation and the degradation of PEM fuel cells - Distinguish between the operational principles of a fuel cell and the water splitting - Explain the chemical reaction concepts applied to hydrogen energy systems. - Apply design tool for electrochemical, hydrogen power systems.		
Contents	**Introduction to Hydrogen Energy Technologies** Basics of Fuel Cells, operational principle of a fuel cell and hydrogen Splitting		
	Types of Fuel Cells Proton Exchange Membrane (PEM) Fuel Cells, Solid-Oxide Fuel Cells (SOFCs), Direct Methanol Fuel Cells, Alkaline Fuel Cells, Phosphoric Acid Fuel Cells and		

	Molten Carbonate Fuel Cells. Operational principles, pros/cons in relation to various applications and cost analysis	
	Proton Exchange Membrane (PEM) Fuel Cells Components and characteristics, Membrane Electrode Assembly (MEA), Evaluation of performance, Voltage losses and their management	
	Materials for PEM Fuel Cells Electrolytes, Electrodes, Electro-catalysts, Gas Diffusion Layers (GDL) and Flow Fields	
	Fuel Cell Thermodynamics and Electrochemistry Basic thermodynamics related to the operation of a fuel cell, Reaction at electrodes, The cell reaction and potential, The variation of potential with pH and temperature, The determination of thermodynamic functions, Electrochemistry of PEM fuel cell,	
	Applications of Fuel Cells Automotive, portable electronic and stationary applications	
	Hydrogen Energy Hydrogen reforming technology, Hydrogen Storage, Hydrogen Production, Hydrogen economy.	
	Water splitting Photoelectrolysis, structured materials for photoelectrochmical water splitting, Tandem photoelectrochemical cells for water splitting, Photocatlytic water splitting,	
Teaching and Learning Methods / Activities	Lectures Laboratory work Home-work assignments	
Evaluation	In-Course Assessments	30 %
	End of Course examination	70 %
Recommended References	• Fuel Cell - Fundamentals (3 rd Ed), Ryan O' Hayre, Suk-Won Cha, Whitney Colella and Fritz B. Prinz, Wiley, 2016 (ISBN 978-1119113805) • Fuel Cells - From Fundamentals to Applications, Supramaniam Srinivasan, Springer, 2006 (ISBN 978-0387251165) • Hydrogen and Fuel Cells: Emerging Technologies and Applications (2 nd Ed), Bent Sørensen, Elsevier Ltd, 2012 (ISBN 978-012387709-3) • Fuel Cells and Hydrogen: From Fundamentals to Applied Research, Viktor Hacker and Shigenori Mitsushima, Elsevier Ltd, 2018 (ISBN 978-0128114599) • Photoelectrochemical Water Splitting: Materials, Processes and Architectures (Energy and Environment Series), Hans-Joachim Lewerenz and Laurie Peter, RSC publishing, 2013 (ISBN 978-1849736473) • Photochemical Water Splitting: Materials and Applications, Neelu Chouhan, Ru-Shi Liu and Jiujun Zhang, CRC Press, 2017 (ISBN 978-1315279640)	

Semester 1			
Course Title	**Laboratory based short projects**		
Course Code	MCET 106 02		
Credit value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	-	-	200
Objectives	• Recall basic concepts associated with relevant characterization techniques • Familiarize with advanced experiments using the above techniques • Provide training in writing short project reports		
Intended Learning Outcomes	• Apply appropriate characterization techniques for real problems • Demonstrate range of materials characterization techniques, data analysis and reporting.		
Contents	Students are expected to perform at least ten of the following short projects independently using specified characterization techniques and submit respective short project reports. - Optical characterization of materials by UV-Vis spectroscopy - Carrier mobility of disordered materials by Time of flight technique - Band gap in semiconductors by Four-probe technique - Carrier concentration of semiconducting materials by Hall effect technique - External Quantum Efficiency measurement of solar cells - Current - Voltage characteristics of solar cells - Structural characterization of materials by XRD - Diffusion coefficient of materials by Impedance spectroscopy - Functional group identification by FTIR spectroscopy - AC Impedance Analysis of solar cells by Auto lab - Sheet resistance of conducting substrates by four probe method - Roughness factor of surface layers by Atomic Force Microscopy - Photoluminescence (PL) of hybrid sample by PL spectroscopy		
Learning Methods / Activities	• Laboratory Work • Writing short project reports		
Evaluation	In-course assessments (Laboratory project reports)	60 %	
	End of course examination	40 %	

Semester 2

No.	Course code	Course Title	Contact hours		Notional hrs	No. of Credits
			Lecture	Practical		
7.	MCET 107 02	Energy Storage Technologies	30	-	100	02
8.	MCET 108 02	Marine and Hydro Energy Technologies	30	-	100	02
9.	MCET 109 02	Bioenergy Technologies	30	-	100	02
10.	MCET 110 03	Grid Integration of Clean Energy System	30	45	150	03
11.	MCET 111 02	Project Development and Management	30	-	100	02
12.	MCET 112 01	Industrial training in clean energy plants[2]	-	-	100	01
13.	MCET 113 02	Group research project [2]	-	-	200	02

[1] to be conducted during first and second semester, [2] Independent learning

Semester 2			
Course Title	**Energy Storage Technologies**		
Course Code	MCET 107 02		
Credit Value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70
Objectives	• Assess different types of energy storage technologies • Explain the operational principle of a well-known secondary battery - Lithium-ion battery • Illustrate the importance of going beyond Lithium-ion batteries • Distinguish various types of super-capacitors and their performances • Discuss thermal and hydro energy storage technologies		
Intended Learning Outcomes	• Compare the practicality of different energy storage systems in the context of available resources • Distinguish between different types of battery chemistries • Introduce the basic operational principle of batteries and super-capacitors • Identify the relative costs, sustainability of each technology and the safety issues • Discuss various types of thermal and hydro energy storage technologies		
Contents	**Introduction to Energy Storage Technologies** Secondary batteries, super-capacitors, thermal and hydro energy storage technologies, high and low power high energy' storage devices		
	Components of a Battery Electrolytes, cathodes, anodes, separators and binders		

	Design and Operation of Major Battery Chemistries Lead-acid, metal-hydride and lithium-ion. Pros/cons of different chemistries, comparison of energy and power densities, cost analysis and charge/discharge characteristics	
	Different Types of Electrolyte Materials Aqueous and non-aqueous liquids, ceramics, gel-polymers, solid-polymers and ionic liquids	
	Different Types of Electrode Materials Graphite, hard-carbon, lithium cobalt oxide, lithium cobalt phosphate and so on.	
	Electrochemistry and Thermodynamics of Batteries Charge transfer at the electrode interfaces, cell resistance, ion diffusion, ion migration and capacity fade	
	Batteries Beyond Lithium-Ion Sodium-ion, sodium-sulfur, magnesium-ion and redox-flow batteries. Pros/cons and highlights on recent research and development of these new type of batteries	
	Applications of Different Types of Batteries Suitable battery types for automotive, portable electronic and stationary applications	
	Performance Evaluation of Batteries State of Health (SOH), State of Charge (SOC), State of Function (SOF) and Electrochemical Impedance Spectroscopic (EIS) evaluations. Safety issues (thermal runaway, short-circuiting and fire/explosion hazard) on batteries, battery management systems, second life of batteries	
	Introduction to super-capacitors Operational principle, different types of super-capacitors and specialty materials	
	Different Types of Materials for Thermal Energy Storage Phase change materials, organic liquids, thermal oils and molten salts	
Teaching and Learning Methods / Activities	Lectures Laboratory works Home-work assignments	
Evaluation	In-course assessments	30 %
	End of course examination	70 %
Recommended References	• Energy Storage - Fundamentals, Materials and Applications (2nd Ed), Robert A. Huggins, Springer, 2016 (ISBN 978-3-319-21239-5) • Energy Storage, Gerard M. Crawley (Eds.), World Scientific, 2017 (ISBN 978-981-3208-95-7) • Modern Batteries - An Introduction to Electrochemical Power Sources (2nd Ed) - Colin A. Vincent and Bruno Scrosati, Butterworth-Heinemann, 1997 (ISBN 0-340-66278-6)	

<table>
<tr><td colspan="4">Semester 2</td></tr>
<tr><td>Course Title</td><td colspan="3">Marine and Hydro Energy Technologies</td></tr>
<tr><td>Course Code</td><td colspan="3">MCET 108 02</td></tr>
<tr><td>Credit value</td><td colspan="3">02</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>30</td><td>-</td><td>70</td></tr>
<tr><td>Objectives</td><td colspan="3">• introduce underlying physics behind wave energy
• explain wave energy technologies
• explain types of wave energy technologies
• introduce reliability and quality of wave power generation
• provide basic design of wave energy generation components
• introduce tidal power extraction
• explain hydro energy technologies
• provide basics of hydro power generator technologies
• introduce reliability and quality of hydro power generation
• provide basic design of hydro energy generation components</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">• explain underlying concepts behind wave energy
• discuss about the types of wave energy generation technologies
• distinguish between technologies and rationale behind their evolution
• design wave energy generation components
• calculate and analysis of hydro energy production
• describe types of hydro energy generation technologies
• distinguish between technologies and rationale behind their evolution
• design hydro energy generation components</td></tr>
<tr><td rowspan="9">Contents</td><td colspan="3">Introduction
Simple amplitude wave theory; Finite amplitude wave theory</td></tr>
<tr><td colspan="3">Wave properties
Reflection, refraction, diffraction, energy transmission</td></tr>
<tr><td colspan="3">Ocean waves: wave generation, wave energy and power, wave power extraction devices</td></tr>
<tr><td colspan="3">Forces on submerged surfaces</td></tr>
<tr><td colspan="3">Basics of wave harboring technology</td></tr>
<tr><td colspan="3">Power reliability/ quality, Grid-code (Hydro energy related)</td></tr>
<tr><td colspan="3">Hydro power generation technologies</td></tr>
<tr><td colspan="3">Blade profile design, Computational Fluid Dynamics (CFD)</td></tr>
<tr><td colspan="3">Tidal power: cause of tides, tidal power extraction</td></tr>
<tr><td>Teaching and Learning Methods / Activities</td><td colspan="3">Lectures
Mini-project
Video-lectures
Flipped classes</td></tr>
<tr><td rowspan="2">Evaluation</td><td colspan="2">In-course assessments</td><td>50 %</td></tr>
<tr><td colspan="2">End of course examination</td><td>50 %</td></tr>
<tr><td>Recommended References</td><td colspan="3">• Basic Coastal Engineering (3rd Ed), Sorensen R. M., Springer Publication, 2006 (ISBN: 0-387-23332-6 or 9780387233321)
• Handbook of coastal and ocean engineering, Kim, Y. C., World Scientific Publishing Co. Pte Ltd, 2010 (ISBN: 981-281-929-0)</td></tr>
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<tr><td colspan="4">Semester 2</td></tr>
<tr><td>Course Title</td><td colspan="3">Bioenergy Technologies</td></tr>
<tr><td>Course Code</td><td colspan="3">MCET 109 02</td></tr>
<tr><td>Credit value</td><td colspan="3">02</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Practical</td><td>Independent Learning</td></tr>
<tr><td>30</td><td>-</td><td>70</td></tr>
<tr><td>Objectives</td><td colspan="3">• Define different types of biomass feedstock
• Familiarize with the existing and emerging bioenergy technologies
• Acquaint with available techniques for purification of biobased products
• Explain life cycle assessment of bioenergy systems</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">• Identify potential biomass feedstock
• Discuss bioenergy technologies
• Relate appropriate separation techniques for various biobased products
• Asses life cycle of bioenergy systems</td></tr>
<tr><td rowspan="5">Contents</td><td colspan="3">Biomass feedstock
Harvested feedstock (1st, 2nd 3rd and 4th generation), residue feedstock (agricultural waste, forestry waste, farm waste, organic components of residential, commercial, institutional and industrial wastes)</td></tr>
<tr><td colspan="3">Biomass conversion technologies
Biochemical conversion (hydrolysis, enzyme & acid hydrolysis, fermentation, anaerobic digestion, transesterification), thermochemical conversion (combustion, gasification, pyrolysis, liquefaction), biorefineries, scaling up emerging technologies</td></tr>
<tr><td colspan="3">Bioseparation
Strategies to recover and purify products, separation of insoluble products (filtration, centrifugation, coagulation and flocculation), separation of soluble products (extraction, precipitation, reverse osmosis, adsorption, chromatography), purification (crystallization, drying)</td></tr>
<tr><td colspan="3">Impacts of bioenergy
Environmental, economic and social impacts, impact on use of land and other resources</td></tr>
<tr><td colspan="3">Life Cycle Assessment
Life cycle inventory, life cycle impact assessment, available tools, process optimization</td></tr>
<tr><td>Teaching and Learning Methods / Activities</td><td colspan="3">Lectures
Field visits
Take home assignments
Presentations</td></tr>
<tr><td rowspan="2">Evaluation</td><td colspan="2">In-course assessments</td><td>30 %</td></tr>
<tr><td colspan="2">End of course examination</td><td>70 %</td></tr>
<tr><td>Recommended References</td><td colspan="3">• Bioenergy: Principles and Applications, Yebo Li, and Samir Kumar Khanal, Wiley-Blackwell , 2016 (ISBN: 1118568311)
• Bioprocess Engineering: Basic Concepts, Michael L. Shuler, Fikret Kargi and Matthew DeLisa, Prentice Hall , 2017 (ISBN: 0137062702)</td></tr>
</table>

Semester 2			
Course Title	**Grid integration of clean energy systems**		
Course Code	MCET 110 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	30	45	75
Objectives	• provide an overall knowledge on how an electricity grid is planned and operated • introduce coordinated operation of energy resources in real-time grid operations • provide an overview of strengths and limitations of clean energy-based generation • introduce energy economics, costing and pricing, financial structuring of clean energy investments		
Intended Learning Outcomes	• describe electric power system planning and operations, including mini-grids and micro-grids • conduct reviews and calculations on grid demand forecasts for capacity and energy • discuss specific features of renewable energy resources, and how such features are integrated into grid operations planning • conduct economic assessment of clean energy technologies, financial structuring of a project and calculation of financial indices to assess bankability • conduct electricity costing and pricing on each type of grid • describe energy policies in several countries, critical review of energy policies, ability to assess strengths and drawbacks		
Contents	**Types of Grids** The "grid", definition/topology of a public electricity grid, trans-national, national, and regional grids, concepts of mini-grids and micro-grids, ac and dc grids, interconnections, features of "strong" and "weak" grids, examples, possible roles of renewable energy in each type of grid. The connection code requirements, impact to the transmission and distribution networks (voltages issues, harmonic issues, etc.)		
	Electric power system operations The electric power system in real time operations, real and reactive power management, frequency and voltage management, demand-supply balance, examples and critical review of design and control philosophy of a power system, demand forecasting		
	Special features of electricity generation from clean energy technologies Intermittency, seasonality, geographic distribution, geographic dispersion, electro-mechanical features, and related probabilistic simulations/calculations, calculations on ancillary services		
	Power reliability / quality, Grid-code, Power transmission, losses, remedies		

	Resource forecasting Wind, solar and hydropower forecasting techniques, limitations, and impacts on dispatch and spinning reserve, related technical and economic calculations	
	Energy economics: Economic comparison of clean energy technologies, mechanisms to encourage smaller developments, economic and financial modelling of clean energy projects	
	Power system economics Short-term demand forecasting, principles of economic dispatch, security constrained dispatch, electricity costing and pricing, capacity and energy costs of generation, and those of delivery, end-use customer pricing, subsidies and surcharges, case studies on Sri Lanka and elsewhere	
Teaching and Learning Methods / Activities	In-person lectures Assisted tutorials Classroom hands-on sessions (on financial structuring of clean energy projects and on electricity costing/pricing) Assignment: Mini-project Video-lectures Flipped classes	
Evaluation	In-course assessments	50 %
	End of course examination	50 %
Recommended References	• National Energy Policy and Strategies, Sri Lanka, 2008 • Renewable Energy Engineering, Nicholas Jenkins and Janaka Ekanayake, Cambridge University Press, 2017 (ISBN-13: 978-1107028487) • Renewable Energy Integration, Lawrence Jones, Academic Press, 2014 (ISBN: 978-0124079106)	

Semester 2			
Course Title	**Project development and management**		
Course Code	MCET 111 02		
Credit value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	30	-	70
Objectives	• introduce the procedures to be followed in installing a project to develop and use a clean energy resource • introduce managing and controlling a project • provide techniques for effective resource allocation • explain social, environmental safeguards and ethical responsibilities • introduce options for project financing and financial management		
Intended Learning Outcomes	• appreciate the laws, regulations, guidelines and procedures to be followed in establishing a greenfield clean energy project • prepare a project pre-feasibility study, and be able to develop the scope for detailed feasibility assessment and engineering designs • assess options, prepare and manage project finances • discuss techniques in planning, resource allocation, managing and controlling a project • appreciate the need to respect social and environmental safeguards,		

	ethical responsibilities	
Contents	**Laws and regulations:** Introduction to laws, regulations, guidelines and procedures to in Sri Lanka to facilitate and regulate energy source development and energy substitution/efficiency improvement, including Sustainable Energy Authority Act, Environmental Authority Act, Electricity Act, and regulations under such Acts, established procedures, case studies on procedures in other countries	
	Project development cycle: reconnaissance, pre-feasibility study, feasibility study, decisions/decision tools, detailed engineering and costing, financing, procurement, project management, testing, commissioning, commercial operation, planning and execution of maintenance. Discussion on degree of confidence and accuracy in each pre-project study, go/no-go decisions, decision tools. Writing the scope of work/terms of reference, case studies of successes and failures in feasibility assessment	
	Project Management: Definitions of projects; examples; importance of project management; project life cycle; project management process for a project; project integration management; project scope management; project time management; network diagrams to represent projects; network planning models; critical path method (CPM); project evaluation and review technique (PERT), introduction to scheduling tools (Ex: MS Project, Project Primavera);project risk management and project communication management, project quality management, procurement management and HR management. Hands-on exercises with scheduling tools	
	Safeguards and Ethics: Social and environmental impact assessment, case studies	
	Financial Accounting Basic accounting procedures and concepts; bookkeeping, trial balance; profit and loss account; balance sheet; cash flow statement. Hands-on session on preparing a trial balance	
	Entrepreneurship and Marketing Definition; Relevant economic, psychological and sociological theories of entrepreneurship; Characteristics and functions of an entrepreneur; Marketing environment; Product lifecycle; Consumer behavior; 4Ps.	
	Energy policy implications and policy analysis Analysis of energy policies of various countries with respect to clean energy development, review of Sri Lanka Energy Policies and Strategies	
Teaching and Learning Methods / Activities	Lectures Video-lectures Flipped classes	
Evaluation	In-course assessments	40 %
	End of course examination	60 %
Recommended References	• The Art and Science of Corporate Investment Decisions (3rd Ed.), Titman and Martin, ISBN-10: 0133479528. • Data Analysis & Decision Making (5th Ed.), S. Albright and Wayne Winston, South-Western Cengage Learning, 2015. • Guide to the Project Management Body of Knowledge -PMBOK Guide (6th Ed.), Project Management Institute.	

Semester 2			
Course Title	**Industrial training in clean energy plants**		
Course Code	MCET 112 01		
Credit value	01		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	-	-	100
Objectives	• Introduce installation of clean energy technologies		
Intended Learning Outcomes	• Explain installation of clean energy technologies		
Contents	**Introduction to installation of clean energy technologies**		
	Industrial Visit: Visit a green field clean energy project, observe its installation, operation, etc.		
Teaching and Learning Methods / Activities	Lectures Mini-project Laboratory exercises		
Evaluation	In-course assessments		60 %
	End of course examination		40 %

Semester 2			
Title	**Group Research Project**		
Course Code	MCET 213 02		
Credit Value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	-	-	200
Objectives	• Familiarize with one of the clean energy technologies • Introduce pre-feasibility study of the identified clean energy technology • Introduce the clean energy technology facility design		
Intended Learning Outcomes	• analyze one of the clean energy technologies • perform a pre-feasibility study • design a simple clean energy facility		
Contents	Analysis includes comparing different types of available designs/technologies in clean energy technologies. Pre-feasibility study contains environmental, social, economic analysis, etc. *(Whatever the items required for a pre-feasible study should be covered.)*		
Learning Methods / Activities	Group project		
Evaluation	Oral examination	30%	
	Progress presentation	30%	
	Project report	40%	

No.	Course code	Course Title	Contact hours		Notional hrs	No. of Credits
			Theory	Practical		
Semester 3						
14.	MCET 214 03	Nanomaterials for Energy Harvest and Storage	30	45	150	03
15.	MCET 215 03	Mathematical modelling for Clean energy technologies	15	90	150	03
16.	MCET 216 02	Critical review on a research topic	15	45	100	02
17.	MCET 217 02	Research Ethics, Proposal Writing and presentation	15	45	150	02
Semester 3 & 4						
18.	MCET 216 20	Research project [2]	-	-	2000	20

[2] Independent learning

Semester 3			
Course Title	**Nanomaterials for Energy Harvest and Storage**		
Course Code	MCET 214 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	30	45	75
Objectives	• Define fundamental laws governing properties of nanomaterials • Provide hands on experience in various nanofabrication approaches • Explain growth of nanomaterials and fabrication of nanodevices. • Demonstrate application of nanotechnology in energy harvest and storage.		
Intended Learning Outcomes	• Classify the various properties of materials at nanoscale • Illustrate application of nanomaterials in energy harvest and storage • Distinguish bottom up and top down nanofabrication approaches • Design nanodevices using appropriate nanofabrication approaches		
Contents	**Physics of Low dimension** Length scales in modern solid-state physics, Dimensionality, Practical definition of dimensionality, Two dimensional electron gas, One dimensional electron gas. **Properties of nanomaterials** **Optical,** Thermal, Magnetic, Structural, Mechanical and Chemical properties of Nanomaterials. Special attention to Carbon Nanomaterials: Fullerene, Single-walled carbon nanotubes and multiwall carbon nanotubes; Structure-property relationships, Physical properties, Applications. **Nanofabrication** **BOTTOM UP approaches** Chemical Synthesis: Self-assembly, Langmuir-Blodgett, Thin Film Growth or Deposition; Physical Vapour Deposition (PVD), Chemical Vapour Deposition (CVD);		

	Spin coating, Langmuir-Blodgett film deposition. Electrodeposition, Self-assembly, Chemical bath deposition, Spray pyrolyis, Theory of film growth: Production, Transport, Condensation, gas impingement, surface diffusion, Nucleation. Molecular Beam Epitaxy **TOP-DOWN Approaches:** Patterning –Lithography: Optical Lithography, E-beam Lithography; Film, Modification: Etching, Cutting, Grinding. **Nanomaterials and nanodevices for clean energy applications:** Operational function of and Applications of nanostructured Solar cells, Water splitting, Supramolecules (MOFs, COFs), Battery, super-capacitors	
Teaching and Learning Methods / Activities	Lectures Laboratory work Group Assignment	
Evaluation	In-course assessments	30 %
	End of course examination	70 %
Recommended References	• Nanotechnology for the Energy Challenge (2nd Ed.), Javier García-Martínez and Zhong Lin Wang (Eds.), 2013 (ISBN: 978-3-527-33380-6). • Linden's Handbook of Batteries, Fourth Edition, Thomas B. Reddy, 2011 (ISBN: 9780071624213) • Nanoparticles: From theory to applications (2nd Ed.), Edited by Gunter Schmid (Eds.), 2010 (ISBN: 978-3-527-32589-4). • Essentials of Nanotechnology, Jeremy Ramsden, 2009 (ISBN: 978-87-7681-418-2) • Nanostructures and Nanomaterials: Synthesis, Properties and Application GuoZhong Cao, 2004 (ISBN: 1-86094-415-9) • Lithium Batteries: Science and Technology, Nazri, Gholam-Abbas, Pistoia and Gianfranco (Eds.), 2003 (ISBN: 978-1-4020-7628-2). • Frank Owens and Charles Poole, The Physics and Chemistry of Nanosolids, John Willey, 2008 (ISBN 13: 978-0470067406, ISBN 12: 0470067403)	

Semester 3			
Course Title	**Mathematical modeling for Clean Energy Technologies**		
Course Code	MCET 215 03		
Credit value	03		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	15	90	45
Objectives	• Familiarize with simple differential equations and solutions • Introduce statistical modelling in clean energy applications • Familiarize with the Matlab environment and learn how to edit, compile, and Run programs in Matlab		
Intended Learning Outcomes	• Formulate simple mathematical models using fundamental conservation laws • Solve systems of differential equations numerically with several techniques of increasing accuracy apply statistical theories to describe cleaner energy systems apply Matlab for data manipulation, data plotting, and programming		
Contents	**Differential Equations and Solutions** Modelling with differential equations; First order equations, Higher Order Linear Ordinary Differential Equations, solution Methods		
	Statistical modelling Simple linear regression, least square estimation, coefficient of determination, multiple linear regression, categorical explanatory variables, sequential methods for model selection		
	Introduction to Matlab The Advantages of MATLAB, Disadvantages of MATLAB, The MATLAB Environment, Using MATLAB as a Calculator, Variables and Arrays, Creating and Initializing Variables in MATLAB, Built-in MATLAB Functions, Introduction to Plotting		
Teaching and Learning Methods / Activities	Lectures Video-lectures Flipped classes		
Evaluation	In-course assessments	40 %	
	End of course examination	60 %	
Recommended References	MATLAB Programming with Applications, Stephen J. Chapman, Global Engineering, Cengage Learning, 2013 (ISBN: 9780495668077). MATLAB Practical A Practical Introduction to Programming and Problem Solving, Elsevier by Stormy Attaway , Elsevier Butterworth-Hein, 2017 (ISBN: 9780128045251)		

Semester 3			
Course Title	**Critical review on a Research topic**		
Course Code	MCET 216 02		
Credit value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	15	45	40
Objectives	• Introduce the concepts of identifying and Managing bibliographies • Provide hands on training in importing and retrieving literature using Bibliographic software • Familiarize with reviewing the literature critically		
Intended Learning Outcomes	• Use bibliographic software competently • Survey the relevant literature • Review gathered literature critically		
Contents	**Literature Survey and Bibliography** Familiarize with online databases, Identify relevant databases, search for relevant literature, download references from databases, Import downloaded references into Endnote / Reference manager library, Analyze the literature, Retrieved literature, insert references into the document and generate bibliography in required style. **Critical literature review** Students are required to carry out extensive literature survey on pre-assigned topics using e-resources and library, critically review gathered resources and submit a comprehensive report with Bibliography using Endnote/reference manager library and deliver an oral presentation.		
Learning Methods / Activities	• Lectures • Assignment		
Evaluation	In course Assessments	40 %	
	Review report with annotated bibliography	60 %	
References	• How to Write and Publish a Scientific Paper (6th Ed.), Day, R. A. and Barbara Gastel, 2006 (ISBN: 0-313-33040-9) • A Scientific Approach to Scientific Writing, John B. and Martin. J., Springer New York, 2011 (ISBN 978-1-4419-9787-6)		

Semester 3			
Title of the course unit	**Research Ethics, Proposal Writing and Presentation**		
Course Code	MCET 217 02		
Credit value	02		
Core/Optional	Core		
Hourly Breakdown	**Theory**	**Practical**	**Independent Learning**
	15	45	40
Objectives	• Create awareness on ethics in research and consequences of plagiarism • Explain fundamentals of effective scientific writing and presentation • Provide training on writing research proposals		
Intended Learning Outcomes	• Explain research ethics and consequences of plagiarism • Apply plagiarism detection software • Develop quality research proposals • Make effective scientific presentations		
Contents	**Research Ethics** Guiding Principles, Collection and storage of data, Data sharing, Research Publications and Dissemination, involvement in Research Supervision, Conflict of Interest, Intellectual Property and Ethical review **Plagiarism** Defining plagiarism in different contexts, Forms of Plagiarism, Copyright infringement and consequences of Plagiarism, Learning to avoid unintentional plagiarism, Observing plagiarism in articles (remote and online), Brute force approaches to plagiarism detection, Plagiarism detection software **Proposal writing and presentation** Interpretation and critical evaluation of results of published research; Formulation of a research problem: Concise literature review, justification, proposed research plan, Gantt chart, identification of resources, budgeting, etc.		
Learning Methods / Activities	Lectures Assignment: Plagiarism checking and reporting Case studies Presentations		
Evaluation	In-course assessments	50 %	
	End of course examination	50 %	
References	• How to Write and Publish a Scientific Paper (6th Ed.), Day. R. A., and Barbara Gastel.,2006 (ISBN: 0-313-33040-9) • A Scientific Approach to Scientific Writing, John B., and Martin. J., Springer (New York), 2011 (ISBN 978-1-4419-9787-6)		

Semester 3 and 4

No.	Course code	Course Unit Title	Notional hours	No. of Credits
18.	MCET 218 20	Research project	2000	20

Semester 3 and 4	
Title	**Research Project**
Course Code	MCET 218 20
Credit Value	20
Core/Optional	Core
Objectives	• Define researchable problems • Provide training to plan and conduct scientific research • Familiarize with different research methods • Develop relevant transferable skills
Intended Learning Outcomes	• Formulate research plan • Analyze scientific data • Compile written scientific reports
Contents	Each student is required to carry out a research study of twelve months duration in the field of clean energy technologies under the supervision of member(s) of the panel of academics. Students could also pursue research studies at institutions other than the University of Jaffna. Under such circumstances, the student is assigned with more than one supervisor; internal supervisor(s) from the panel of academics at the University of Jaffna and external supervisor(s) from the institution where the research project is carried out. On completion of the research study, each student is required to submit a dissertation and defend his/her dissertation in front of a panel of examiners appointed by the senate.
Learning Methods / Activities	Laboratory / Field work Writing dissertation Presentation
Evaluation	Dissertation Pass *Viva voce* Examination Pass

Annex IV: 4. Programme Delivery and Learner Support System

The programme will be delivered using blended, student centered teaching and learning strategies with independent learning and judicious use of ICT and various teaching and learning aids.

The mode of programme delivery includes in-person and video lectures, quiz, in-class and take-home assignments, assisted tutorial, classroom hands-on session, flipped class, laboratory visit and demonstration, laboratory work, writing laboratory report, field visit, field work, seminar presentation, case study, mini-project, group project, research project and writing dissertation.

An efficient learner support system, such as well-equipped lecture halls and laboratories, resourceful library, computer room with ICT facilities, *etc*., is in place.

Further, guest lectures and workshops will be conducted during the study programme regularly.

Annex V: 5. Programme Assessment Procedure/Rules

Formative and summative examinations in the program:

Each course unit shall be evaluated with formative and summative assessment components: **in-course assessments** (based on quizzes, tutorials, assignments, field trips, etc.) and **end of course examination**, in which In-course Assessments carry a minimum of 30 %.

Exact nature of evaluation procedure of each course unit is provided in the detailed syllabus of the respective course units. 80 % attendance in theory and practical classes is mandatory to sit for the end of course examination.

Scheme of Grading (Grades/Grade Points/ Marks ranges):

Range of Marks	Grade	Grade Point Value (GPV)
85 -100	A^+	4.00
80 - 84	A	4.00
75-79	A^-	3.70
70-74	B^+	3.30
65-69	B	3.00
60-64	B^-	2.70
55-59	C^+	2.30
50-54	C	2.00
45-49	C^-	1.70
40-44	D^+	1.30
35-39	D	1.00
00-34	E	0.00

Calculation of Grade Point Average (GPA):

Overall Grade Point Average (OGPA) will be calculated as $\mathrm{OGPA} = \frac{\sum_i C_i G_i}{\sum_i C_i}$, where, C_i and G_i are the Credit value and the Grade Point value respectively of the i^{th} Course Unit.

Contribution by each semester to final GPA:

Each semester effectively carries 25% contribution to the final GPA. However, advanced laboratory practical course unit will be conducted in both first and second semesters, while research project will be conducted in both third and fourth semesters.

Contribution by in-plant training etc. to final GPA:

Out of 60 credits, the following course units contribute to in-plant training:

MCET 110 03	Grid Integration of Clean Energy System
MCET 112 01	Field work in clean energy plants
MCET 113 02	Group research project

Repeat / Make up examinations:

If a student is absent for an End of Course examination of a particular course unit for reasons acceptable to the University Senate, his/her result(s) will be recorded as WH (Withheld). He/she shall be permitted to sit for the examination at the next available opportunity and it will be considered as his/her first attempt.

If a student is absent for an End of Course examination of a course unit for reasons not acceptable to the University Senate or without giving a valid reason, his/her result(s) will be recorded as IC (Incomplete).

The student shall be allowed to sit the examination at the next available opportunity and the maximum grade obtainable is C.

A student will be permitted to repeat the End of Course examination twice only. The maximum period allowed to complete the MSc degree shall be four academic years.

Guidelines on thesis / proposal presentation and defense:

The student will be initially required to select a suitable project of his/her choice, carry out extensive literature survey and orally present the motivation, purpose and plan of the research work. If the project plan is acceptable, the student will be assigned a supervisor and allowed to carry out the proposed plan. Otherwise, the student will be asked to revise the project plan in consultation with an assigned supervisor. The student is expected to maintain a log book and consult the supervisor at least one hour per week throughout the academic year. Also, he/she has to orally present the progress of his/her project regularly.

After successful completion of the research project, the student is expected to submit a soft bound copy of the dissertation for evaluation. Later, he/she has to defend the dissertation in front of a panel of examiners. Finally, the student should submit 3 hard bound copies of the dissertation incorporating corrections, if any.

Guidelines on conduct of research:

Each student is required to carry out a research study of twelve months duration in the field of clean energy technologies under the supervision of member(s) of the panel of academics.

Students could also pursue research studies at institutions other than the University of Jaffna. Under such circumstances, the student is assigned with more than one supervisor; internal supervisor(s) from the panel of academics at the University of Jaffna and external supervisor(s) from the institution where the research project is carried out.

Guidelines on comprehensive examination:

Research project will be evaluated by marking the dissertation and viva voce examination. The student must pass both examinations.

The **project supervisor** will award marks for items (i) – (vii) (**120 marks**) and a **second examiner** will also mark the items (ii) – (vii) (**80 marks**).

Criteria for evaluating the dissertation:

(i) Student performance and initiative (maximum marks available: 40 from project supervisor)

- Did the student possess required skills and initiative or did he/she need a lot of help and guidance?
- Did the student plan the project well?

- Was the student able to achieve more within the given time?
- How well did the student acquire new experimental, computational or theoretical skills?
- How well did the student handle any unexpected difficulties?

(ii) Presentation of the report (maximum marks available : 10 from each examiner)

- Is the report neat?
- Does the style conform to that of a scientific publication?
- Are the grammar and spelling good?
- Is the report divided into appropriate sections and subsections?
- Is the report presented in a logical order?
- Are the pages numbered?
- Are all figures and tables numbered and do they have appropriate captions?
- Is the quality of graphical and other figures good?
- Is a complete list of references given in a logical style at the end of the report?

(iii) Background to the work (maximum marks available : 10 from each examiner)

- Is the significance of the project explained? (What is the scientific importance of this work?)
- Has the project been placed in a wider context?
- Are there sufficient references with respect to related publications? Is there evidence of a successful literature survey?
- Is the specific objective of the project made clear?

(iv) Background theory (maximum marks available : 10 from each examiner)

- Is the theory discussed clearly and concisely, with all symbols explained?
- Is sufficient information provided for the reader to understand the theory to be applied?

(v) Methodology of the project (maximum marks available : 10 from each examiner)

- Are the techniques described adequately?
- In experimental work, are the equipment and sampling described?
- In theoretical and computational work, are the techniques used explained and justified?

(vi) Presentation and analysis of data (maximum marks available : 30 from each examiner)

- Are the results presented in a comprehensible manner?
- Is the quality of the results good?
- Is the quantity of the results sufficient?
- Are errors and uncertainties in the data and methods discussed adequately?
- Have any cross checks been made to verify the data?
- Have the data been checked against any similar data exist?
- Is the analysis appropriate?
- Are errors and uncertainties in the analysis discussed adequately?
- Have any cross checks been made to verify the methods used?
- Have the results been checked against any similar work reported?
- Could further conclusions have been drawn from the student’s data?

(vii) Overall conclusions (maximum marks available : 10 from each examiner)

- Are the results summarized concisely?
- Are directions for future work suggested?

Guidelines on thesis defense examination:

On completion of the research study, each student is required to submit a dissertation and defend his/her research work in front of a panel of examiners appointed by the university senate.

Annex VI: 7. Panel of Teachers/Internal Resource Persons

Name of the Lecturer	**Designation**	**Average No. of Teaching, Practical and Supervision Hours/Week**												
		Internal Programmes (i) T+P+S					**Ext. Programmes (ii)**				**Proposed Program (iii)**		**Total Hours (i)+(ii)+(iii)**	
		Under-graduate			Post-graduate		Under-graduate		Post-graduate					
		Teaching (T)	**Practical (P)[1]**	**Supervision (S)[2]**	**Teaching (T)**	**Supervision (S)**	**Teaching (T)**	**Supervision (S)**	**Teaching (T)**	**Supervision (S)**	**Teaching (T)**	**Supervision (S)**	**Teaching (T)**	**Sup. (S)**
Faculty of Science														
Prof.K.Kandasamy	Emeritus Professor	04	-	-	-		02	-	-	-	01	02	07	02
Prof.P.Ravirajan	Professor	06	03	04	-	03	-	-	-	-	02	02	08	12
Prof.Ms.M.Senthilnanthanan	Associate Professor	05	04	02	-	01	-	-	-	-	02	02	07	09
Dr.K.VIgnarooban	Senior Lecturer(Gr I)	06	03	02	-	-	-	-	-	-	02	02	08	09
Dr.T.Pathmathas	Senior Lecturer(Gr II)	06	02	03	-	-	-	-	-	-	01	02	07	07
Dr. G. Sashikesh	Senior Lecturer(Gr II)	05	04	02	-	-	-	-	-	-	01	02	06	08
Dr.Ms.S. Ubenthiran	Senior Lecturer(Gr II)	05	02	03	-	-	-	-	-	-	01	02	06	07
Dr A.Thevakaran	Senior Lecturer(Gr II)	05	02	02	-	-	-	-	-	-	01	02	06	06
Dr.Ms.R.Shivatharsiny	Senior Lecturer(Gr II)	05	03	02	-	-	-	-	-	-	01	02	06	07
Mr.S.Senthuran	Lecturer	Study leave									01	-	01	-
Faculty of Engineering														
Prof.A.Atputharajah	Professor	Dean/Engineering									01	02	01	02
Dr.A.Anburuvel	Senior Lecturer(Gr II)	03	01	02	-	-	-	-	-	-	01	02	04	05
Dr.D.N.Subramanium	Senior Lecturer(Gr II)	06	02	04	-	-	-	-	-	-	01	02	07	08
Dr.B.Ketheesan	Senior Lecturer(Gr II)	06	02	02	-	-	-	-	-	-	01	02	07	06

[1]one hour per practical session, [2]one hour per student

Annex VI: 7. Panel of Teachers / External Resource Persons

Name	**Qualification**	**Affiliation**
Professor V.Dhayalan	BSc, MSc, PhD (Bergen)	Faculty of Engineering and Science, Western Norway University of Applied Sciences, Norway
Professor Alfred A. Christy	BSc(Pera), PhD(Bergen)	Faculty of Engineering & Science, University of Agder, Norway
Professor Talal Rahman	BSc, MSc, PhD (Bergen)	Faculty of Engineering and Science, Western Norway University of Applied Sciences, Norway
Professor Reggie Davidraju	BSc, MSc (Trondheim) PhD (Narvik)	Electrical and Computer Engineering University of Stavanger, Norway
Mr. Balashankar Gulendran	BSc, MSc (Trondheim)	Senior Instrument & SAS Engineer BP RAE Project, Aker Solutions, Norway
Dr. Vajeeston Ponniah	BSc, MSc (India) PhD (Oslo)	Department of Chemistry, University of Oslo, NORWAY
Prof. N. Muthukumarasamy	BSc, MSc, PhD (India)	Department of Physics, Coimbatore Institute of Technology, India

Annex VII: 13. Fee structure

Fees	**Per Student (Rs.)**		**Per Student (Rs.)**
	Year 1	**Year 2**	**Total (2 years)**
Tuition Fee	150,000.00	50,000.00	200,000.00
Registration Fee	6,000.00	4,000.00	10,000.00
Library fee	2,000.00	0.00	2,000.00
Laboratory fee – Non refundable	25,000.00	90,000.00	115,000.00
Examination fees	12,000.00	4,000.00	16,000.00
Use of Computer Lab	3,000.00	1,000.00	4,000.00
Other Fees (please specify each) Statement and Result sheet	2,000.00	1,000.00	3,000.00
Total	**200,000.00**	**150,000.00**	**350,000.00**
Repeat Examination per Course			3,000.00

Annex VIII: 14. Total estimated budget per student (according to commission circular 04/2016)

University/HEI: University of Jaffna

Programme: Master of Science in Clean Energy Technologies

Period of Study : Two Years

No of Students: 30 for 1st year & 10 for 2nd year

A. Total Earnings		LKR	LKR
1. Registration fee (30 x 6,000/-)		180,000.00	
2. Tuition fee (30x 150,000/-)		4,500,000.	
3. Library fee (30x 2000/-)		60,000.00	
4. Laboratory fee (30 x 25,000/-)		750,000.00	
5. Computer usage fee (30 x 3000/-)		90,000.00	
6. Examination Fee (30 x 12 x 1000/-)		360,000.00	
7. Statement & Result Sheets (30 x 2000/-)		60,000.00	
Total Course Fee = 200,000/- per student for year 1		-	6,000,000.00
1. Registration fee (10x 5,000/-)		50,000.00	
2. Tuition fee (+ supervision and exminers fee) (10 x 50,000/-)		500,000.00	
3. Laboratory fee (10x 90,000/-)		900,000.00	
4. Computer usage fee (10 x 1000/-)		10,000.00	
5. Examination Fee (10 x 4 x 1000/-)		400,000.00	
6. Statement & Result Sheets (10 x 1000/-)		10,000.00	
Total Course Fee = 150,000/- per student for year 2			1,870,000.00
HRNCET grant for Equipment and course development			2,300,000.00
Total Earning			**10,170,000.00**
B. Direct Cost			
i) Initial Expenditure (Advertisement, Postage, etc.)		100,000.00	
ii) Selection(Exam & Interview)		95,000.00	
a) Exam			
i) Setting & Moderation	5,000.00		
ii) Marking	10,000.00		
iii) Supervisor, Invigilator, Hall attendant etc	10,000.00		
iv) Other expenses	5,000.00		
b) Interview			
i) Panel Members Payment	50,000.00		
ii) Other expenses	15,000.00		
-	95,000.00		
iii) Inauguration		40,000.00	
a) Handbook printing	10,000.00		
b) Refreshment, Photo & Others	30,000.00		
	40,000.00		
iv) Teaching		1,756,500.00	
a) Lecture fees (**1st Year**) (24 x 15 x LKR 2500)	900,000.00		
Lecture fees (**2nd Year**) (10 x 15 x LKR 2500)	600,000.00		
b) Practical fees			
i) Lecturer (90 x 1000/-)	90,000.00		
ii) Demonstrator (90 x 750/-)	67,500.00		
iii) Technical Officer (90 x 600/-)	54,000.00		
iv) Lab Attendant (90 x 500/-)	45,000.00		
	1,756,500.00		
v) Travelling expenses		200,000.00	
vi) Lab Bench fee		500,000.00	

vii)	Project : (Group project / Final Dissertation)		330,000.00	
	a) Supervision			
	i) 1st Year (group project) = (30 x 3000/-)	90,000.00		
	ii) 2nd Year (Dissertation) = (10 x 6000/-)	60,000.00		
	b) Evaluation			
	i) 1st Year (group project) = (30 x 2 x 2000/-)	120,000.00		
	ii) 2nd Year (Dissertation) = (2 x 10 x 3000/-)	60,000.00		
	-	330,000.00		
viii)	Project Presentation / Oral Examination on mini project or Final Dissertation		90,000.00	
ix)	<u>Examination</u>		222,800.00	
	a) Setting & Moderation (2x12x1,200/-) + (2x4x1200/)	38,400.00		
	b) Translation (12 x 500/-) + (4 x 500/-)	8,000.00		
	c) Marking (2 x 30 x 12 x 100/-) + (2 x 10 x 4 x 100/-)	80,000.00		
	d) Payment to Exam Branch			
	Supervision and handling (14x200/-)+(4x200/-)	3,200.00		
	Typing Question Paper (12x150/-) + (4x150/-)	2,400.00		
	Duplicating & Packeting (12 x 50/-) +(4 x 50/-)	800.00		
	e) Supervisor, Invigilator, Hall attendant	60,000.00		
	f) Other expenses	30,000.00		
		222,800.00		
x)	Guest Lecture fees (Foreign (Rs.5,000/-), Local (3,000/-) Per hour)		50,000.00	
xi)	Seminar workshop & Social Interaction & Publication (2x 75,000/-)		150,000.00	
xii)	Stationary		300,000.00	
xiii)	Award for student for best performance		20,000.00	
xiv)	Library Fee		30,000.00	
xv)	Computer usage fee (Faculty of Graduate Studies)		90,000.00	
xvi)	Statement & Result Sheets		70,000.00	
xvii)	Lab equipment for Fac. of Eng. (Biomass + Wind energy)		1,800,000.00	
xviii)	Development of the course (fees for consultatnts and resource persons)		500,000.00	
xix)	UGC (0.01% of the Income to be transferred to the UGC to the credit of the University Self Financing Activity Vote)		977.00	
	Direct Cost (Total)			**6,345,277.00**
C. Indirect Cost				
(i)	University Development Vote (30 % of Indirect Cost)	1,147,404.90		
	Department of Physics (Research lab) (15 %)		573,702.45	
	Department of Chemistry (Research lab) (8 %)		305,974.64	
	Department of Interdisciplinary Studies (Mechanical Workshop) (7 %)		267,727.81	
(ii)	Vice Chancellor’s Vote (Max 5% of Indirect Cost)		191,234.15	
(iii)	Payments to the involved Staff Members (65 %)			
	Overall Supervisory			
	a) Course Coordinator allowance,			
	243,000.00	243,000.00	243,000.00	
	54,000.00	54,000.00	54,000.00	
	Financial Administration			
	a) Finance Branch		250,000.00	
	Additional Overtime		75,000.00	
	General Administration			
	a) Establishment Branch (Academic)		40,000.00	

	b) Examination Branch	100,000.00	
	c) Academic Branch	40,000.00	
	d) Faculty Staff - Faculty of Graduate Studies Staff	1,424,069.95	
	Maintenance of Lecture Halls and others	200,000.00	
viii)	Contingencies	50,000.00	
	Indirect Cost (Total)		**2,736,043.95**
Total Expenditure (Direct and indirect cost)			**9,081,360.95**
D. Excess of Total Income over Total Costs / Expenditure			**1,088,639.05**
Total Allocations to Development Votes / Total Income			0.11

Annex IX: 15. Reviewers Report

Title of the Degree:

Master of Science in Clean Energy Technologies (Coursework and Research)

[Two years duration, 60 credits in which 20 credit research (SLQF -10)]

Please comment on the followings

1	Acceptability of the Background and the Justification	The proposed Master of Science in Clean Energy Technologies (coursework and Research) of two year duration is aimed at producing highly knowledgeable and skilled postgraduates with sound core knowledge and research experience in Clean Energy Technologies to meet the growing demand in the field of Clean Energy Technologies, such as solar photovoltaic (PV), solar thermal, hydro energy, wind, bioenergy, etc. This is in line with the national policy of Sri Lanka to meet 20 % of the total power generation by the year 2020 through clean energy resources other than hydro power. As such, I confirm that the background and the justification is acceptable as they address a nationally important issue and have the necessary postgraduate level course material.
2	Relevance of proposed degree program to Society	The proposed degree program is very relevant to the present day energy need of the society and in particular to the Sri Lankan renewable energy sector. The country needs more and more personnel trained at postgraduate level with research experience to undertake energy related responsibilities in the years to come. The trained workforce would be useful to emerging needs of employers work in the field of Clean Energy Technologies.
3	Entry Qualification and Admission Process	These are of acceptable standards as per Sri Lankan Qualification Frame Work. Since Essential Science for Energy Technologies course unit is available as a leveling course and the contents of the proposed course unit doesn't require any prior hard core physics/chemistry/mathematical knowledge, any graduate with a science based degree other than medicine would be able to follow the course. The curriculum developers may consider to admit these graduates. Perhaps, an entry written examination may be conducted to select suitable graduate to this programme.
4	Program Structure	Well-structured 60 credits MSc degree program (coursework and research) of two year duration (four semesters) which is compliance with Sri Lankan Qualification framework. This program has a provision to exit taught master degree at the second semester.
5	Program Content	Covers from basics to more advanced topics. Maintain internationally accepted Quality and standard. It is noted that this master degree programme (coursework and research) incorporated 20 credits research work out of 60 credits (equivalent to SLQF 10). In the second year of the programme, students has to follow three course units Nanomaterials for Energy Harvest and Storage, Critical review on a research topic, Research Ethics, Proposal Writing and presentation. The knowledge gained from

		following these units will help them to conduct independent research work of 20 credits in the renewable research area. In the first year, under Prototype Fabrication for Clean Energy Applications course unit, the students will also be allowed to build a prototype product in any of the following area: solar PV/solar thermal system or mini Biomass plant or micro wind power plant.
6	Teaching Learning Methods	Satisfactory as it adopts wide range of teaching learning methods such as in-person lectures, video-lectures, tutorials, lab work, field work, mini project, flipped classes, quizzes, hands-on sessions home assignment so that to meet for producing the graduates with multi-skills and strong knowledge in Clean Energy Technologies.
7	Assessment Strategy /Procedure	Satisfactory; These are of internationally accepted levels
8	Resource Availability - Physical	Sufficient to maintain the program
9	Qualifications of Panel of Teachers (Internal & External)	The teaching panels, both internal and external, of about more than fifteen academics hold PhD degree in Physics / Chemistry / Engineering eared in the relevant areas from institutes in developed countries such as UK, US, Japan, Australia, South Africa, Norway etc.
10	References / Reading Materials	Satisfactory
11	Recommendation (Please mark one of the following)	

	a. Recommended for next stage of processing	Recommended
	b. Recommended for the next stage of evaluation subject to further improvement in the following areas	-------
	c. Not suitable for the next stage of evaluation due to following reasons	-------

		Reviewer 1	Reviewer 2
1	Name	Prof. M.A.K.Lakshman Dissanayake BSc Hons (Ceylon), MS, PhD (Indiana, USA), DSc(Wayamba)	
2	Designation	Research Professor, Institute of Fundamental Studies, Kandy & Professor Emeritus (Physics), University of Peradeniya. Former Director, Postgraduate Institute of Science (2003-2008).	
3	Signature		
4	Date	22-02-2018	

Annex IX: 15. Reviewers Report

Name of the degree programme:

Master of Science in Clean Energy Technologies (Coursework and Research)
[Two years duration, 60 credits in which 20 credit research (SLQF -10)]

Please comment on the followings

1	Acceptability of the Background and the Justification	**Very well written. Acceptable as it is without any change.**
2	Relevance of proposed degree program to Society	**Highly relevant and timely M.Sc. Degree Programme. Clean Energy is the future energy. Personnel trained in Clean Energy Technologies is a timely requirement which the proposed M.Sc. programme is concentrating on. Fossil fuel is a limited energy resource which is going to exhaust in about 50 years if the consumption is at the current rate. Fossil fuels contribute heavily to the environmental pollution and associated health problems such as respiratory diseases, cancer etc. Clean energy technologies would overcome these undesirable effects and will be beneficial to the mankind and the society. For instance, fuel cells would be the cleanest energy resource giving water as the byproduct.**
3	Entry Qualification and Admission Process	**Good and up to the standard.**
4	Program Structure	**Exceptionally good. Well arranged.**
5	Program Content	**Involves almost everything regarding clean energy technologies; both fundamentals and applications. However, I fell that there is a small add up to do, i.e., better to include fuel cells also since they are the cleanest energy resources.**
6	Teaching Learning Methods	**Excellent.**

7	Assessment Strategy/Procedure	**Fine. Very good. Acceptable standard.**
8	Resource Availability - Physical	**University of Jaffna through NORPART Programme has established a Clean Energy Resource Centre. As such, University of Jaffna is well equipped with all the necessary physical resources to offer this degree programme.**
9	Qualifications of Panel of Teachers (Internal & External)	**Highly talented AND QUALIFIED STAFF IS READILY AVAILABLE. Support from International experts such as Professor V. Dhayalan is also available.**
10	References/Reading Materials	**Excellent sources of reference are quoted. Best source of references for PG degree programmes is relevant journal publications. Access to journal publications should be made available.**
11	Recommendation (Please mark one of the following)	
	a. Recommended for next stage of processing	**Highly Recommended.**
	b. Recommended for the next stage of evaluation subject to further improvement in the following areas	
	c. Not suitable for the next stage of evaluation due to following reasons	

		Reviewer 1	**Reviewer 2**
1	Name	**R.M.G. RAJAPAKSE**	
2	Designation	**SENIOR PROFESSOR IN CHEMISTRY**	
3	Signature		23/02/2018
4	Date	**22/02/2018**	

Annex IX: 15. Reviewers Report

Name of the degree programme:

Master of Science in Clean Energy Technologies (Coursework and Research)
[Two years duration, 60 credits in which 20 credit research (SLQF -10)]

Please comment on the followings

1	Acceptability of the Background and the Justification	Clean Energy technologies being a multi-disciplinary subject area with application of physics, chemistry and other science subjects to electrical engineering systems, it is encouraged to see that two faculties are planning to offer this master degree programme. As discussed in the background this MSc provides applications of fundamental sciences and operating principles related to clean energy systems. The background and justification is acceptable.
2	Relevance of proposed degree program to Society	In an era in which renewable energy is gaining global attention and Sri Lankan Government's aspiration to meet our energy demand 100% by indigenous energy sources, this MSc programme will provide the best exposure to our engineers/scientist to confidently work with clean energy systems. Therefore the programme is relevant and add value to the future development.
3	Entry Qualification and Admission Process	Acceptable
4	Program Structure	It is better to introduce some optional modules in 2nd year. Credit distribution seems to be not logical. For example 2 credit course is proposed for a mature technology such as wind energy technologies whereas 3 credit course is proposed for hydrogen energy technologies. The credit allocation and content covered in 'Essential science for energy technologies' seems to be not adequate.
5	Program Content	Course content of some programmes are well defined whereas in some only topics are given. For example in the module on 'Wind Energy Technologies', many topics are given at the end but without describing the breadth and depth that will be covered. The following is a brief comments about each module: a) Essential science for energy technologies – even though most of the topics suggested in this module is covered in the undergraduate courses, mature students may have forgotten about most of the content and slow delivery with ample

		examples/tutorials is a must. Therefore it is recommended to increase the credit allocation of this to 3. b) Wind Energy Technologies – Some topics need more description. The section on 'Basics of generator technology, back emf' could be moved to MCET 101 02. Topics like 'Power reliability/ quality, Grid-code' and 'Power transmission, losses, remedies' are more appropriate for the module MCET 110 03. Topics such as environmental assessment and wind turbine control could be included. c) Instrumentation and Characterization techniques – Not an expert to comment on this module d) Solar Energy Technology – effect of shading and remedial measures could be included e) Hydrogen Energy Technologies - Not an expert to comment on this module f) Advanced Laboratory Practical – Extensive list of laboratory experiments are suggested. g) Energy Storage Technologies – In 'Introduction to Energy Storage Technologies' both 'high power low energy' and 'low power high energy' storage devices could be dealt with h) Wave and Hydro Energy Technologies - Some topics need more description. As this module covers both wave and tidal technologies, it is proposed to change the title as 'Marine and Hydro Energy Technologies' i) Bioenergy Technologies – This module is ok. j) Grid integration of clean energy systems – Even though the title discuss about the grid integration some of the topics such as 'Financing' and 'Energy policy implications and policy analysis' covered are not at all relevant to the title. The connection code requirements, impact to the transmission and distribution networks (voltages issues, harmonic issues, etc.) are more relevant topics and they are not at all included. k) Project development and management – This seems to be covering most of the essential components. Group project included here could be offered as an independent study. l) Prototype fabrication for clean energy applications – Unfortunately this does not add any value at MSc level. This is mainly workshop practice which is usually covers in the first year of undergraduate courses. It is well worth considering an independent study or a research project instead of this module. m) Nanomaterials for Energy Harvest and Storage – This is more suitable as an optional module.

		n) Computational Methods – the content of this module is not coherent with the rest of the course. Also topics are not connected at all. o) Critical review on a Research topic – It is not clear what is covered under 'Online laboratory work'. It is worth considering adding an assignment to this module. p) Research Ethics, Proposal Writing and Presentation - In-course assessments render more marks.
6	Teaching Learning Methods	Teaching learning method include lectures, tutorials, lab classes, mini projects, assignments, etc.
7	Assessment Strategy/Procedure	Both in-course and end of the course assessments are included for all the modules. The marks distribution is acceptable.
8	Resource Availability - Physical	Acceptable
9	Qualifications of Panel of Teachers (Internal & External)	Acceptable
10	References/Reading Materials	Acceptable
11	Recommendation (Please mark one of the following)	
	a. Recommended for next stage of processing	
	b. Recommended for the next stage of evaluation subject to further improvement in the following areas	**X** Course structure and module content need further improvements
	c. Not suitable for the next stage of evaluation due to following reasons	

		Reviewer 1	**Reviewer 2**
1	Name	**Prof. J.B. Ekanayake**	
2	Designation	**Professor of Electrical and Electronic Engineering, University of Peradeniya**	
3	Signature		
4	Date	**01/03/2018**	

Responds to reviewer's comments

Reviewer's recommendation	**Curriculum developers' response**
A student exit from this programme will not have any research exposure. Even though it is a taught programme, the world practice is to introduce a short research project so that a student will have some research exposure. It is highly recommend to introduce an independent study or a short research project before their exit.	Group Research Project is incorporated. Revised curriculum includes independent study amounts to 05 credits.
Wind Energy Technologies – Some topics need more description. The section on 'Basics of generator technology, back emf' could be moved to MCET 101 02. Topics like 'Power reliability / quality, Grid-code' and 'Power transmission, losses, remedies' are more appropriate for the module MCET 110 03. Topics such as environmental assessment and wind turbine control could be included.	Incorporated
Essential science for energy technologies – even though most of the topics suggested in this module is covered in the undergraduate courses, mature students may have forgotten about most of the content and slow delivery with ample examples/tutorials is a must. Therefore it is recommended to increase the credit allocation of this to 3.	Incorporated
Solar Energy Technology 'effect of shading and remedial measures could be included'	Incorporated
Energy Storage Technologies – In 'Introduction to Energy Storage Technologies' both 'high power low energy' and 'low power high energy' storage devices could be dealt with.	Incorporated
Wave and Hydro Energy Technologies - Some topics need more description. As this module covers both wave and tidal technologies, it is proposed to change the title as 'Marine and Hydro Energy Technologies'	Modified the title.
Grid integration of clean energy systems – Even though the title discuss about the grid integration some of the topics such as 'Financing' and 'Energy policy implications and policy analysis' covered are not at all relevant to the title. The connection code requirements, impact to the transmission and distribution networks (voltages issues, harmonic issues, etc.) are more relevant topics and they are not at all included.	Incorporated
Project development and management – This seems to be covering most of the essential components. Group project included here could be offered as an independent study.	Incorporated. Group project has been separated.
Prototype fabrication for clean energy applications – Unfortunately this does not add any value at MSc level. This is mainly workshop practice which is usually covers in the first year of undergraduate courses. It is well worth considering an independent study or a research project instead of this module.	Revised as Fieldwork in clean plants.

Nanomaterials for Energy Harvest and Storage – This is more suitable as an optional module.	Incorporated
Computational Methods – the content of this module is not coherent with the rest of the course. Also topics are not connected at all.	Revised
Critical review on a Research topic – It is not clear what is covered under 'Online laboratory work'. It is worth considering adding an assignment to this module.	Incorporated
Research Ethics, Proposal Writing and Presentation - In-course assessments render more marks.	Incorporated

As per your comments, credit values were increased for Essential Science, Wind Energy and research project as follows:

No.	Course code	Course Title	Lecture hrs	Practical hrs	No. of Credits
		Semester 1			
1.	MCET 101 02	Essential science for Energy Technologies	45	-	03
2.	MCET 102 02	Wind Energy Technologies	30	-	02
3.	MCET 103 02	Instrumentation and Characterization Techniques	30	-	02
4.	MCET 104 03	Solar Energy Technologies	45	-	03
5.	MCET 105 03	Hydrogen Energy Technologies	45	-	03
6.	MCET 106 03	Advanced Laboratory Practical [1,2]	200 notional hrs		02
		Semester 2			
7.	MCET 107 02	Energy Storage Technologies	30	-	02
8.	MCET 108 02	Marine and Hydro Energy Technologies	30	-	02
9.	MCET 109 02	Bioenergy Technologies	30	-	02
10.	MCET 110 03	Grid Integration of Clean Energy System	40	15	03
11.	MCET 111 02	Project Development and Management[2]	30		02
12.	MCET 112 03	Fieldwork in Clean Energy Technologies	100 notional hrs		01
13.	MCET 112 03	Group research project			02
		Sub-total (Equivalent to 1500 notional hours)			30

[1] to be conducted during first and second semester, [2] Independent learning

Table II – Course units to be offered in the Second Year

No.	Course code	Course Title	Lecture Hrs	Practical hrs	No. of Credits
Semester 3					
14.	MCET 213 03	Nanomaterials for Energy Harvest and Storage	30	45	03
15.	MCET 214 03	Mathematical modelling for Clean energy technologies	15	90	03
16.	MCET 215 02	Critical review on a research topic	15	45	02
17.	MCET 216 02	Research Ethics, Proposal Writing and presentation	15	45	02
Semester 3 and 4					
18.	MCET 217 20	Research project	2000 notional hrs		20
Sub-total					30
Total					60

Recommendation

I have gone through the revised curriculum and the above response my comments. I confirmed that my comments have been incorporated and recommend the revised curriculum for next stage of processing.

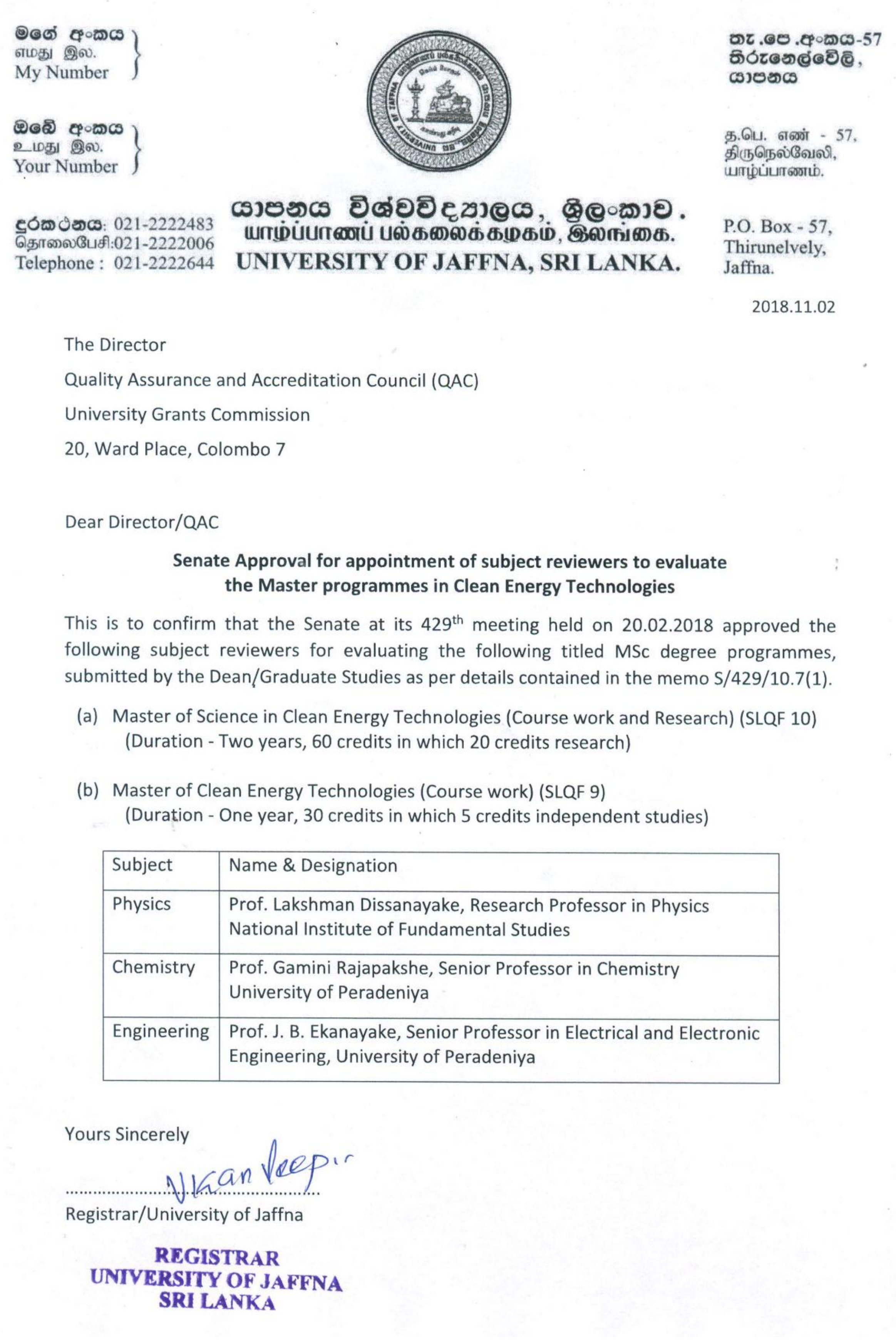
……………………………………………

Professor Janaka Ekanayake

Department of Electrical and Electronic Engineering

University of Peradeniya

Annex X: 15.2. Nomination by Senate (Evidence)



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My Number

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Your Number

දුරකථනය: 021-2222483
தொலைபேசி:021-2222006
Telephone : 021-2222644

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யாழ்ப்பாணப் பல்கலைக்கழகம், இலங்கை.
UNIVERSITY OF JAFFNA, SRI LANKA.

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த.பெ. எண் - 57,
திருநெல்வேலி,
யாழ்ப்பாணம்.

P.O. Box - 57,
Thirunelvely,
Jaffna.

2018.11.02

The Director
Quality Assurance and Accreditation Council (QAC)
University Grants Commission
20, Ward Place, Colombo 7

Dear Director/QAC

Senate Approval for appointment of subject reviewers to evaluate the Master programmes in Clean Energy Technologies

This is to confirm that the Senate at its 429th meeting held on 20.02.2018 approved the following subject reviewers for evaluating the following titled MSc degree programmes, submitted by the Dean/Graduate Studies as per details contained in the memo S/429/10.7(1).

(a) Master of Science in Clean Energy Technologies (Course work and Research) (SLQF 10)
(Duration - Two years, 60 credits in which 20 credits research)

(b) Master of Clean Energy Technologies (Course work) (SLQF 9)
(Duration - One year, 30 credits in which 5 credits independent studies)

Subject	Name & Designation
Physics	Prof. Lakshman Dissanayake, Research Professor in Physics National Institute of Fundamental Studies
Chemistry	Prof. Gamini Rajapakshe, Senior Professor in Chemistry University of Peradeniya
Engineering	Prof. J. B. Ekanayake, Senior Professor in Electrical and Electronic Engineering, University of Peradeniya

Yours Sincerely

....
Registrar/University of Jaffna

REGISTRAR
UNIVERSITY OF JAFFNA
SRI LANKA

Annex XI An extract of Strategic Management Plan (Corporate Plan of the University)

University of Jaffna Sri Lanka

Strategic Management Plan
2017-2021

DR | Capital works & Planning

The Council at its 440th meeting held on 29.07.2017 approved / ~~did not approve / noted~~ the above.

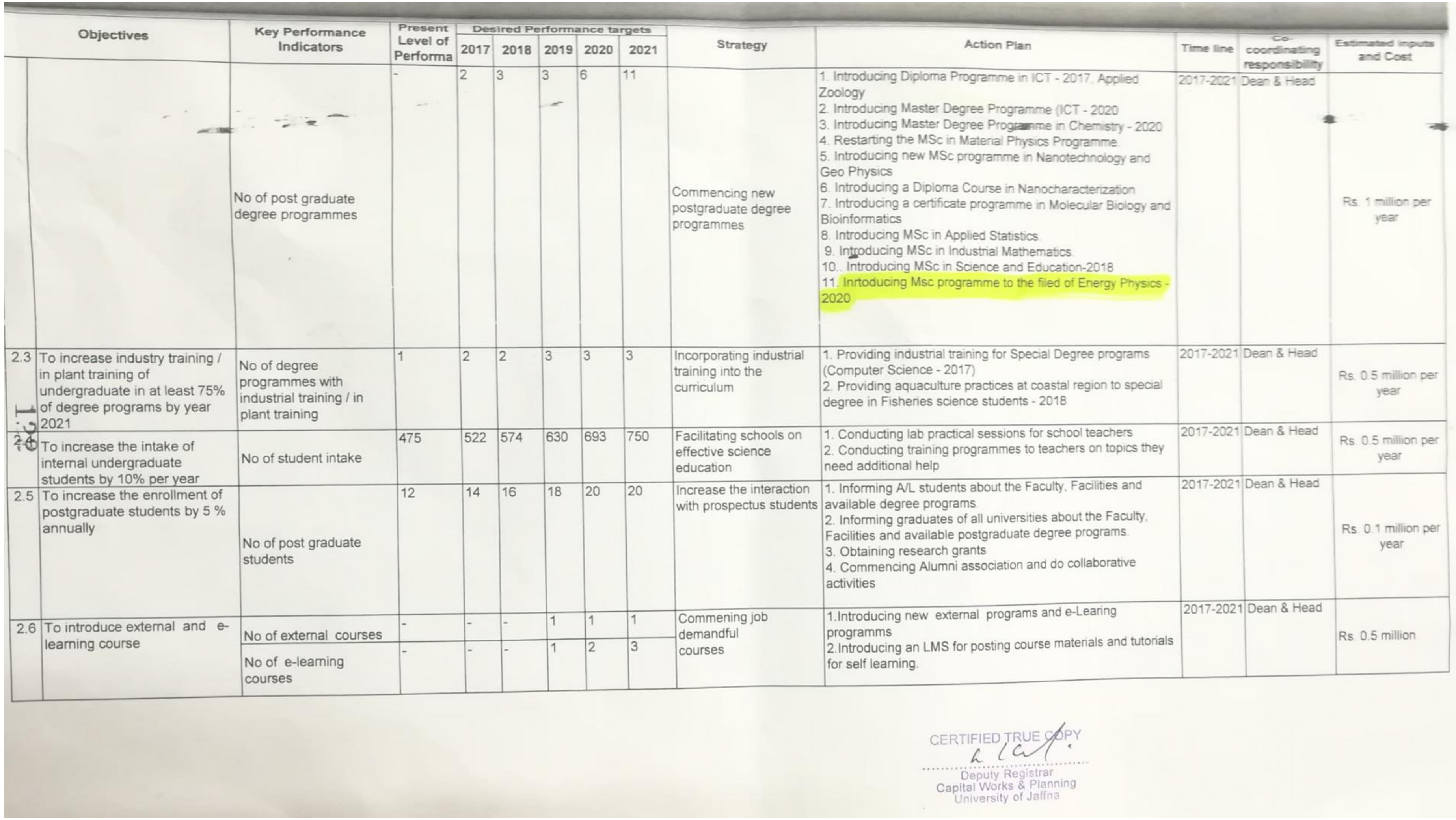
Registrar

Registrar's Office
University of Jaffna.

Certified true copy

N.RAJAVISAHAN
Deputy Registrar
Capital Works & Planning
University of Jaffna
Jaffna, Sri Lanka.

Annex XI An extract of Strategic Management Plan (Corporate Plan of the University)



	Objectives	Key Performance Indicators	Present Level of Performa	Desired Performance targets 2017	2018	2019	2020	2021	Strategy	Action Plan	Time line	Co-coordinating responsibility	Estimated inputs and Cost
		No of post graduate degree programmes	-	2	3	3	6	11	Commencing new postgraduate degree programmes	1. Introducing Diploma Programme in ICT - 2017, Applied Zoology 2. Introducing Master Degree Programme (ICT - 2020 3. Introducing Master Degree Programme in Chemistry - 2020 4. Restarting the MSc in Material Physics Programme. 5. Introducing new MSc programme in Nanotechnology and Geo Physics 6. Introducing a Diploma Course in Nanocharacterization 7. Introducing a certificate programme in Molecular Biology and Bioinformatics 8. Introducing MSc in Applied Statistics. 9. Introducing MSc in Industrial Mathematics. 10.. Introducing MSc in Science and Education-2018 11. Inrtoducing Msc programme to the filed of Energy Physics - 2020	2017-2021	Dean & Head	Rs. 1 million per year
2.3	To increase industry training / in plant training of undergraduate in at least 75% of degree programs by year 2021	No of degree programmes with industrial training / in plant training	1	2	2	3	3	3	Incorporating industrial training into the curriculum	1. Providing industrial training for Special Degree programs (Computer Science - 2017) 2. Providing aquaculture practices at coastal region to special degree in Fisheries science students - 2018	2017-2021	Dean & Head	Rs. 0.5 million per year
2.4	To increase the intake of internal undergraduate students by 10% per year	No of student intake	475	522	574	630	693	750	Facilitating schools on effective science education	1. Conducting lab practical sessions for school teachers 2. Conducting training programmes to teachers on topics they need additional help	2017-2021	Dean & Head	Rs. 0.5 million per year
2.5	To increase the enrollment of postgraduate students by 5 % annually	No of post graduate students	12	14	16	18	20	20	Increase the interaction with prospectus students	1. Informing A/L students about the Faculty, Facilities and available degree programs. 2. Informing graduates of all universities about the Faculty, Facilities and available postgraduate degree programs. 3. Obtaining research grants 4. Commencing Alumni association and do collaborative activities	2017-2021	Dean & Head	Rs. 0.1 million per year
2.6	To introduce external and e-learning course	No of external courses	-	-	-	1	1	1	Commening job demandful courses	1.Introducing new external programs and e-Learing programms 2.Introducing an LMS for posting course materials and tutorials for self learning.	2017-2021	Dean & Head	Rs. 0.5 million
		No of e-learning courses	-	-	-	1	2	3					

CERTIFIED TRUE COPY
Deputy Registrar
Capital Works & Planning
University of Jaffna

Refer 2.2.11 – Introducing a MSc programme in the field of Energy Physics by 2020

Annex XII Approval of the Senate and the Council for commencing Master degree programmes in Clean Energy Technologies

Annex XII(a) Senate approval

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உமது இல.
Your Number

දුරකථනය: 021-2222483
தொலைபேசி:021-2222006
Telephone : 021-2222644

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யாழ்ப்பாணப் பல்கலைக்கழகம், இலங்கை.
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யாழ்ப்பாணம்.

P.O. Box - 57,
Thirunelvely,
Jaffna.

2018.11.02

The Director

Quality Assurance and Accreditation Council (QAC)

University Grants Commission

20, Ward Place

Colombo 7

Dear Director/QAC

Senate Approval for the Master programmes in Clean Energy Technologies

This is to confirm that the Senate at its 429th meeting held on 20.02.2018 approved the proposal for the following titled new self-financing MSc degree programmes, submitted by the Dean/Graduate Studies as per details contained in the memo S/429/10.7.

(a) Master of Science in Clean Energy Technologies (Course work and Research) (SLQF 10)
(Duration - Two years, 60 credits in which 20 credits research)

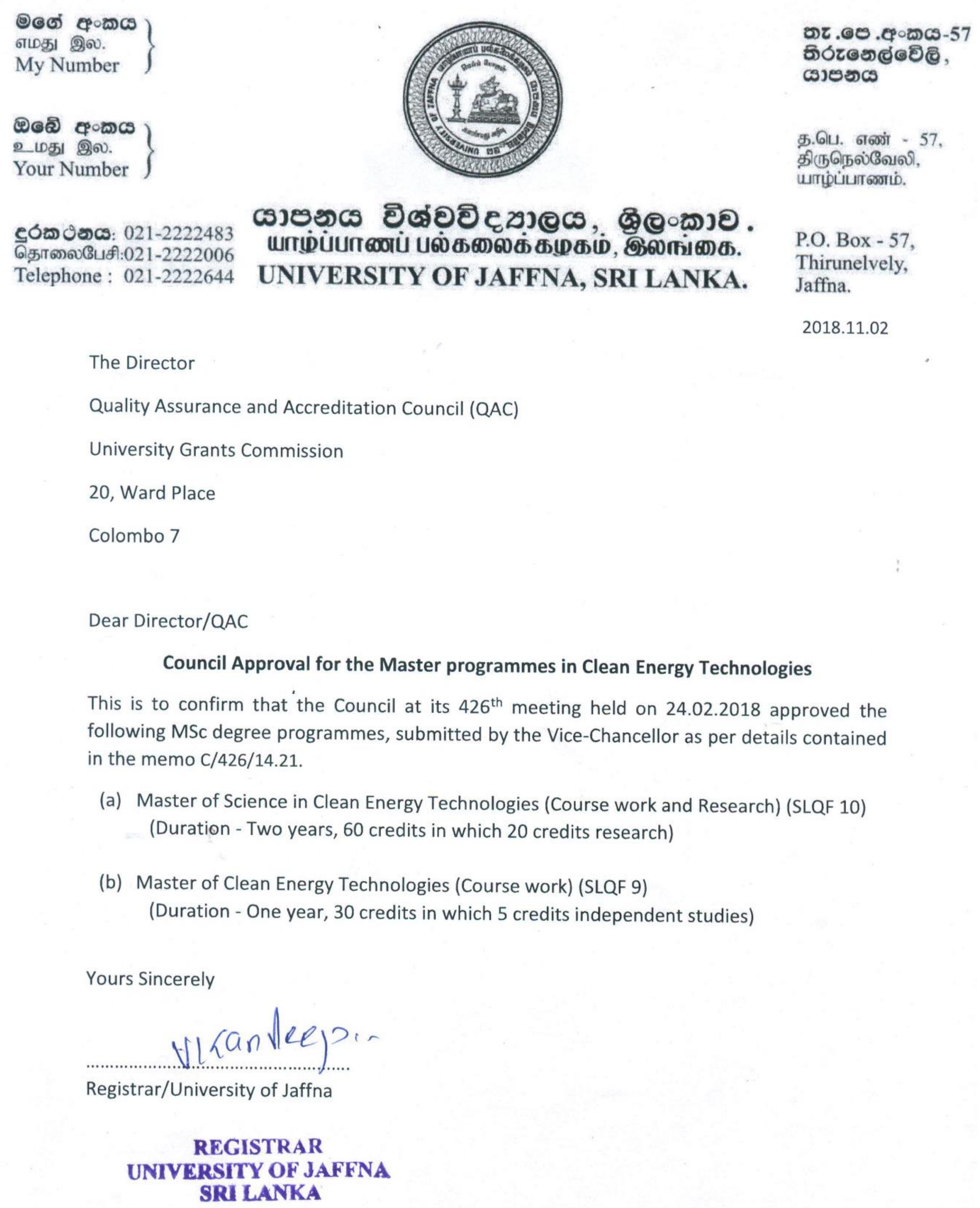
(b) Master of Clean Energy Technologies (Course work) (SLQF 9)
(Duration - One year, 30 credits in which 5 credits independent studies)

Yours Sincerely

……………………………………………………
Registrar/University of Jaffna

REGISTRAR
UNIVERSITY OF JAFFNA
SRI LANKA

Annex XII(a) Council approval



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யாழ்ப்பாணப் பல்கலைக்கழகம், இலங்கை.
UNIVERSITY OF JAFFNA, SRI LANKA.

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யாழ்ப்பாணம்.

P.O. Box - 57,
Thirunelvely,
Jaffna.

2018.11.02

The Director

Quality Assurance and Accreditation Council (QAC)

University Grants Commission

20, Ward Place

Colombo 7

Dear Director/QAC

Council Approval for the Master programmes in Clean Energy Technologies

This is to confirm that the Council at its 426th meeting held on 24.02.2018 approved the following MSc degree programmes, submitted by the Vice-Chancellor as per details contained in the memo C/426/14.21.

(a) Master of Science in Clean Energy Technologies (Course work and Research) (SLQF 10)
(Duration - Two years, 60 credits in which 20 credits research)

(b) Master of Clean Energy Technologies (Course work) (SLQF 9)
(Duration - One year, 30 credits in which 5 credits independent studies)

Yours Sincerely

VKandeepan
....
Registrar/University of Jaffna

REGISTRAR
UNIVERSITY OF JAFFNA
SRI LANKA

<u>Annex XIII (a) :</u> Collaborative agreement between University of Jaffna and Western Norway University of Applied Sciences (HVL) for Higher Education and Research collaboration on Nanomaterials for Clean Energy Technologies. Under this agreement, several activities such as staff and students exchange and purchasing research equipment and consumable needed for the MSc programmes in Clean Energy Technologies.

Western Norway
University of
Applied Sciences

APPENDIX 1 TO MOU BETWEEN WESTERN NORWAY UNIVERSITY OF APPLIED SCIENCES (HVL) AND UNIVERSITY OF JAFFNA (UOJ) SIGNED ON 14.03.2017

<u>COLLABORATION AGREEMENT</u>

This collaboration agreement between HVL and UOJ, hereafter referred to as *the partners,* shall regulate the cooperation regarding the project: **Higher Education and Research collaboration on Nanomaterials for Clean Energy Technologies (HRNCET).**

Project ID: NORPART-2016/10237

NORPART (Norwegian Partnership Programme for Global Academic Cooperation) is funded by the Norwegian Ministry of Education and Research and the Norwegian Ministry of Foreign Affairs, and is administered by the Norwegian Centre for International Cooperation in Education (SIU).

This collaboration agreement is based on and regulated by the **Project Document** and by the **Project Contract signed** between Western Norway University of Applied Sciences as the main partner and SIU (attachment 1 to appendix 1).

Provisions

The partners agree to:

(a) appoint a project coordinator who shall be responsible for the relevant partner's role in the implementation and local management of the Project;

Coordination of research projects covered by this MoU will rest upon:

Professor Dhayalan Velauthapillai
Faculty of Engineering and Business Administration
Western Norway University of Applied Sciences, P.O. Box 7030, 5020 Bergen, Norway
Tel 0047 55 58 77 11
E-mail: <u>Dhayalan.Velauthapillai@hvl.no</u>

Professor Punniamoorthy Ravirajan
Department of Physics
University of Jaffna
Faculty of Science
Jaffna, JA 40 000
Sri Lanka
Tel: 0094 71 856 1715
E-mail: <u>pravirajan@gmail.com</u>

(b) use any part of the Funds received exclusively for the purposes of implementing the Project; establish appropriate procedures for managing the Project's financial aspects (hereunder keeping separate accounts for the Project, compliant with internationally recognised accounting principles); allow SIU to upon request verify the project accounts and its underlying documentation and to inspect the progress of the project activities; and contribute as necessary to reports to be submitted to SIU by the Institution in Norway;

Western Norway University of Applied Sciences (HVL) will refund costs for project activities included in the budget to University of Jaffna (UOJ) by receipt of documentation such as certified copies of invoices and/or receipts. Costs cannot exceed figures in the budget.

(c) comply with any instructions made by SIU regarding suspension and repayment of the Funds, regardless of any reservations, rights of set-off or other objections that it may have vis-à-vis the Institution in Norway; and

(d) comply with all applicable statutes, laws and regulations in force or entering into force in the project period, as well as recognised norms for good project governance, and ensure that adequate steps shall at all times are taken to prevent/mitigate risk of irregularities, corruption and/or other unethical practices, in compliance with SIU's «Guidelines for handling irregularities» (accessible on SIU's webpage).

Signatures

Accepted for and on behalf of		Accepted for and on behalf of	
Western Norway University of Applied Sciences		**UNIVERSITY OF JAFFNA**	
and duly authorised		and duly authorised	
Signature:	Bjørg Kristin Selvik	Signature:	Varasara
Name:	Dr. Bjørg Kristin Selvik	Name:	Professor (Ms) V. Arasaratnam
Designation:	Pro Rector	Designation:	Vice- Chancellor
Date:	March 2017	Date:	March 2017
Place:	Jaffna, Sri Lanka	Place:	Jaffna, Sri Lanka

VICE CHANCELLOR
University of Jaffna
Jaffna, Sri Lanka

Annex XIII (b) ***MOU signed between University of Jaffna and Western Norway University of Applied Sciences (HVL) for Academic and Research collaboration***

Western Norway
University of
Applied Sciences

MEMORANDUM OF UNDERSTANDING

Memorandum of Understanding (MoU) with regard to the establishment of a collaborative relationship in areas of

ACADEMIC AND RESEARCH COLLABORATION

Made and entered into by and between

Western Norway University of Applied Sciences, Norway
(Hereinafter referred to as "**HVL**")

and

University of Jaffna, Sri Lanka
(Hereinafter referred to as **"UOJ"**)

Recognising:

- that cultural and scientific interaction is indispensable to institutions of higher education in developing their educational and research activities, and
- that institutions of higher education are enriched by international collaboration,

the named institutions hereby record their understanding.

ARTICLE I

The purpose of this Memorandum of Understanding is to develop and carry out collaborative activities within areas of common interest of the named institutions.

ARTICLE II

The scope of collaboration on academic and research activities in this Memorandum of Understanding can include, but are not limited to, the following categories:

1. Exchange of staff and students.
2. Research and teaching collaboration in the areas of mutual interest to both parties
3. Joint scientific publications
4. Exchange of academic materials made available by both parties.
5. Organisation of symposia, conferences, short courses and meetings on research issues of mutual interest.

ARTICLE III

To implement the aims and purposes expressed in ARTICLES I and II, the following is mutually understood and agreed:

1. Development of a specific project taking place within this Memorandum of Understanding should take the form of a supplementary agreement which will in detail outline key responsible people, sources of funding, and specific collaborative activities.
2. The final approval of any project will be dependent upon the availability of guaranteed support funds.
3. Progress of work of any supplementary agreement under the Memorandum of Understanding will be reviewed and approved by designated responsible people of both parties.
4. Neither the Western Norway University of Applied Sciences nor University of Jaffna will be held responsible for any liability whatsoever; furthermore, neither party shall be required to purchase any insurance against loss or damage to any personal property to which this Memorandum of Understanding relates.

5. Based on the principles of mutual respect and mutual benefit, the parties will protect each other's reputation and support each other's programmes and work.

6. The joint language of collaboration will be English.

ARTICLE IV

Duration of the Memorandum of Understanding:

This Memorandum of Understanding will come into effect on the last date of signing and shall be effective for a period of five years. Thereafter it will be reviewed and can be amended or renewed as agreed by both parties. Amendments to the Memorandum of Understanding can take place at any time by an exchange of letters.

Signatures

Accepted for and on behalf of		Accepted for and on behalf of	
Western Norway University of Applied Sciences		**UNIVERSITY OF JAFFNA**	
and duly authorised		and duly authorised	
Signature:	BjørgKristinSelvik	**Signature:**	N Arasara
Name:	Dr. Bjørg Kristin Selvik	**Name:**	Professor (Ms) V. Arasaratnam
Designation:	Pro Rector	**Designation:**	Vice- Chancellor
Date:	March 14. 2017	**Date:**	March 14, 2017
Place:	Jaffna, Sri Lanka	**Place:**	Jaffna, Sri Lanka

VICE CHANCELLOR
University of Jaffna
Jaffna, Sri Lanka