Master of Science

Renewable Energy Engineering

2023-24Assessment Report

Electrical Engineering and Renewable Energy Department

Feng Shi

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# 1 Program Mission and Educational Objectives

## 1.1 Program Mission

The Master of Science in Renewable Energy Engineering (MSREE) program goal is to provide graduates for careers in areas of renewable energy engineering including but not limited to solar PV, solar thermal, wind power, wave power, geothermal energy, transportation, energy storage, hydroelectric and traditional energy fields such as power systems, smart grid, energy management, energy auditing, energy systems planning, energy economics, energy policy and development, carbon accounting and reduction, and controls and instrumentation. MSREE graduates will enter renewable energy engineering careers as leaders in design, site analysis, product, application, test, quality control, and sales.

The MSREE program supports the university mission of offering “innovative, professionally-focused undergraduate and graduate degree programs” and providing “a hands-on, project-based learning environment” with an emphasis on “innovation, scholarship, and applied research”. The MSREE program has been designed to align with the university mission and to prepare graduates to be energy engineering professionals who have advanced knowledge and skills that enable them to assume a broad range of technical leadership roles. The flexibility in the degree options gives various forms of research opportunity for students to explore the current technology and meet the industrial needs.

## 1.2 Program Educational Objectives

The Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. The Program Educational Objectives (PEOs) of Oregon Tech’s Master of Science in Renewable Energy Engineering program are these:

* PEO1: MSREE graduates will excel as leaders in the various fields of energy engineering.
* PEO2: MSREE graduates will demonstrate an ability to apply advanced engineering methods to the solutions of complex energy-related engineering problems.
* PEO3: MSREE graduates will demonstrate an ability to acquire emerging knowledge and remain current in the dynamic field of renewable energy.

## 1.3 Relationship between Program Objectives and Institutional Objectives

These program educational objectives map to the Oregon Tech’s institutional mission statement and core themes by offering statewide educational opportunity in an innovative and rigorous applied degree program in engineering oriented toward graduate success and an appreciation for the role of the engineer in public service.

# 2 Program History and Description

## 2.1 Program History

In 2005, the Oregon Institute of Technology (Oregon Tech) began offering its new Bachelor of Science degree in Renewable Energy Systems program (BSRES) at its satellite campus in Portland, Oregon. In 2008, the BSRES degree was discontinued and replaced by the Bachelor of Science degree in Renewable Energy Engineering (BSREE). Analysis of the marketplace and observed growth in career options across the renewable energy fields revealed significant opportunities for graduates with a solid energy engineering education. Building upon this strong foundation of renewable energy engineering education, the MSREE was launched in the Portland-Metro campus in 2012. In 2013, an accelerated, concurrent degree option was launched for exceptional undergraduate students in the BS Renewable Energy Engineering and BS Electrical Engineering programs. The MSREE concurrent degree was launched in Klamath Falls in 2016. Full time offering of the MSREE program was extended to the Klamath Falls campus for the first time in 2018.

We anticipate MSREE graduates will enter energy engineering careers as leaders in the fields of power engineering, PV/semiconductor processing engineering, facilities and energy management, energy system integration engineering, HVAC and hydronics engineering, design and modeling engineering for net-zero energy buildings, biofuels plant and operations engineering, energy systems control engineering, power electronics engineering, utility program management, as researchers and educators in renewable energy fields, as well as in the roles of LEED accredited professionals (AP) and renewable energy planners and policy makers. Graduates of the program will be able to pursue a wide range of career opportunities, not only within the emerging fields of renewable energy, but within more traditional areas of energy engineering as well. MSREE graduates with strong interests in research and academia will be well situated to pursue further advanced degrees at PhD granting institutions.

## 2.2 Program Description

The MSREE program is designed to help students to understand and apply the principles of energy and power concepts to the next generation of technologies improving battery storage, building energy systems, grid integration of renewables and solar and thermal energy systems.

## 2.2.1 Degree Requirements

The Master of Science in Renewable Energy Engineering is a rigorous curriculum that requires 45 credit hours and approximately two years to complete.

## 2.2.2 Area of Focus

Students working toward the MSREE degree must complete REE specialization sequences from the list below. Based on the career goals and interest they may choose one of the sequences listed below. One sequence constitutes three courses under the titles listed below.

* Advanced Energy Storage
* Biofuels and Biomass
* Electrical Power Systems
* Energy Efficient Building Systems
* Energy Storage
* Fuel Cell Systems
* Geothermal Energy
* Global Energy Issues
* Hydro Power Systems and Integration
* Photovoltaic Systems and Processes
* Wind Power Systems and Integration
* Electric Vehicles

In addition to the specialization sequence, students must complete the following required courses

* Energy Engineering, I, II and III
* Graduate Research/Project/Thesis

## 2.3 Industry Relationships

The REE programs have strong relationships with industry, particularly through the program-level Industry Advisory Council (IAC) and REE alumni. The IAC has been instrumental in the success of the REE program. Representatives from corporations, government institutions and non-profit organizations comprise the IAC, giving the BSREE and MSREE a broad constituent audience. The IAC provides advice and counsel to the REE program with respect to the areas of curriculum content advisement, instructional resources review, career guidance and placement activities, program accreditation reviews, and professional development advisement and assistance. In addition, each advisory committee member serves as a vehicle for public relations information and potentially provides a point of contact for the development of specific opportunities with industries for students and faculty.

## 2.4 Program Locations

Among the advantages that make Oregon Tech an ideal institution for offering the MSREE program is the benefit of having a campus in urban Portland in proximity to the Pacific Northwest’s energy industry cluster, and with close ties to Oregon Tech’s campus in rural Southern Oregon, which exceptional natural energy resources and on-campus facilities generating renewable energy. The Portland campus allows students to leverage their classroom experience within internships at the Northwest's world-class energy and power companies. Graduate-level courses are also offered at the Klamath Falls campus. Online courses offer flexibility to concurrent degree and full-time students in both campuses.

## 2.5 Enrollment and Graduates

The inaugural graduating class in Spring 2014 included just one student. Sixty students have graduated from the program as of Summer 2024 term. Table 1 shows the enrollment of 2020-24.

Table 1: MSREE Enrollment per year for AY2020-24

# 3 Cycle of Assessment for Program Outcomes

## 3.1 Program Outcomes

The MSREE program builds on the engineering knowledge students gained as undergraduates. The MSREE program outcomes are these:

(a) an ability to identify, formulate, and solve energy-related engineering problems.

(b) an ability to communicate effectively.

(c) an ability to independently acquire knowledge of contemporary technical, political, and economic issues related to energy.

MSREE students who are graduating from the accelerated BS+MSREE degree program are required to meet the program level outcome of the undergraduate program as well as the institutional-level essential student learning outcomes (ESLOs).

## 3.2 Assessment Methodology

The assessment of the program outcomes was reviewed, and decision has been made to consider ENGR596, 597, 598 Graduate Thesis/Project course to evaluate the program outcomes. The MSREE outcome assessment cycle was revised and year 2023-24 was used to assess the first outcome using ENGR596, 597, 598 Graduate Thesis/Project and REE515 Energy Engineering I. This course involves the final work of students in the MSREE degree and provides a window into the three program outcomes. Starting in AY 2022-23, each outcome will be assessed each year, following the new MSREE outcome assessment cycle presented in Table 2.

Students taking ENGR596, 597, 598 have to present a written thesis or project report and defend it in front of a committee composed by their advisor, a member of the department, and an external committee member. The three members of the committee read the written document prior to the defense. Department faculty who are members of the student committees but not their ENGR596, 597, 598 advisors will be assigned with the assessment of outcomes. Assessment year 2022-23 has been used as a resetting point, considering all three outcomes, to continue with a regular 3-year cycle, as shown in Table .2

## 3.3 Assessment Cycle

Table 2. MSREE Outcome Assessment Cycle

|  |  |  |  |
| --- | --- | --- | --- |
|  | 2022-23 | 2023-24 | 2024-25 |
| 1. Problem Solving
 | ENGR596/7/8ENGR511 | ENGR596/7/8REE515 |  |
| 1. Communication
 | ENGR596/7/8ENGR511 |  | ENGR596/7/8REE516 |
| 1. Independent/Contemporary
 | ENGR596/7/8ENGR511 |  |  |

## 3.4 Curriculum Map

The MSREE curriculum map is shown in Table .3. The table identifies how each program outcome appears within the curriculum at the Foundation (Introduction), Practice (Reinforcement and Application) and Capstone (Synthesis) levels. The original assessment plan considered assessment of the program outcomes in different courses over a three-year cycle. However, faculty found out that the selected courses were not representative of the program outcomes and the methodology had to be revised. Long considerations during academic years 2016-17 and 2017-18 led to the decision that REE 599 (now ENGR596/7/8) Graduate Thesis/Project was the best course to evaluate the program outcomes. The table identifies how each program outcome appears within the curriculumat the Foundation (Introduction)(F), Practice (Reinforcement and Application)(P) and Capstone(Synthesis)(C) levels.

Table 3. MSREE Curriculum Mapping

|  |  |  |  |
| --- | --- | --- | --- |
| Course | Outcome A | Outcome B | Outcome C |
| Graduate Research Methods/ Innovation - Required |
| REE 511 Research Methods I | - | F | - |
| REE 512 Research Methods II | - | F | - |
| REE 513 Research Methods III | - | F | - |
| Energy Engineering - Required |
| REE 515Energy Engineering I | - | - | F,P |
| REE 516Energy Engineering II | - | - | F |
| REE 517Energy Engineering III | - | - | F |
| Power Systems Engineering - Elective |
| REE 529Power Systems Analysis | F,P | - | - |
| REE 549 Power Systems Protection and Control | F,P | - | - |
| REE 569 Grid Integration of Renewables | F,P | - | - |
| Electric Vehicles– Elective |
| REE587 Advanced Electric Drive Vehicle | F,P |  |  |
| REE588 Energy Storage for Electric Vehicle | F,P |  |  |
| REE589 Autonomous Drive | F,P |  |  |
| Energy Efficient Building Systems– Elective |
| REE 533Heating, Ventil/AC | F | - | - |
| REE 553Energy Systems Mange/Audt | F,P | - | - |
| REE 573 Energy Efficient Build design | F,P | - | - |
| Photovoltaic Systems and Processes - Elective |
| REE 545 Applied Photvoltaics | F,P | - | - |
| REE 565 Semiconductor Process Engg | F,P | - | - |
| REE 525 Solid-State Physics/Photovoltaics | F,P | - | - |
| REE 5xx Elective |
| REE 5xx Elective I | Varies |
| REE 5xx Elective II |
| REE 5xx Elective III |
| Graduate Thesis – Required  |
| ENGR59X Graduate R&D/Project/Thesis | C | C | C |
| ENGR59X Graduate R&D/Project/Thesis | C | C | C |
| ENGR59X Graduate R&D/Project/Thesis | C | C | C |

# 4 Summary of Assessment Activities & Evidence of Student Learning

The assessment methodology is discussed and revised periodically by the department meeting during convocation. The assessment is conducted annually by two different methods, one based on the criteria statement in Table.2 and another based on the indirect assessment conducted for the graduated students as an exit survey. The indirect assessment provides information about the students’ achievement of program and institutional learning outcomes.

The MSREE faculty conducted formal assessment during the 2021-22 academic year using direct measures, such as designated assignments and evaluation of coursework normally assigned. Additionally, the student outcomes were assessed using indirect measures, primarily results from a graduate exit survey.

## 4.1 Methods for Assessment of Program Outcomes

At the beginning of the assessment cycle, an assessment plan is generated by the Assessment Coordinator in consultation with the faculty. This plan includes the outcomes to be assessed during that assessment cycle (according to Table 2), as well as the courses and terms where these outcomes will be assessed.

The program outcomes are evaluated as part of the course curriculum primarily by means of students’ final theses or projects. These theses or projects require the student to apply math, science, and engineering principles learned in the course to solve a particular problem requiring the use of modern engineering methodology and effectively communicating the results.

A systematic, rubric-based process is then used to quickly assess the level of attainment of a given program outcome, based on a set of performance criteria. The work produced by each student is evaluated according to the different performance criteria, and assigned a level of 1-developing, 2-accomplished, or 3-exemplary. The results for each outcome are then summarized in a table and reviewed by the faculty at the annual Closing-the-Loop meeting.

The acceptable performance level is to have at least 80% of the students obtain a level of accomplished or exemplary in each of the performance criteria for any given program outcome.

If any of the direct assessment methods indicates performance below the established level, that triggers the continuous improvement process, where all the direct and indirect assessment measures associated with that outcome are evaluated by the faculty, and based on the evidence, the faculty decides the adequate course of action. The possible courses of action are these:

* Collect more data (if there is insufficient data to reach a conclusion as to whether the outcome is being attained or not); this may be the appropriate course of action when assessment was conducted on a class with low enrollment, and it is recommendable to re-assess the outcome on the following year, even if it is out-of-cycle, in order to obtain more data.
* Make changes to the assessment methodology (if the faculty believe that missing the performance target on a specific outcome may be a result of the way the assessment is being conducted, and a more proper assessment methodology may lead to more accurate numbers); for example, this could be the suggested course of action if an outcome was assessed in a lower-level course, and the faculty decide that the outcomes should be assessed in a higher-level course before determining whether curriculum changes are truly needed.
* Implement changes to the curriculum (if the faculty concludes that a curriculum change is needed to improve attainment of a particular outcome). A curriculum changes will be the course of action taken when the performance on a given outcome is below the target level, and the evidence indicates that there is sufficient data and an adequate assessment methodology already in place, and therefore there is no reason to question the results obtained.

If the faculty decide to take this last course of action and implement curriculum changes, the data from the direct assessments is analyzed and the faculty come up with a plan for continuous improvement, which specifies what changes will be implemented to the curriculum to improve outcome performance.

In addition to direct assessment measures, indirect assessment of the student outcomes is performed on an annual basis through a graduate exit survey.

The results of the direct and indirect assessment, as well as the conclusions of the faculty discussion at the Closing-the-Loop meeting are included in the annual MSREE Assessment Report, which is reviewed by the Department Chair and the Director of Assessment for the university. The suggested changes to the curriculum are presented and discussed with the entire department faculty at the annual Convocation meeting in Fall, as well as with the Industry Advisory Board at the following IAB meeting. If approved, these changes are implemented in the curriculum and submitted to the University Graduate Council (if catalog changes are required) for the following academic year.

## 4.2 AY2023-24Targeted Direct Assessment Activities

The sections below describe the 2023-24 targeted assessment activities and detail the performance of students for each of the assessed outcomes. Unless otherwise noted, the tables report the number of students performing at a developing level, accomplished level, and exemplary level for each performance criteria, as well as the percentage of students performing at an accomplished level or above. Outcomes (b), we as assessed for academic year 2023-24 by means of one thesis or project completed during the year by graduating student of the MSREE program under the course denoted ENGR 596, 598. This student conducted her graduate research or thesis. Dr. Chitra Vanugopla advised one student.

One graduate student advised by Dr.Chitra Vanugopla from Portland-Metro campus has accomplished her thesis on “Design and Analysis of Utilizing Ice Thermal Energy Storage for a Chiller Plant Facility on a Research Campus in Portland, Oregon, USA”. She identified one of the grand challenges in renewable energy research and applications utility scale energy storage and come up with a solution to use Ice Thermal Energy Storage to store renewable energy generated power. This solution addresses both renewable energy storage and cooling supply simultaneously. This student geared up contemporary knowledge of heat pump, energy storage, and cooling supply to address the urgent issues of renewable energy independently. The thesis is assessed by Dr. Feng Shi for outcomes (a).

The minimum acceptable performance level for all outcomes is to have 80% or more of the students performing at the accomplished or exemplary level for all performance criteria. The summary data presented in this section represent the percentages of students meeting course-specific criteria.

## 4.2.1 Targeted Assessment for Outcome (a):an ability to identify, formulate, and solve energy-related engineering problems.

This outcome was assessed in ENGR 596, 598–Graduate Thesis or Project by means of an evaluation of a final graduate-level thesis or project. Students submitted a well-organized graduate thesis with good abstract, state of art information from many sources, test credibility, shows evidence of application and use of research information in the thesis, analyze and critique different sources and answers all questions. The research work should be presented well with good audience contact in the oral defense and/or use good writing mechanics and presentation techniques in the submitted thesis. Students submitted written documentation of their work, presented an oral defense, and made revisions and corrections based on feedback from both written and oral presentations of work.

Two MSREE students were assessed from using the performance criteria listed in the table below. The minimum acceptable performance level was to have above 80% of the students performing at the accomplished or exemplary level in all performance criteria.

4 summarizes the results of this targeted assessment. The results indicate that the performance level of 100% was met on all performance criteria for this program outcome, that is, 100% of students were able to communicate, present and acquire the relevant information required for the research.

Table 4. Targeted Assessment for Outcome (a) (N=1)

|  |
| --- |
| Outcome (a): an ability toidentify, formulate, and solve energy-related engineering problems. |
| Performance Criteria | 1-Developing | 2-Accomplished | 3-Exemplary | %Students >= 1 |
| Identifies technical problems |  |  | 1 | 100% |
| Formulates problems. |  |  | 1 | 100% |
| Implement a solution |  |  | 1 | 100% |

## 4.3 Summary of Indirect Assessment for 2023-24

In addition to direct assessment measures, the student outcomes are normally indirectly assessed through a graduate exit survey.

The survey asked students to indicate how well the MSREE program prepared them in each of the three specified outcomes.

The survey includes the following questions:

* **Q MREE 1 - Program Student Learning Outcomes for Renewable Energy Engineering M.S. Please rate your proficiency in the following areas.**

(High Proficiency/Proficiency / Some Proficiency / Limited Proficiency)

(1.a) An ability to identify formulate, and solve energy-related engineering problems

(1.b) An ability to communicate effectively

(1.c) An ability to independently acquire knowledge of contemporary technical, political, and economical issues related to energy

* **Q MREE 2 - Program Student Learning Outcomes for Renewable Energy Engineering M.S. How much has your experience at Oregon Tech contributed to your knowledge, skills, and personal development in these areas?**

(Very much / Quite a bit / Some / Very little)

(2.a) An ability to identify formulate, and solve energy-related engineering problems

(2.b) An ability to communicate effectively

(2.c) An ability to independently acquire knowledge of contemporary technical, political, and economical issues related to energy

A total of 2 students graduated in AY2022-23, but no graduated students (N=0) filled out the exit survey.

# 5 Review of Assessment Results

This section describes the changes resulting from the assessment activities carried out during the academic year 2023-24. The objective set for all programs in the EERE department is to have at least 80% of the students perform at the level of accomplished or exemplary in all performance criteria of the assessed outcomes.

Tables 7,8,9 show the summary of 2023-24 and 2022 – 23 direct assessment results of outcome(a), (b), and (c). The resultsshow the outcome is stable inb.2 and b.3 irrespective of number of sample size. The attainment of outcome b.1for AY2022-23 was not available. In AY2023-24, the percent of students assessed at a level of 2-accomplished or above is 100%. This shows positive improvement in the attainment of outcome assessment.

The rubric for outcome(a), (b) and (c)are included in the Appendix.

Table 7. Summary of direct assessment for Outcome (a)

|  |  |  |
| --- | --- | --- |
| Performance Criteria | AY2023-24 (N=1)%Students>= 1 | AY 2022-23 (N=2)%of students ≥2 |
| a.1-Identifies technical problems | 100% | 100% |
| a.2-Formulates problems. | 100% | 100% |
| a.3-Implement a solution | 100% | 100% |

## 5.1 Review of Assessment Methodology

This section describes changes to the assessment methodology that were proposed in the 2022-23assessment cycle for implementation in the 2023-24assessment cycle.

The faculty discussed about the Coursework-only and Graduate Research and Development (ENGR 596) options. In the course work only option, the student completes an additional approved REE graduate

specialization sequence (9 credits) in lieu of a graduate thesis/project/R&D. Students should get prior approval for the sequence from their academic advisor or MSREE Program Director.

The Graduate Research and Development (ENGR 596) option involves conducting research and/or developing a project in a chosen topic. The scope of the research or project must meet the standards for graduate work, like thegraduate thesis and graduate project options. In the case of students following the accelerated BS/MSREE path who have not completed an undergraduate capstone project, the scope of the project must also meet therequirements for the undergraduate capstone project. However, the requirements of review for this option are lower. Under this option, an oral defense before a faculty committee is not required. The work is graded exclusivelyby the faculty advisor supervising the work, who will also determine the particular deliverables appropriate to thenature of the work performed by the student (e.g., project report, oral presentation, live demonstration, etc.). Faculty decided to include these options in the AY2021-22 assessment cycle.

# 6 Review of Assessment Results and Closing the Loop

A special REE faculty meeting was conducted 26 October 2024 to review the MSREE assessment report. Faculty also discussed changes needed for MSREE curriculum and decided to continue the discussion further in the future meetings. To increase the sample sizes to get statistically meaningful results it was decided to include more course in the assessment. Also, the courses for next three-year assessment cycle were decided. Table. 6 shows the courses that are assessed in AY2022-23 to AY2024-25.

Table 6: Assessment Cycle for AY2022-23 to AY2024-25

|  |  |  |  |
| --- | --- | --- | --- |
|  | 2022-23 | 2023-24 | 2024-25 |
| 1. Problem Solving
 | ENGR 597/8REE517 | ENGR 597/8, REE515 |  |
| 1. Communication
 | ENGR 597/8REE517 |  | ENGR 597/8, REE516 |
| 1. Independent/Contemporary
 | ENGR 597/8REE517 |  |  |

It was believed that by including most of the sequences in one or more outcome assessment we should be able to get stable feedback about the curriculum and outcomes achieved.

The outcomes are attached in the appendix. 8

# 8 Appendix MSREE Program Rubrics

OUTCOME A RUBRIC – An ability to IDENTIFY, FORMULATE, AND SOLVE TECHNICAL PROBLEMS

Course:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Grade\_\_\_\_\_\_

|  |
| --- |
| **Students must demonstrate the following Program Outcome**A). An ability to identify, formulate and solve technical problems. |
| Criteria | 1-Developing | 2-Accomplished | 3-Exemplary | Score |
| **Identifies technical problems** | Classifies information to develop possible solutions (comp).Distinguishes what is known/unknown for a problem (comp). | Identifies where an improvement can be made for a problem solution (analyze).Develops possible alternative solutions to a given solution. (app.). | Assembles new solution information from various solutions (syn).Assesses effectiveness of problem solutions (Eval). |  |
| **Formulates Problems.** | Describes problem to be solved (know).Visualize a problem with diagrams (comp).Specifies problem scope (comp.).States a problem in words (app.).  | Specifies problem and appropriate models (appl.).Determines the limits of a problem (app.).Analyzes problem variable limits for a basic model (anal.). | Builds variables, resources and limits into a problem statement (syn).Assess problem statement with regard to objectivity, relevance and validity (eval.).  |  |
| **Implement a solution** | Describe implementation process and documentation (know.).Describe several documentation methods and it’s relationship to problem (comp.). | Applies manage/team skills to implement solution (app.).Communicates (oral/written) recommended solutions (app.).Reviews/critiques documentation by others to problem at hand (anal.). | Apprises effectiveness of techniques to problem at hand (anal.).Uses management/team solutions to implement final solution (syn.).Evaluate recommendations/solutions with respect to impact factors (eval.). |  |

OUTCOME B RUBRIC – An ability to Communicate Effectively

Course:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Grade\_\_\_\_\_\_

|  |
| --- |
| **Students must demonstrate the following Program Outcomes**B). an ability to communicate effectively. |
| Criteria | 1-Developing | 2-Accomplished | 3-Exemplary | Score |
| **Orally Communicate information**  | Presentation is disorganized, lacks a cohesive flow; Missing requirements. Questions unanswered. No visual aids; Reads report; Little audience contact, Weak delivery. | All requirements met; Organized, but does not flow well. Answers most questions. Some visual aids; Good presentation technique and delivery. | Plans, prepares and delivers a well organized presentation; All requirements met. Analyzes and answers all questions. Good visual aids; Good presentation techniques; Good audience contact (eye contact, voice). |  |
| **Written communication** | Poor Organization; Missing basic components. Many grammatical and mechanical errors. A summary. | Organized, abstract; Possess a style. Good grammar and writing mechanics. Summarize and classifies. | Well organized and developed; Good abstract; Selects appropriate style, form and tone. Good grammar and writing mechanics; Good use of elements of writing processes. Analyzes and critiques effectively. |  |
| **Acquiring information from various sources** | Few sources, mostly Web sources; Inadequate application and usage of information.  | Various sources; Tests credibility; Good application and usage. | State of the art information from many sources; Analyzes information; Tests credibility; Applies and uses information well.  |  |

OUTCOME C RUBRIC – Independently acquire knowledge of contemporary technical, political, and economic issues related to energy

Course:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Student Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Grade\_\_\_\_\_\_

|  |
| --- |
| **Students must demonstrate the following Program Outcome**C). an ability to independently acquired knowledge of contemporary technical, political and economic issues related to energy. |
| Criteria | 1-Developing | 2-Accomplished | 3-Exemplary | Score |
| **Knowledge of contemporary issues in context** | Lists and recognizes socio-economic, political, and environmental issues | Contextualizes information, organizes information by categories, recognizing relevance to specific examples | Identifies how information is interrelated; Applies contextualized information to actual situations |  |
| **identifying, gathering and analyzing information.** | Identifies tools needed to conduct research and improve skills | Explains how what has been learned will improve research; Develop independent learning skills. | Applies what has been learned to a project; Independent research conducted.  |  |

**MS RENEWABLE ENERGY ENGINEERING**

**GRADUATE THESIS/PROJECT EVALUATION RUBRIC**

**Student Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Type of Work:** ❐**MS Thesis** ❐**MS Project**

**Degree:** ❐**BS/MSREE** ❐**MSREE**

**Evaluator’s Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Date of Evaluation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**EVALUATION OF KEY AREAS:**

(Please evaluate each one of the key areas according to how well the work produced by the candidate satisfies the descriptions provided. You may add any comments or observations to support or complement your assessment in each key area.)

**1. Well Chosen Topic**

Focuses narrowly on a specific research question or engineering design contribution; right scale and level of difficulty, relevant to the discipline, significant, makes an adequate contribution.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**2. Builds on Previous Research**

The literature review shows awareness of wide range of relevant work and leading experts. The work motivates the chosen approach by citing appropriate published works and explains why alternate methods were not chosen.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**3. Strong Methodology**

Presents a systematic approach (including testing and evaluation) to the overall research or design problem. The methodology followed is sound and adequate for the particular project/topic. Design decisions are adequately justified based on the application or sound design principles.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**4. Solid Understanding of the Discipline**

Shows accuracy and rigor in the theoretical, design, and experimental aspects of the work; evidences sophisticated understanding of all relevant materials (sources, methods, theory, past results, etc.)

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**5. Adequate Use of Evidence**

Accurate and critical use of data tointerpret results; results are sufficient to assess the performance of the proposed solution and support conclusions.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**6. Comprehensive**

Adequate coverage and discussion of the key issues, sources, results (answers the research question or R&D specification). Demonstrated ability to critically evaluate the validity and reliability of the work done.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**7. Conclusion and Future Work**

Conclusion or summary succintly addresses the R&D problem, provides the key contributions made, and facilitates or guides future work on the topic.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**8. Communication**

Clear and appropriate language throughout, excellent synthesis, awareness of limitations/ambiguity/nuance/complexity; clarity of expression, proper use of specialist vocabulary and figures.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**9. Satisfies Formal Criteria**

Meets all the formal requirements in terms of format, style, length, formalities, etc.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**10. Overall Quality**

Overall, the work is of appropriate quality in terms of content and format for a MS thesis or project.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**ASSESSMENT OF MSREE PROGRAM OUTCOMES:**

(Please evaluate each one of the following outcomes according to the degree to which the work produced by the candidate evidences achievement of the particular outcome. You may add any comments or observations to support or complement your assessment in each outcome.)

**(a) an ability to identify, formulate, and solve energy-related engineering problems.**

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**(b) an ability to communicate effectively.**

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**

**(c)** an ability to independently acquired knowledge of contemporary technical, political and economic issues related to energy.

❐ Developing ❐Accomplished ❐Exemplary

**Evaluator’s Comments**