Master in Renewable Energy and the Environment – Curriculum Prerequisite & Progression

Program Level	Course Structure & Progression Path	Prerequisite / Requirement
Level 1 **Core Semesters**	1. **7161-ME-3:** Renewable Energy Systems 2. **7162-ME-3:** Environment and Sustainability 3. **7163-ME-3:** Advanced Heat Transfer	**None (NA)**
Level 2 **Specialization & Core**	1. **7164-ME-3:** Solar Energy *(Required)* 2. **71XX-ME-3:** Elective-1 *(From List 1)* 3. **71XX-ME-3:** Elective-2 *(From List 2)*	**None (NA)**
Progression Gateway	**Successful Completion of 18 Credit Hours**	**18 credit hours must be successfully completed from Levels 1 & 2**
Level 3 **Advanced Electives & Capstone**	1. **71XX-ME-3:** Elective-3 *(From List 3)* 2. **71XX-ME-3:** Elective-4 *(From List 4)* 3. **7185-ME-3:** Project *(Component 1)*	**Requires 18 credits completed from Levels 1 & 2**
Level 4 **Final Semester**	1. **71XX-ME-3:** Elective-5 *(From List 4)* 2. **7185-ME-3:** Project *(Component 2 / Defense)*	**Continuous enrollment in Project**

Program Completion & Graduation Requirements

Requirement	Condition
Master's Project	Successful defense of the Master's Project report and oral presentation
Minimum GPA	Minimum **3.5 overall Cumulative Grade Point Average (CGPA)**
Scientific Publication	Submission of at least **one scientific paper** to a specialized journal or conference, derived from the Master's Project

Total coursework before/through the gateway: 18 credit hours from Levels 1 and 2.
Progression to Level 3: Requires successful completion of those 18 credit hours.
Project: Component 1 begins at Level 3 and Component 2/Defense continues into Level 4.

Master in Renewable Energy and the Environment – List of Selected Elective Courses

List	Course Code	Course Title	Required/ Elective	Pre-Requisite Courses	Credit Hours
List: 1	7166-ME-3	Numerical Methods	Elective	NA	3
	7168-ME-3	Photovoltaic Energy Systems	Elective	NA	3
	7169-ME-3	Geothermal Energy	Elective	NA	3
	7170-ME-3	Advanced Fluid Mechanics	Elective	NA	3
List: 2	7171-ME-3	Wind Energy	Elective	NA	3
	7173-ME-3	Energy Conversion	Elective	NA	3
	7174-ME-3	Energy Storage Systems	Elective	NA	3
	7175-ME-3	Electrical Systems Related to Renewable Energy	Elective	NA	3
List: 3	7165-ME-3	Energy Efficiency	Elective	NA	3
	7172-ME-3	Finite Elements Method	Elective	NA	3
	7177-ME-3	Computational Fluid Dynamics	Elective	NA	3
	7178-ME-3	Optimization of Energy Systems	Elective	NA	3
	7179-ME-3	Advanced Mathematics	Elective	NA	3
List: 4	7180-ME-3	Economic Aspects Of Renewable Energy	Elective	NA	3
	7181-ME-3	Energy Comfort In Buildings	Elective	NA	3
	7182-ME-3	Environmental Pollution	Elective	NA	3
	7183-ME-3	Energy Management	Elective	NA	3
	7184-ME-3	Desalination	Elective	NA	3
	7176-ME-3	Energy Policy, Planning and Sustainable Development	Elective	NA	3

APPENDICES

APPENDIX A – COURSE SYLLABI

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7161-ME-3	**Course Name**	Renewable Energy systems
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	1/1		
3. Course Instructor	Dr. Sultan Alqahtani		
4. Textbook, title, author, and year	**Textbook:** 1. Wind and Solar power system By: Mukund R. Patel, Ph.D.,P.E. **a. Other supplemental materials:** 1. JeeJoe Michael , IniyanS , Ranko Goic,"Flat plate solar photovoltaic–thermal (PV/T) systems: A reference guide", Volume 51, November 2015, Renewable Energy Reviews. 2. HG Teo, PS Lee, MNA. Hawlader,"An active cooling system for photovoltaic modules",Appl. Energy, 90 (1) (2012).		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course, categorized under Engineering Science, provides a quantitative and applied introduction to renewable energy systems with emphasis on the Saudi Arabian context. Students examine solar, wind, hydro, bioenergy, geothermal, ocean (wave, tidal, OTEC), and fuel cell technologies through their underlying physical principles, mathematical models, performance characteristics, and environmental impacts. The course integrates resource assessment, simple system sizing, and efficiency calculations using fundamental mathematics, statistics, and simulation tools. Students apply critical thinking to compare technologies, evaluate feasibility under technical, economic, and environmental constraints.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Required	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes

6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 Explain the underlying physical, environmental, and engineering-science principles of major renewable energy technologies (solar, wind, hydro, bioenergy, geothermal, ocean, fuel cells) and their relevance to the NREP. PLO 3 Apply mathematical and analytical methods to model and perform preliminary design calculations for selected renewable energy systems (e.g., sizing, performance estimation, basic optimization of key parameters). PLO 4 Analyze and compare the technical, environmental, and economic performance of alternative renewable energy options using quantitative indicators (e.g., capacity factor, simple payback) and basic decision-making tools. PLO 5 Assess the environmental impacts and sustainability implications of renewable energy projects, including land use, emissions, and resource consumption, in the context of Saudi Arabian regulations and societal needs. PLO 6 Use digital and analytical tools (e.g., spreadsheets, MATLAB/Python, or simple energy modeling software) to perform basic modeling, data analysis, and performance assessment of renewable energy systems. PLO 7 Prepare and present a structured scientific report or project proposal on a renewable energy topic that includes clear objectives, methodology, preliminary analysis, and discussion of expected outcomes. PLO 9 Demonstrate awareness of professional ethics, safety, and responsible conduct in the design, analysis, and communication of renewable energy solutions, particularly within the Saudi Arabian energy transition.
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Introduction to Renewable Energy and Saudi Arabia's National Renewable Energy Program (NREP).	3
2.	**Solar energy:** solar thermal conversion devices, storage and applications, solar cell fundamentals, different solar cell technologies, photovoltaic systems, solar assisted heating, and cooling systems, scope in Saudi Arabia.	6
3.	**Fuel cell:** importance for fuel cell, classification of fuel cells, basic principle, design, materials used for developing fuel cells, applications and future prospects, scope in Saudi Arabia.	6
4.	**Bioenergy:** biofuels and feedstocks for its production; Various biofuels: biodiesel, bioethanol, biobutanol, biohydrogen, biogas and biooil; concept of biorefinery,	6

		scope in Saudi Arabia.	
	5.	**Hydro-electric energy:** Types of Hydroelectric Energy Plants; mini/micro-hydel systems, scope in Saudi Arabia.	6
	6.	**Ocean Wave energy:** Introduction to wave energy, resources and potential, examples from passed and current R&D facilities. Simplified wave theory; orbits, propagation velocities, stored & transported wave energy, scope in Saudi Arabia.	6
	7.	**Geothermal Energy:** Resources, types of wells, methods of harnessing the energy, scope in Saudi Arabia.	6
	8.	**Ocean Thermal Energy Conversion (OTEC):** Principle of operation, development of OTEC plants, Tidal and wave energy, Potential and conversion techniques, mini-hydel power plants.	3
	9.	**Wind Energy**: Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Details of Wind Turbine Generator.	3
	Total		45
8. Any other information	**Course Assessment***		

	Activity	**Assessment% (Marks)**
	Mid Exams (Mandatory)	40% (40 Marks)
	Quiz (Blackboard)	15% (15 Marks)
	Project/Assignment/ Reports	15% (15 Marks)
	Final Exam	30% (30 Marks)
	Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7162-ME-3</td><td>Course Name</td><td>Environment and Sustainability</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">1/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Dr. Mustafa</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
1 Blewitt, J. (2014). Understanding Sustainable Development, Second Edition. Routledge, Abingdon. ISBN: 9780415707824.
2 Dresner, S. (2008). The Principles of Sustainability, Second Edition. Earthscan, London. ISBN: 9781840074969.
3 Sustainability - A Comprehensive Foundation by Heriberto Cabezas, (Open Access TextBook) , 2019</td></tr>
<tr><td>5. Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course introduces the scientific and applied foundations of environment and sustainability, with emphasis on energy–environment linkages and the Saudi context. Students study global and local environmental challenges, climate change, resource use, and sustainable development, and apply quantitative metrics, simple models, and decision tools to assess environmental risk, sustainability performance, and policy options. Through case studies, problem-solving, and a structured mini-project, students evaluate sustainable infrastructure and policies in the Kingdom, integrating ethical, cultural, and public health dimensions.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Required</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="3">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Explain the scientific principles underlying climate change, biosphere processes, and physical resource cycles, and relate them to global and local sustainability challenges.
PLO 2 Formulate sustainability-related research or policy questions, select appropriate qualitative and quantitative methods, and analyze data or literature to draw evidence-based conclusions.
PLO 4 Apply quantitative indicators and basic analytical methods (e.g., emission factors, footprint metrics, simple cost–benefit concepts) to evaluate environmental and economic aspects of alternative solutions.
PLO 5 Assess environmental policies and infrastructure options by integrating sustainability principles, Saudi regulatory frameworks, societal needs, and public health considerations.</td></tr>
</table>

	PLO 6 **Use** sustainability metrics and digital tools (e.g., spreadsheets, basic data analysis software) to **quantify** indicators such as carbon footprint, water footprint, and resource efficiency for simple systems. PLO 8 **Work effectively in teams** to develop and present a sustainability-focused policy brief or project concept, demonstrating leadership, collaboration, and professional behavior. PLO 10 **Reflect critically** on the ethical, cultural, and historical dimensions of sustainability and articulate a personal plan for continued learning and professional development in environmental sustainability.
7. Brief list of topics to be covered	see table below

No	List of Topics	Contact Hours
1.	Introduction to Sustainability: Humanity and the Environment.	6
2.	Climate and Global Change	4
3.	Biosphere	4
4.	Physical Resources: Water, Pollution, and Minerals	4
5.	Environmental and Resource Economics	5
6	Modern Environmental Management	4
7	Sustainable Energy Systems	6
8	Problem-Solving, Metrics, and Tools for Sustainability	4
9.	Sustainability: Ethics, Culture, and History	4
10	Sustainable Infrastructure, The Evolution of Environmental Policy in the KSA	4
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7163-ME-3	**Course Name**	Advanced Heat Transfer
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	1/1		
3. Course Instructor	Prof.Dr.Irfan Anjum Magami		
4. Textbook, title, author, and year	**Textbook:** 1. Johannes Wurm, Matthias Fitl, Michael Gumpesberger, EsaVäisänen, Christoph Hochenauer "Advanced heat transfer analysis of continuously variable transmissions (CVT)" Applied Thermal Engineering 114 (2017). 2. Heat and Mass Transfer: Fundamentals &Applications,5th Edition by Yunus A. Çengel, Afshin J. Ghajar (McGraw-Hill, 2015), ISBN: 978-0-07-339818-1 3. Heat Transfer - 10th Edition by J. P. Holman (McGraw-Hill,2010), ISBN -0073529362 4. Incropera, F. De Witt, D. , P., “Introduction to Heat Transfer”, John – Wileyand Sons, 2006. Amir Faghri, Yuwen Zhang, John R. Howell, “Advanced heat and mass transfer”, Global Digital Press, 2010.		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This graduate course provides an advanced treatment of heat transfer, emphasizing rigorous mathematical formulation and solution of conduction, convection, and radiation problems relevant to modern energy and thermal systems. Starting from first principles, students derive and apply governing differential equations, boundary and initial conditions, and dimensionless groups to analyze steady and transient heat and mass transfer in 1D/2D/3D configurations. The course integrates analytical methods, numerical/computational techniques, and boundary-layer theory, and extends to phase-change phenomena and radiation exchange. Emphasis is placed on using advanced tools and modeling approaches to design and evaluate thermo-fluid components and systems in realistic engineering applications.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Required	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes

6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Formulate** the governing differential equations and appropriate boundary/initial conditions for multidimensional, steady and unsteady conduction, convection, and radiation problems in engineering systems. PLO 2 **Develop advanced problem-solving strategies** to design, and critically evaluate engineering systems dominated by heat and mass transfer processes**.** PLO 3 **Apply** analytical and numerical solution techniques (e.g., separation of variables, similarity solutions, finite-difference/finite-volume methods) to **solve and interpret** advanced heat and mass transfer problems. PLO 4 **Analyze and evaluate** the thermal performance of components and systems (e.g., boundary-layer flows, boiling/condensation surfaces, heat exchangers) using dimensionless parameters, empirical correlations, and quantitative design criteria. PLO 6 **Use** advanced computational tools (e.g., MATLAB/Python, CFD or heat transfer solvers) to **model, simulate, and post-process** thermo-fluid problems, assessing mesh independence, convergence, and basic uncertainty.

7. Brief list of topics to be covered

No	List of Topics	Contact Hours
1.	Introduction And Basic Concepts, Application Areas of Heat Transfer, Specific Heats of Gases, Liquids, and Solids, Heat Transfer Mechanisms	3
2.	Steady state and transient conduction, convection, and radiation heat transfer.	6
3.	Advanced computational and analytical techniques for conduction, convection, and radiation.	6
4.	External and internal fluid flow.	3
5.	Free, forced, and mixed convection; Phase change heat transfer, including boiling and condensation	3
6.	Laminar and turbulent convection heat transfer; Boundary layer theory	6
7.	Radiation heat transfer.	6
8.	Mass transfer in laminar and turbulent flow	6
9.	Cooling of electronic equipment	3
10.	Design of engineering systems involving thermo-fluid phenomena.	3
Total		45

8. Any other information

Course Assessment*

Activity	Assessment% (Marks)
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)

	Final Exam Total	30% (30 Marks) 100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7164-ME-3	**Course Name**	Solar Energy
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	1/1		
3. Course Instructor	Dr. Talal		
4. Textbook, title, author, and year	**Textbook:** 1. Solar Energy Engineering, Soteris A. Kalogirou, 2 Edition, Academic Press (2013), ISBN: 9780123972705 **a. Other supplemental materials:** • Dunlop, James P. Photovoltaic systems. Amer Technical Pub, 2012. ISBN: 9781935941057. • Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, New York, Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2013. ISBN: 9780470873663 • Tiwari, Gopal Nath, et al. Handbook of solar energy: theory, analysis and applications. Springer Science Busines Media, 2016. ISBN: 978-981-10-0807-8. • Smets, Arno H. M., et al. Solar energy: the physics and engineering of photovoltaic conversion, technologies and systems. UIT Cambridge Ltd., 2016. ISBN: 978-1906860325		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course provides a rigorous introduction to solar energy conversion with emphasis on photovoltaic (PV) electricity generation and thermal applications. Students develop the ability to quantify solar resource availability, understand solar radiation geometry, and calculate irradiance on arbitrarily oriented surfaces. The course covers PV cell physics, I–V characteristics, PV module and array design, thermal behavior of solar components, and performance modeling of flat-plate collectors and basic solar systems. Analytical methods and simple computational tools are used to design and evaluate solar systems for different applications under realistic operating conditions.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Required	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes

<table>
<tr><td>6. Specific goals for the course</td><td>a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Calculate extraterrestrial and terrestrial solar irradiance on horizontal and arbitrarily tilted surfaces using solar geometry relationships and basic radiation models.
PLO 2 Design and size basic PV and solar thermal systems for specified loads and operating conditions, performing performance estimations and parametric studies to meet given technical requirements.
PLO 3 Analyze the operation of a solar cell and PV module by using equivalent circuit models to determine I–V and P–V characteristics under varying irradiance and temperature.
PLO 4 Evaluate the optical interaction of solar radiation with opaque and transparent materials by calculating absorption, reflection, and transmission energy rates, and relating them to system performance.
PLO 6 Identify and quantify the dominant heat transfer modes (conduction, convection, radiation) in solar collectors or PV modules and apply flat-plate collector and simple thermal models to predict temperature and efficiency.</td></tr>
<tr><td>7. Brief list of topics to be covered</td><td>
<table>
<tr><th>No</th><th>List of Topics</th><th>Contact Hours</th></tr>
<tr><td>1.</td><td>Source of radiation, solar constant, solar charts, measurement of diffuse, global and direct solar radiation</td><td>3</td></tr>
<tr><td>2.</td><td>Pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder</td><td>6</td></tr>
<tr><td>3.</td><td>Solar Non-Concentrating Collectors- Design considerations – Classification air, liquid heating collectors.</td><td>6</td></tr>
<tr><td>4.</td><td>Derivation of efficiency and testing of flat plate collectors –Analysis of concentric tube collector - Solar green house.</td><td>3</td></tr>
<tr><td>5.</td><td>Design – Classification– Concentrator mounting –Focusing solar concentrators Heliostats.</td><td>6</td></tr>
<tr><td>6.</td><td>Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker.</td><td>6</td></tr>
<tr><td>7.</td><td>Photo-voltaic cell – characteristics-cell arrays-power electric circuits for output of solar panels.</td><td>6</td></tr>
<tr><td>8.</td><td>Choppers-inverters-batteries-charge regulators, Construction concepts, Solar ponds.</td><td>6</td></tr>
<tr><td>9.</td><td>Energy Storage -Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber’s salt-organic compounds.</td><td>3</td></tr>
<tr><td colspan="2">Total</td><td>45</td></tr>
</table>
</td></tr>
<tr><td>8. Any other information</td><td>Course Assessment*</td></tr>
<tr><td></td><td>
<table>
<tr><th>Activity</th><th>Assessment% (Marks)</th></tr>
<tr><td>Mid Exams (Mandatory)</td><td>40% (40 Marks)</td></tr>
<tr><td>Quiz (Blackboard)</td><td>15% (15 Marks)</td></tr>
<tr><td>Project/Assignment/ Reports</td><td>15% (15 Marks)</td></tr>
</table>
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	Final Exam Total	30% (30 Marks) 100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7165-ME-3	**Course Name**	Energy Efficiency
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	3/2		
3. Course Instructor	Dr. Ali Anqi		
4. Textbook, title, author, and year	**Textbook:** 1. Energy Management Principles (Second Edition) , Applications, Benefits, Savings, Craig B. Smith and Kelly E. Parmenter ,ISBN: 978-0-12-802506-2 **a. Other supplemental materials:** Guide to Energy Management, Seventh Edition 7th Edition by Barney L. Capehart Ph.D. CEM , Wayne C. Turner Ph.D. PE CEM , William J. Kennedy Ph.D. PE		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the concepts, methods, and quantitative tools needed to analyze and improve energy efficiency in buildings, industry, and energy systems. Students review different forms of energy and energy conversion processes, then learn how to model energy flows, identify losses, and evaluate conservation options. Emphasis is placed on energy management, energy auditing, cost–effectiveness analysis, and environmental impacts of energy use, including pollutants and greenhouse gas emissions. The course also addresses materials and technologies for energy conservation and storage, equipping students to propose and assess efficiency measures within technical, economic, and sustainability constraints.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes
6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Explain** the main types of energy resources, energy conversion processes, and typical end-use sectors, and relate them to opportunities for improving energy efficiency. PLO 3 **Develop** simple energy balance and end-use models for buildings or industrial systems, identifying major losses and potential efficiency improvements using a systems-thinking approach. PLO 4 **Apply** quantitative methods and economic measures (e.g., payback period, net savings, cost of conserved energy) to **evaluate** the cost-effectiveness of alternative energy efficiency and conservation options.		

	PLO 5 **Assess** the environmental implications of different energy efficiency measures, including changes in fuel use, emissions, and pollutants, in the context of sustainability and relevant regulations. PLO 6 **Use** basic analytical and digital tools (e.g., spreadsheets, simple simulation or auditing tools) to process energy-use data, calculate performance indicators (e.g., energy intensity, savings potential), and compare materials and technologies for energy conservation and storage.
7. Brief list of topics to be covered	see table below
8. Any other information	**Course Assessment***

No	List of Topics	Contact Hours
1.	Introduction to Energy and Energy Efficiency	3
2.	System analysis	6
3.	Systems thinking and Energy Systems	6
4.	Methods for evaluation of large and complex energy systems and Energy system modeling.	6
5.	Understanding about Energy and user behavior	6
6.	Energy Economics	6
7.	Energy portfolio sustainability management	6
8.	Business logics in modern energy systems	6
Total		45

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7166-ME-3</td><td>Course Name</td><td>Numerical Methods</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Prof. Dr. Irfan Anjum Magami</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
Steven Chapra and Raymond Canale , Numerical Methods for Engineers, 8th Edition, 2021, McGraw Hill
ISBN10:1260232077 ISBN13:9781260232073
a. Other supplemental materials:
1. Amos Gilat, Vish Subramaniam Numerical Methods for Engineers and Scientists, 3rd Edition, Wily, 2013, ISBN: 978-1-118-55493-7</td></tr>
<tr><td>1 Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course develops the mathematical and computational foundations of numerical methods for solving engineering and scientific problems. Students learn how to formulate mathematical models (algebraic equations, ODEs, PDEs) and apply appropriate numerical techniques for root-finding, linear systems, interpolation, regression, numerical differentiation and integration, and solution of initial- and boundary-value problems. Emphasis is placed on error analysis, stability and convergence, and the practical implementation of algorithms using programming tools (e.g., MATLAB/Python). Students interpret and validate numerical results, compare methods, and document their work in a professional technical format.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>2 Specific goals for the course</td><td colspan="3">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Explain the theoretical basis, assumptions, and limitations of key numerical methods (for roots, linear systems, interpolation, integration, differentiation, and differential equations) used in engineering analysis.
PLO 2 Formulate engineering and scientific problems into appropriate mathematical models (algebraic systems, ODEs, simple PDEs) and select suitable numerical methods for their solution.
PLO 3 Implement and apply numerical algorithms (e.g., bracketing and open methods, direct and iterative linear solvers, Runge–Kutta, finite-difference schemes) using programming/software tools, and analyze truncation and round-off errors.
PLO 6 Use computational tools (e.g., MATLAB/Python or equivalent) to code, test, and debug numerical methods; generate tables and plots; and perform</td></tr>
</table>

	basic parametric and convergence studies. PLO 7 **Prepare** clear, well-structured technical reports or lab assignments that document problem formulation, numerical approach, code structure, results, error analysis, and interpretation, demonstrating professional and reflective practice in numerical computation.
3 Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Modeling, Computers, and Error Analysis: Mathematical Modeling and Engineering Problem Solving, Programming and Software, Approximations and Round-Off Errors, Truncation Errors, and the Taylor Series.	3
2.	Roots of Equations: Bracketing Methods, Open Methods, Roots of Polynomials	6
3.	Linear Algebraic Equations: Gaussian Elimination, LU Decomposition, and Matrix Inversion, Special Matrices and Gauss-Seidel iteration methods	6
4.	Curve Fitting: Least-Squares Regression, Interpolation, Fourier Approximation	6
5.	Numerical Differentiation and Integration: Newton-Cotes Integration Formulas, Integration of Equations, Numerical Differentiation	6
6.	Ordinary Differential Equations: Runge-Kutta Methods, Stiffness, and Multistep Methods, Boundary-Value and Eigenvalue Problems	6
7.	Partial Differential Equations: Finite Difference for Elliptic Equations, Finite Difference for Parabolic Equations, Finite volume method.	6
8.	Matlab Programming as a tool for Numerical Methods	6
	Total	45

4 Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7168-ME-3</td><td>Course Name</td><td>Photovoltaic Energy Systems</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Dr. Sultan Al-Shehri</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
1. Chetan Singh Solanki., Solar Photovoltaic: “Fundamentals, Technologies and Application”,3 rded.,PHI Learning Pvt., Ltd., 2017
a. Other supplemental materials:
• Messenger, Roger, and Amir Abtahi. Photovoltaic systems engineering. CRC press, 2017. ISBN : 9781439802922
• Smets, Arno H. M., et al. Solar energy: the physics and engineering of photovoltaic conversion, technologies and systems. UIT Cambridge Ltd., 2016. ISBN: 978-1906860325
• Mukerjee, A. K., and Nivedita Thakur. Photovoltaic systems: analysis and design. PHI Learning, 2014. ISBN: 978-8120340174
• Balfour, John, et al. Introduction to photovoltaic system design. Jones & Bartlett Learning, 2013. ISBN: 978-1409624675</td></tr>
<tr><td>5. Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course provides an applied and quantitative study of photovoltaic (PV) energy systems, with emphasis on stand-alone configurations. Students learn solar geometry, resource assessment, and PV device behavior, then use mathematical models to estimate irradiance on tilted surfaces, predict PV energy yield, and size system components. The course covers PV module characteristics, balance-of-system (BOS) components (batteries, charge controllers, inverters, wiring, protection), and design of stand-alone PV systems under technical, economic, and regulatory constraints. Students apply analytical and digital tools to design, model, and evaluate PV systems, including cost and performance calculations and consideration of relevant codes and safety practices.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
</table>

6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Determine** solar position, incidence angle, and irradiance on horizontal and tilted surfaces using solar geometry relationships, and use these to estimate available solar resource at a given site. PLO 2 **Formulate** a structured design procedure for a stand-alone PV system (including load assessment, resource analysis, and component selection), and **justify** key design assumptions and constraints. PLO 3 **Apply** mathematical and equivalent-circuit models of PV modules and arrays to calculate I–V/P–V characteristics, operating points, and expected energy yield under varying irradiance and temperature. PLO 4 **Evaluate** the performance and economic viability of PV systems by calculating indicators such as array sizing margins, battery autonomy, system efficiency, and simple cost metrics (e.g., cost per kWh, payback period). PLO 6 **Use** digital tools (e.g., spreadsheets, MATLAB/Python, or PV sizing software) to model, size, and analyze PV systems, including parametric studies on array size, storage capacity, and load profiles.
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	The Solar Resource : solar spectrum, sun position, sun path diagrams, solar and clock times, clear sky insolation on a collecting surface, solar radiation measurements, resource of solar data.	3
2.	Photovoltaic Materials and Electrical Characteristics : semiconductor physics, generic PV cell circuit model, modules and arrays, I-V curves, impact of temperature, shading impacts, crystalline silicon technologies	6
3.	Thin-film PV. array cell, p-n junction, structure, I-V characteristics of a PV module, maximum power point.	6
4.	Grid-Connected PV Systems : I-V Curves of simple loads and batteries, interfacing with the utility, system sizing, economic considerations.	6
5.	Stand-Alone PV Systems : load estimation, batteries and their properties, array and battery sizing.	6
6.	Hybrid-PV systems, case study of PV powered water pumping.	6
7.	Mechanical Considerations: material properties, mechanical system requirements, design and installation guidelines, forces acting on PV arrays, array mounting systems design mechanical load and stress.	6
8.	Forces acting on PV arrays, array mounting systems design mechanical load and stress.	3
9.	Codes and standards Related to PV Systems: National Electric Code (NEC) and IEEE Standard 1547.	3
Total		45

8. Any other information	**Course Assessment***	
	Activity	**Assessment%**

	Mid Exams (Mandatory) Quiz (Blackboard) Project/Assignment/ Reports Final Exam Total	**(Marks)** 40% (40 Marks) 15% (15 Marks) 15% (15 Marks) 30% (30 Marks) 100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7169-ME-3</td><td>Course Name</td><td>Geothermal Energy</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Dr. Saleel</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
1. Geothermal Energy Systems: Exploration, Development, and Utilization. Ernst Huenges (Editor), Patrick Ledru (Editor). ISBN: 978-3-527-64061-2. August 2011
2. Geothermal Energy: Sustainable Heating and Cooling Using the Ground, Editor(s):Marc A. Rosen, Seama Koohi-Fayegh, 2016 Print ISBN:9781119180982 |Online ISBN:9781119181002 |DOI:10.1002/9781119181002 © 2017 John Wiley & Sons, Ltd.
3. Geothermal Energy: From Theoretical Models to Exploration and Development. Stober, Ingrid, and Kurt Bucher. Springer, 2013a. Other supplemental materials:
4. Sheldon, P. (2005) Earth's Physical Resources: An Introduction (Book 1 of S278 Earth's Physical Resources: Origin, Use and Environmental Impact), The Open University, Milton Keynes
5. Smith, S. (2005) Water: The Vital Resource (Book 3 of S278 Earth's Physical Resources: Origin, Use and Environmental Impact), The Open University, Milton Keynes</td></tr>
<tr><td>5. Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course provides a scientific and applied introduction to geothermal energy and its use for heating, cooling, and power generation. Students examine geothermal resources, ground temperature profiles, and heat transfer in soils and rocks, and learn how ground-source heat pumps and other geothermal systems are designed and operated. Emphasis is placed on simple mathematical modeling of heat extraction/injection, estimation of energy output and system efficiency, and assessment of environmental and economic performance. The course also addresses thermal energy storage, site suitability, and the opportunities and limitations of geothermal energy deployment in different contexts.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
</table>

6. Specific goals for the course

a. Specific outcomes of instruction

By the completion of the course the student should be able to:

PLO 1 **Explain** geothermal resource types (hydrothermal, enhanced geothermal, shallow ground) and their main applications in heating, cooling, and power generation, using appropriate scientific and engineering terminology.

PLO 3 **Apply** basic heat transfer and thermodynamic relationships (e.g., ground temperature profiles, ($Q = \dot{m} c_p \Delta T$)) to **analyze** the performance of simple geothermal systems such as ground-source heat pumps.

PLO 4 **Evaluate** the technical and economic performance of geothermal systems by calculating indicators such as heat extraction rate, coefficient of performance (COP), seasonal performance factors, and simple cost metrics (e.g., cost per kWh).

PLO 5 **Assess** the environmental and societal implications of geothermal projects—such as land use, subsidence, induced seismicity, emissions, and groundwater impacts—using quantitative and qualitative sustainability criteria.

PLO 10 **Investigate and summarize** recent developments, standards, or case studies in geothermal energy, reflecting on knowledge gaps, future research needs, and personal learning goals related to sustainable geothermal utilization.

7. Brief list of topics to be covered

No	List of Topics	Contact Hours
1.	**Introduction to Geothermal Energy:** thermal structure of the earth, history of geothermal energy use, geothermal energy resources, applications of geothermal energy, fundamentals of thermodynamics, heat transfer, and fluid mechanics that are related to geothermal energy systems.	6
2.	**Background and Technologies**: components of geothermal energy systems such as heat pumps, heat exchangers, heating, ventilating, and air conditioning (HVAC) equipment and energy storage units.	6
3.	**Underground Thermal Energy Storage:** Common types of underground TES are described: soil and earth bed; borehole; aquifer; rock cavern; container/tank; and solar pond.	6
4.	**Geothermal Heating and Cooling:** heating in winter and cooling in summer, in partial or full manners. Geothermal energy as a heat source for electricity generation and heating.	9
5.	**Geothermal Well Systems**: Hydrothermal Systems, Geothermal Doublets, Enhanced-Geothermal-Systems, Hot-Dry-Rock Systems, Deep-Heat-Mining, Drilling Techniques for Deep Wellbores, Geophysical Methods, Exploration and Analysis.	6
6.	**Renewability and Sustainability of Geothermal Energy Systems:** Role of geothermal energy systems to play as a contributor to sustainable development.	6

	7.	**Environmental Issues Related to Deep Geothermal Systems:** Advantages and disadvantages, limitations, worldwide status of geothermal resource utilization	6
		Total	45
8. Any other information	**Course Assessment***		

	Activity	Assessment% (Marks)
	Mid Exams (Mandatory)	40% (40 Marks)
	Quiz (Blackboard)	15% (15 Marks)
	Project/Assignment/ Reports	15% (15 Marks)
	Final Exam	30% (30 Marks)
	Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7170-ME-3	**Course Name**	Advanced Fluid Mechanics
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	2/1		
3. Course Instructor	Dr. Saleel		
4. Textbook, title, author, and year	**Textbook:** 1. Applied Fluid Mechanics (7th Edition) by Robert L. Mott, Joseph A. Untener (Pearson,2014), ISBN -0132558920 **a. Other supplemental materials:** 1. Advanced Engineering Fluid Mechanics, Muralidhar K and Biswas G, Narosa, Latest Edition. ISBN: 978-81-8487-385-6 2. Introduction to Fluid Mechanics, Robert F. W and McDonald T. A, John Wiley & Sons, Latest Edition. ISBN: 978-1-119-60376-4		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This graduate course provides an advanced treatment of fluid mechanics with emphasis on rigorous mathematical formulation and solution of fluid flow problems relevant to engineering applications. Students derive and manipulate the Navier–Stokes equations, apply them to internal and external flows, and analyze laminar, turbulent, steady, and unsteady regimes. Topics include boundary-layer theory, potential flow, turbulence modeling, and transient phenomena such as water hammer. Analytical methods, similarity solutions, and introductory numerical approaches are used to obtain velocity, pressure, and shear-stress distributions. The course strengthens students' ability to model, analyze, and interpret complex fluid flows using fundamental principles and modern computational tools.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes
6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Formulate** the governing equations of fluid motion (continuity and Navier–Stokes equations) in differential and integral forms, and **identify** appropriate simplifications for incompressible, steady, and fully developed flows. PLO 2 **Analyze** external and internal flows using boundary-layer theory and potential-flow methods, including the use of similarity solutions and		

<table>
<tr><td></td><td>superposition of elementary potential flows to predict velocity fields and pressure distributions.
PLO 3 Apply the Navier–Stokes equations and boundary conditions to obtain velocity, pressure, and shear-stress distributions for canonical internal flows (e.g., flow between parallel plates, pipe flow, annular flow) and validate results using dimensionless analysis.
PLO 4 Evaluate turbulent flows and transient phenomena (e.g., pipe turbulence, basic turbulence models, and water hammer) by using empirical correlations, simplified governing equations, and dimensionless parameters (e.g., Reynolds, friction factor) to estimate key flow quantities.
PLO 6 Use computational and analytical tools (e.g., MATLAB/Python or CFD/fluids solvers) to implement numerical solutions of selected fluid-flow problems, perform parametric and convergence studies, and present results clearly in technical formats (plots, tables, brief reports).</td></tr>
<tr><td>7. Brief list of topics to be covered</td><td>
<table>
<tr><th>No</th><th>List of Topics</th><th>Contact Hours</th></tr>
<tr><td>1.</td><td>Basic concepts and fundamentals (Definition and properties of fluids, Path Lines, Streamlines, and Stream Functions, Langragian and Eulerian description, Vorticity and Circulation.</td><td>6</td></tr>
<tr><td>2.</td><td>Governing Equations of Fluid Motion (Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation).</td><td>6</td></tr>
<tr><td>3.</td><td>Navier Stokes Equations (in Cartesian, cylindrical, and spherical coordinates, Couette flow, in pipes, between two plates)</td><td>6</td></tr>
<tr><td>4.</td><td>Potential flow (Vorticity and circulation, Irrotational flow , source flow, sink flow, free vortex flow, superimposed flow patterns, source and sink pair, Doublet, flow over circular cylinder, source and sink pair in a uniform flow).</td><td>9</td></tr>
<tr><td>5.</td><td>Boundary layer (Exact and approximate solution of laminar boundary layer, Turbulent boundary layer (approximate solution using 1/7 power velocity profile, pressure gradient in boundary layer flow, boundary layer separation and its control).</td><td>6</td></tr>
<tr><td>6.</td><td>Unsteady flow (discharge with varying head, unsteady flow in pipes, variation of pressure wave in pipes (water hammer), surge tank).</td><td>6</td></tr>
<tr><td>7.</td><td>Turbulent flow (Statistical Approach—One-Point Averaging, Zero-Equation Turbulent Models, One-Equation Turbulent Models, Two-Equation Turbulent Models, Stress-Equation Models, Equations of Motion in Fourier Space, Large Eddy Models)</td><td>6</td></tr>
<tr><td colspan="2">Total</td><td>45</td></tr>
</table>
</td></tr>
<tr><td>8. Any other</td><td>Course Assessment*</td></tr>
</table>

information		
	Activity Mid Exams (Mandatory) Quiz (Blackboard) Project/Assignment/ Reports Final Exam Total	**Assessment%** **(Marks)** 40% (40 Marks) 15% (15 Marks) 15% (15 Marks) 30% (30 Marks) 100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7171-ME-3</td><td>Course Name</td><td colspan="2">Wind Energy</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td colspan="2">3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="4">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="4">Dr. Sultan Alqahtani</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="4">Textbook:
1 James F. Manwell, Jon G. McGowan, Anthony L. Rogers, Wind Energy Explained: Theory, Design and Application, 2nd Edition,2010, Wiley ISBN: 978-0-470-01500-1

2 Wind Energy, Mathematical Problems in Engineering. 2013; DOI 10.1155/2013/759686</td></tr>
<tr><td>5. Specific course information</td><td colspan="4">a. Brief description of the content of the course (catalog description)
This course develops the fundamental principles and quantitative methods needed to analyze and design wind energy systems. Using thermodynamics, fluid mechanics, and basic mechanical and electrical engineering concepts, students study wind resource assessment, aerodynamics of horizontal-axis wind turbines, rotor and drivetrain performance, and electrical power generation from wind. Emphasis is placed on the momentum theory and Betz limit, blade element/momentum concepts, power curve analysis, and estimation of energy yield. Students perform calculations of wind statistics, turbine output, and simple economic indicators, and review current standards and practices in wind energy engineering.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="4">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="4">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td colspan="2">English</td></tr>
<tr><td>Hardware/software usage</td><td colspan="2">For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="4">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 6 Use digital tools (e.g., spreadsheets, MATLAB/Python, or wind-analysis software) to model wind speed distributions, generate turbine power curves, and perform parametric studies on key design variables (hub height, rotor diameter, turbine type).
PLO 7 Prepare and deliver clear, well-structured technical reports and/or presentations on wind resource assessment and wind turbine performance, using appropriate engineering language, figures, and quantitative evidence.
PLO 8 Work effectively in teams to plan and execute a mini wind-energy</td></tr>
</table>

	design or assessment project, coordinating tasks, managing time and responsibilities, and documenting group decisions and outcomes. PLO 9 **Recognize and discuss** professional, ethical, and safety considerations in wind energy projects, including land use, community impacts, wildlife interactions, and responsible reporting of performance and environmental data. PLO 10 **Critically review** current literature, standards, and best practices in wind energy, and **reflect** on the need for continual learning and professional development to keep pace with evolving technologies and regulations in the wind sector.
7. Brief list of topics to be covered	

No	List of Topics	Contact Hours
1.	Introduction.	6
2.	Types of wind turbines.	6
3.	Properties of wind near the surface of the earth.	6
4.	Theory of the amount of motion and mass survival.	6
5.	Limits of the power factor of turbines' horizontal axis	6
6.	Suction turbines and lifting turbines.	6
7.	Using a plant to increase the extracted capacity.	6
8.	Generating electricity.	3
	Total	45

8. Any other information

Course Assessment*

Activity	Assessment% (Marks)
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7172-ME-3	**Course Name**	Finite Element Method
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	2/1		
3. Course Instructor	Prof. Irfan Anjum Magami		
4. Textbook, title, author, and year	**Textbook:** 1. Finite element analysis: theory and application with ANSYS by Saeed Moaveni (4th Edition, Pearson Prentice Hall, 2015), ISBN 10: 0133840808 **a. Other supplemental materials:** Introduction to the Finite Element Method, Fourth Edition by J. N. Reddy, (McGraw-Hill Education, 2019), ISBN: 9781259861901		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the theory and application of the finite element method (FEM) for solving engineering and scientific problems involving complex geometries and boundary conditions. Students learn how to formulate governing differential equations in weak/variational form, construct element shape functions, derive element stiffness and load matrices, assemble global systems, apply boundary conditions, and interpret numerical results. The course focuses on 1D and 2D elements for structural, thermal, and simple fluid-flow problems, and emphasizes error estimation, mesh refinement, and the use of FEM software to analyze realistic engineering systems		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes
6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Explain and derive** the basic finite element formulations for 1D and 2D problems, including shape functions, element stiffness matrices, and load vectors, starting from governing differential equations. PLO 2 **Formulate** engineering problems (structural, thermal, and simple fluid-flow) in variational or weighted-residual form, and **select** suitable element types, interpolation orders, and boundary-condition representations. PLO 3 **Assemble and solve** global finite element systems for discretized models, apply appropriate boundary conditions, and **analyze** the influence of		

	mesh density, element type, and numerical integration on solution quality. PLO 6 **Use** FEM-related computational tools (e.g., MATLAB/Python scripts and/or commercial FEM software) to model, simulate, and post-process engineering problems, including contour plots, stress/temperature fields, and simple parametric studies.
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Introduction to the Finite Element Method	3
2.	Linear and Non-Linear Shape Functions	6
3.	Finite Element Formulations	6
4.	1-Dimensional Element	6
5.	2-Dimensional Element	6
6.	3-Dimensional Element	6
7.	FEM applied to Structural Problems	3
8.	FEM applied to Thermal Problems	3
9.	FEM applied to Fluid Flow Problems	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7173-ME-3	**Course Name**	Energy Conversion
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	2/1		
3. Course Instructor	Dr.Saad As-Shehrani		
4. Textbook, title, author, and year	**Textbook:** Frank Krieth and D. Yogi Goswami, editors. Handbook of Energy Efficiency and Renewable Energy. CRC Press, 2007 **a. Other supplemental materials:** Ahmed F. Ghoniem, Energy Conversion Engineering: Towards Low CO2 Power and Fuels New Edition, Cambridge University Press; New edition (January 13, 2022)		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the scientific principles and quantitative methods underlying energy conversion from primary sources into useful forms such as electricity, heat, and mechanical work. Students examine thermal, electrical, chemical, and nuclear energy, and study key conversion technologies including heat engines, power plants, fuel cells, batteries, and emerging energy systems (e.g., EVs, LNG vehicles, biofuels). Emphasis is placed on applying thermodynamics, basic electrochemistry, and simple performance models to estimate efficiencies, energy balances, and emissions, and to compare different energy conversion pathways for industrial and societal applications.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes
6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Differentiate and classify** major non-renewable and renewable energy sources, describing their primary characteristics, typical applications, and roles in industrialized society. PLO 3 **Apply** fundamental thermodynamic and electrochemical relationships (e.g., energy balance, efficiency) to **analyze** the operation and performance of heat engines, power plants, fuel cells, and batteries. PLO 4 **Calculate and compare** the efficiencies and specific energy outputs of different energy conversion pathways using quantitative performance metrics. PLO 5 **Assess** environmental and sustainability aspects of selected energy conversion technologies, including emissions, resource use, and lifecycle implications, in the context of national and global energy challenges.		

	PLO 6 **Use** basic analytical and digital tools (e.g., spreadsheets, simple simulation or plotting software) to construct energy flow diagrams, perform parametric efficiency studies, and visualize performance characteristics of energy conversion systems.
7. Brief list of topics to be covered	(see topics table below)
8. Any other information	**Course Assessment***

No	List of Topics	Contact Hours
1.	Introduction to Energy Conversion and Energy Resources	6
2.	Basic Thermodynamics for Energy Conversion Enthalpy, Heat Capacities, Reactions, Entropy, T-S, Other Types of Cycles	6
3.	Thermal Energy Conversion Systems	6
4.	Renewable Energy Conversion Overview	6
5.	Chemical-to-Thermal and Chemical-to-Electrical Conversion	6
6.	Electric Energy Conversion and Power Systems Context	3
7.	Advanced and Emerging Energy Conversion Technologies	3
8.	Environmental and Sustainability Assessment of Energy Conversion	3
9.	Economic considerations and Environmental issues of Energy Conversion	3
10	Integrative Analysis and Case Studies	3
Total		45

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7174-ME-3	**Course Name**	Energy Storage Systems
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	2/1		
3. Course Instructor	Dr. Saleel		
4. Textbook, title, author, and year	**Textbook:** Energy Storage: Fundamentals, Materials and Applications, Authors: Huggins, Robert, Springer International Publishing, 2016, Hardcover ISBN: 978-3-319-21238-8 **a. Other supplemental materials:** Engineering Energy Storage, OdneStokke Burheim,2017, Academic Press, eBook ISBN:9780128141014		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the scientific principles and engineering applications of energy storage technologies across thermal, mechanical, electrochemical, and hydrogen systems. Students study sensible heat, latent heat (phase change), thermochemical storage, flywheels, compressed air, and heat pumps, as well as electrochemical storage (batteries, redox flow batteries, supercapacitors) and hydrogen production, storage, and use. Emphasis is placed on quantitative performance analysis (energy density, power density, round trip efficiency, capacity, lifetime, and cost), and on evaluating technology suitability for different temperature ranges and applications, including transport. Case studies (e.g., Denmark) are used to assess the role of energy storage in low carbon energy systems and local contexts.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes

6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Explain** the operating principles and key performance metrics of major thermal, mechanical, electrochemical, and hydrogen-based energy storage technologies (e.g., flywheels, compressed air, PCMs, batteries, super capacitors, hydrogen). PLO 3 **Apply** thermodynamic and electrochemical relationships to **quantify** the capacity and performance of selected storage systems under specified operating conditions. PLO 4 **Compare and evaluate** alternative storage technologies for given applications using quantitative indicators such as energy/power density, efficiency, lifetime, and levelized cost of storage. PLO 5 **Assess** the environmental and sustainability implications of different storage options, including life-cycle considerations, resource use, emissions, and their role in enabling high shares of renewables in local and international case studies. PLO 9 **Discuss professional and ethical aspects** related to large-scale deployment of energy storage and reflect on responsible engineering decisions in storage technology selection and implementation.
7. Brief list of topics to be covered	(see table below)
8. Any other	**Course Assessment***

No	List of Topics	Contact Hours
1.	Introduction.	6
2.	Thermal and Mechanical energy: flywheels, compressed air, heat pumps, vacuum solar thermal collector	6
3.	Thermal and Mechanical energy: thermo-chemical for application at different temperatures.	6
4.	Thermal and Mechanical energy: phase change materials for application at different temperatures.	6
5.	Electrochemical: Introduces students to the fundamental aspects of electrochemistry in order to differentiate between various types of batteries	3
6.	Electrochemical: to understand the working principles of flow redox batteries and supercapacitors.	3
7.	Electrochemical: to understand the working principles of supercapacitors.	3
8.	Hydrogen: Describes the advantages and limitations of hydrogen	3
9.	Hydrogen: Describes the roles of hydrogen in today’s economy and in the future.	3
10	Hydrogen: describe the technologies for the production, storage and use of hydrogen. Finally the safety considerations are outlined.	3
11	Hydrogen: describe the safety considerations used for the production, storage and use of hydrogen	3
	Total	45

information		
	Activity Mid Exams (Mandatory) Quiz (Blackboard) Project/Assignment/ Reports Final Exam Total	**Assessment%** **(Marks)** 40% (40 Marks) 15% (15 Marks) 15% (15 Marks) 30% (30 Marks) 100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7175-ME-3</td><td>Course Name</td><td colspan="2">Electrical Systems Related To Renewable Energy</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td colspan="2">3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="4">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="4">Dr. Sultan Alqahtani</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="4">Textbook:
Electric Renewable Energy Systems. 1st Edition. Authors: Muhammad Rashid. eBook ISBN: 9780128006368. Paperback ISBN: 97801280404838
a. Other supplemental materials:
Aldo Da Rosa, Fundamentals of Renewable Energy Processes, Elsevier Academic Press, 2005</td></tr>
<tr><td>5. Specific course information</td><td colspan="4">a. Brief description of the content of the course (catalog description)
Learn about Sources of renewable energy, Fundamentals of wind, wave, Solar thermal and photovoltaic, Hydraulic energy Selection and sizing of systems components, Technology of renewable energies Management and evaluation of the profitability of renewable energy projects and companies Common electrical renewable generation schemes; interfacing renewable energy to existing grid-connected power, Electrical Equipment and Systems, Detailed consideration of photovoltaic inverter battery systems, Design aspects of renewable electrical energy systems, Integration of renewables into the grid.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="4">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="4">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td colspan="2">English</td></tr>
<tr><td>Hardware/software usage</td><td colspan="2">For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="4">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
CLO1.1 PLO 1.1 Identify the energy supply and demand, need for more energy
CLO1.2 PLO 1.2. Discuss the cost and environmental impact of various Renewable energy sources (hydro, solar, wind, tidal, waves)
CLO2.1 PLO 2.1 Construct power converter topologies for solar and wind.
CLO3.1 PLO 3.1 Choose power quality and safety code for solar and wind systems.</td></tr>
<tr><td>7. Brief list of topics to be</td><td colspan="4"><table><tr><th>No</th><th>List of Topics</th><th>Contact Hours</th></tr></table></td></tr>
</table>

covered	1.	Sources of renewable energy, Fundamentals of wind, Wave, Solar thermal and photovoltaic, Hydraulic energy, Electrical conversion system	6
	2.	Selection and sizing of systems components, Technology of renewable energies (solar, wind, hydroelectricity, Fuel cells, Geothermal), Management and evaluation of the profitability of renewable energy projects and companies	9
	3.	Common electrical renewable generation schemes; interfacing renewable energy to existing grid-connected power, single phase, three phase supply, circuits and power transformers.	6
	4.	Renewable energy Generators, and control, AC-DC converters, DC-DC converters, power transmissions and power systems.	6
	5.	Design aspects of renewable electrical energy systems: phases, fault analysis, flow study and system stability.	6
	6.	Control of photovoltaic technology: Power point tracking, PV characteristics, mode of operation of PV system	6
	7.	Integration of renewable energy systems into the grid: power generation, voltage control, power quality, regulations for connection.	6
		Total	45

8. Any other information	**Course Assessment***	
	Activity	**Assessment% (Marks)**
	Mid Exams (Mandatory)	40% (40 Marks)
	Quiz (Blackboard)	15% (15 Marks)
	Project/Assignment/ Reports	15% (15 Marks)
	Final Exam	30% (30 Marks)
	Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7176-ME-3</td><td>Course Name</td><td colspan="2">Energy Policy, Planning And Sustainable Development</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td colspan="2">3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="4">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="4">Dr.Ali Alqahtani</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="4">Textbook:
Understanding Energy and Energy Policy Dec 9, 2014 by Timothy F. Braun and Lisa M. Glidden
Energy Policy Analysis: A Conceptual Framework, Nov 15, 2012 by Michael S Hamilton
a. Other supplemental materials:
Energy Management Systems, Operation and Control of Electric Energy Transmission Systems Authors: Handschin, Edmund, Petroianu, Alexander, 1991</td></tr>
<tr><td>5. Specific course information</td><td colspan="4">a. Brief description of the content of the course (catalog description)
This course examines how energy policy, planning, and markets shape sustainable development at national and global levels. Students study the structure and operation of electricity and fuel markets, policy instruments (tariffs, subsidies, standards, carbon pricing), and regulatory frameworks for conventional and renewable energy. Emphasis is placed on quantitative evaluation of policy impacts using basic economic, environmental, and energy-system metrics (e.g., prices, costs, emissions, access, and reliability). Through case studies, students analyze the links between energy policy, economic development, environment, and social welfare, with particular reference to sustainable development goals.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="4">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="4">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td colspan="2">Language of instruction</td><td>English</td></tr>
<tr><td colspan="2">Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="4">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Explain key concepts in energy policy, planning, and energy markets, and relate them to national energy security, accessibility, and development objectives.
PLO 2 Formulate structured policy or planning questions (e.g., tariff reform, subsidy design, renewable targets) and design a simple quantitative framework to assess their impacts on stakeholders.
PLO 4 Apply basic economic and financial tools (e.g., levelized cost of energy,</td></tr>
</table>

	marginal cost curves, simple cost–benefit analysis) to **evaluate** alternative energy policy options and power-sector investments. PLO 5 **Assess** the environmental and social implications of energy policies (e.g., emissions, air quality, equity of access) using quantitative indicators and sustainability criteria, including alignment with SDGs and national strategies. PLO 6 **Use** publicly available data and digital tools (e.g., spreadsheets, simple modeling tools) to **analyze** energy consumption, prices, emissions, and policy scenarios, and summarize results in basic policy-analytical formats (tables, graphs, indicators).
7. Brief list of topics to be covered	see table below

No	List of Topics	Contact Hours
1.	Introduction.	3
2.	Energy policy and its importance	6
3.	Evaluation of sound energy policies	6
4.	Evaluation of energy policy on human life.	6
5.	Renewable energy policy	6
6.	Electricity markets and policies	6
7.	Why Economics Matters, Global Oil & Gas Markets	6
8.	Energy policy and sustainable development	3
9.	Energy policy and environment	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7177-ME-3	**Course Name**	Computational Fluid Dynamics
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	3/2		
3. Course Instructor	Dr. Ahamad Saleel		
4. Textbook, title, author, and year	**Textbook:** ▪ Sreenivas Jayanti, Computational Fluid Dynamics for Engineers and Scientists, Springer Netherlands, Hardcover ISBN 978-94-024-1215-4, 2018 ▪ Atul Sharma, Introduction to Computational Fluid Dynamics: Development, Application and Analysis, Print ISBN:9781119002994, Wiley, 2017 **a. Other supplemental materials:** ▪ JiyuanTu Guan HengYeoh Chaoqun Liu, Computational Fluid Dynamics, 3rd Edition, A Practical Approach, Elsevier, 2018 ▪ John F, Wendt, Computational Fluid Dynamics: An Introduction, Von Karman Institute Book, Springer; 3rd ed. 2009		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the theory and practice of Computational Fluid Dynamics (CFD) for simulating fluid flow and heat transfer in engineering systems. Students review the governing equations (conservation of mass, momentum, and energy), their discretization using finite-volume/finite-difference methods, and common spatial and temporal schemes. Emphasis is placed on grid generation, numerical stability and convergence, turbulence modeling, and verification and validation. Students “learn by doing” through programming simple CFD solvers and by using commercial software (e.g., ANSYS Fluent) to set up, run, and post-process simulations of practical problems, with attention to best practices and ethical use of CFD results.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes

6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Explain** the governing equations of fluid flow and heat transfer (continuity, Navier–Stokes, energy) and the principles of their discretization using finite-difference/finite-volume methods, including consistency, stability, and convergence concepts. PLO 3 **Implement and apply** basic CFD algorithms (e.g., 1D/2D diffusion and convection–diffusion solvers, SIMPLE-type pressure–velocity coupling) in a programming environment to solve benchmark problems and analyze numerical errors. PLO 6 **Use** commercial and/or open-source CFD tools (e.g., ANSYS Fluent, plus pre- and post-processors) to construct meshes, select turbulence and physical models, run simulations, and conduct parametric studies for engineering flows. PLO 7 **Prepare and present** concise technical reports on CFD case studies, clearly documenting problem definition, modeling assumptions, numerical setup, results, and comparisons with analytical/experimental data using appropriate figures and quantitative analyses. PLO 9 **Evaluate and reflect on** the reliability, limitations, and ethical use of CFD in engineering decision-making by applying verification and validation procedures and discussing model uncertainty, mesh quality, and responsible interpretation of results.
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Introduction: Governing differential equations; Nature of coordinates; Discretization methods – Four basic rules – Aspects of numerical dissipation and dispersion – Artificial viscosity - Control volume formulation	3
2.	Heat conduction problems; Steady and unsteady one-dimensional conduction – Multi-dimensional situations – Use of over relaxation and under relaxation – Geometric considerations and other coordinate systems – Source tern linearization – Irregular geometries.	9
3.	Convection and diffusion: Solution of steady, one-dimensional, and multi-dimensional problems – One-way coordinates and false diffusion – Vorticity based methods – Staggered grid - Pressure and velocity corrections	6
4.	The solution of Navier-Stokes equations for incompressible flows - SIMPLE and SIMPLER algorithms - Numerical methods for compressible flow equations – Solution of the transonic full potential equation –Unsteady transonic potential flow and Euler equations.	6
5.	Numerical methods for boundary layer type equations – Inverse methods, separated flows, and viscous-inviscid interaction – Methods for internal flows and application to free-shear flows	9
6.	Solving three-dimensional and unsteady boundary layers – Turbulent flow models and calculations –Modern	6

		developments in grid generation and finite-volume mesh generation	
	7.	Automatic grid generation for complex geometry problems – Unstructured meshes and adaptive grids – Introduction to modern CFD relevant to supercomputers and parallel processors	6
	Total		45
8. Any other information	**Course Assessment***		

	Activity	Assessment% (Marks)
	Mid Exams (Mandatory)	40% (40 Marks)
	Quiz (Blackboard)	15% (15 Marks)
	Project/Assignment/ Reports	15% (15 Marks)
	Final Exam	30% (30 Marks)
	Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7178-ME-3</td><td>Course Name</td><td colspan="2">Optimization of Energy Systems</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td colspan="2">3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="4">2/1</td></tr>
<tr><td>3. Course Instructor</td><td colspan="4">Dr. Ali Anqi</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="4">Textbook:
▪ Essentials of Thermal System Design and Optimization, Prof. C. Balaji, Aue Books, New Delhi in India and CRC Press in the rest of the world.
▪ Design and optimization of thermal systems, Y.Jaluria, Mc Graw Hill, 1998.</td></tr>
<tr><td>5. Specific course information</td><td colspan="4">a. Brief description of the content of the course (catalog description)
This course introduces the theory and practice of optimization for energy systems. Students learn how to formulate mono- and multi-objective engineering optimization problems, select and apply appropriate optimization algorithms, and couple optimizers with simulation models of energy systems. Emphasis is placed on mathematical problem formulation (decision variables, constraints, objectives), local vs. global optimization methods, multi-objective trade-off analysis, robustness under uncertainty, and surrogate modeling to reduce computational cost. Students use numerical tools to optimize the design and operation of representative energy systems and communicate their results in a professional technical format.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="4">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="4">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Required</td><td>Language of instruction</td><td colspan="2">English</td></tr>
<tr><td>Hardware/software usage</td><td colspan="2">For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="4">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 2 Formulate well-posed mono- and multi-objective optimization problems for energy systems by defining decision variables, objective functions, and equality/inequality constraints based on physical and economic models.
PLO 3 Apply appropriate optimization algorithms to solve linear and nonlinear engineering optimization problems, and interpret convergence behavior and solution quality.
PLO 4 Evaluate trade-offs between conflicting objectives (e.g., cost vs. efficiency vs. emissions) using multi-objective optimization concepts, Pareto</td></tr>
</table>

	fronts, and simple decision-making criteria. PLO 6 **Use** numerical and digital tools (e.g., MATLAB/Python, optimization libraries, and simulation software) to couple energy system models with optimizers, perform parametric and sensitivity analyses, and construct surrogate models to reduce computational cost. PLO 7 **Prepare and present** concise technical reports or presentations that describe the optimization problem, methods, assumptions, results (including graphs such as Pareto fronts), and conclusions, demonstrating clear technical communication and reflective discussion of limitations..
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Introduction to Optimization in Energy Systems	3
2.	Mathematical Formulation of Optimization Problems	6
3.	Unconstrained and Constrained Optimization Methods	6
4.	Local vs. Global Optimization Algorithms	6
5.	Multi-Objective Optimization and Trade-Off Analysis	6
6.	Handling Uncertainty and Robust Optimization (Introductory)	6
7.	Surrogate Modeling and Reduced-Order Models	3
8.	Simulation–Optimization Frameworks for Energy Systems	3
9.	Implementation Tools and Case Studies	3
10.	Mini-Project and Reporting	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7179-ME-3</td><td>Course Name</td><td colspan="2">Advanced Mathematics</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td colspan="2">3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="4">3/2</td></tr>
<tr><td>3. Course Instructor</td><td colspan="4">Dr. Irfan Anjum Magami</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="4">Textbook:
Erwin Kreyszig Advanced Engineering Mathematics 10th Edition, Wiley; 10th edition (August 16, 2011)
a. Other supplemental materials:
▪ Stephen Andrilli& David Hecker : Elementary Linear Algebra, Third Edition, Academic Press, 2003.
▪ W. W. Bell: Special Functions for Scientists and Engineers, Dover Publications, 2004.
▪ Sokolnikoff and Redheffer – Mathematics of Physics and Engineering. 2nd edition McGraw Hill,1967.
▪ Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill International</td></tr>
<tr><td>5. Specific course information</td><td colspan="4">a. Brief description of the content of the course (catalog description)
This course develops advanced mathematical tools required for modeling and solving engineering and physical problems. Topics include key concepts in linear algebra (vector spaces, matrices, eigenvalues/eigenvectors), classification and solution methods for second-order partial differential equations (wave, heat, and Laplace equations), and an introduction to tensor calculus for continuum mechanics and field theories. Emphasis is placed on formulating engineering problems as mathematical models, applying analytical solution techniques (e.g., separation of variables, Fourier series, eigen function expansions), and using symbolic/numerical software to support analysis and visualization.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="4">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="4">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td colspan="2">Language of instruction</td><td>English</td></tr>
<tr><td colspan="2">Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="4">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Explain core concepts of linear algebra (vector spaces, inner products, matrices, determinants, eigenvalues and eigenvectors) and their relevance to modeling and solving engineering problems.
PLO 2 Classify and formulate second-order partial differential equations (elliptic, parabolic, hyperbolic) from physical governing equations, and specify</td></tr>
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<table>
<tr><td></td><td>appropriate boundary and initial conditions.
PLO 3 Apply analytical methods such as separation of variables, Fourier series/eigenfunction expansions, and transform methods to solve canonical PDEs (wave, heat, Laplace) and interpret the solutions in an engineering context.
PLO 6 Use mathematical software (e.g., MATLAB, Python with NumPy/SciPy, or symbolic tools) to perform matrix computations, eigenvalue problems, series expansions, and to visualize PDE solutions (plots, contour maps).
PLO 7 Perform and document basic tensor calculus operations (index notation, tensor transformation rules, gradient/divergence in tensor form) in short technical assignments, demonstrating clear mathematical communication and professional presentation of derivations and results.</td></tr>
<tr><td>7. Brief list of topics to be covered</td><td>
<table>
<tr><th>No</th><th>List of Topics</th><th>Contact Hours</th></tr>
<tr><td>1.</td><td>Linear Algebra:Vector spaces, Basis, Dimension, Inner product spaces, Gram-Schmidth Process, Linear Transformations, Range and Kernel, Isomorphism, Matrix of transformations and Change of Basis.</td><td>11</td></tr>
<tr><td>2.</td><td>Series Solutions of ODE and Sturm-Liouville Theory: Power series solutions about ordinary point, Legendre equation and Legendre polynomials, Solutions about singular points; The method of Frobenius, Bessel equation and Bessel Functions. Sturm-Liouville problem and Generalized Fourier series.</td><td>11</td></tr>
<tr><td>3.</td><td>Partial Differential Equations: First order PDEs, Linear equations, Lagrange method, Cauchy method, Charpits method, Jacobi method. Second order PDEs, Classifications, Formulation and method of solutions of Wave equation, Heat equation and Laplace equation.</td><td>12</td></tr>
<tr><td>4.</td><td>Tensor Calculus: Line, area and volume integrals, Spaces of N-dimensions, coordinate transformations, covariant, contravariant and mixed tensors, fundamental operation with tensors, Quotient Law the line element and metric tensor, conjugate tensor, Christoffel's symbols, covariant derivative.</td><td>11</td></tr>
<tr><td colspan="2">Total</td><td>45</td></tr>
</table>
</td></tr>
<tr><td>8. Any other information</td><td>Course Assessment*</td></tr>
<tr><td></td><td>
<table>
<tr><th>Activity</th><th>Assessment% (Marks)</th></tr>
<tr><td>Mid Exams (Mandatory)</td><td>40% (40 Marks)</td></tr>
<tr><td>Quiz (Blackboard)</td><td>15% (15 Marks)</td></tr>
<tr><td>Project/Assignment/ Reports</td><td>15% (15 Marks)</td></tr>
<tr><td>Final Exam</td><td>30% (30 Marks)</td></tr>
<tr><td>Total</td><td>100% (100 Marks)</td></tr>
</table>
</td></tr>
</table>

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7180-ME-3</td><td>Course Name</td><td>Economic Aspects of Renewable Energy</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">4/2</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Dr. Ali Alqahtani</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
Kaltschmitt, Martin; Streicher, Wolfgang; Wiese, Andreas; (2007). Renewable Energy: Technology, Economics, and Environment. New York, NY. Springer BerlinHeidelberg
a. Other supplemental materials:
Komor, Paul, (2004). Renewable Energy Policy. Lincoln, NE. iUniverse, Inc.
Abdelhamid, Lilia; Bahmed, Lylia; Benoudjit, Azzeddine," Impact of renewable energies - environmental and economic aspects",Management of Environmental Quality; Bradford Vol. 23, Iss. 1, (2012).</td></tr>
<tr><td>5. Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course examines the economic, environmental, and policy dimensions of renewable energy systems. Students learn to quantify energy outputs and costs; apply financial and economic evaluation tools (e.g., levelized cost of energy, net present value); and compare renewable options with conventional energy systems. The course integrates basic energy principles, technology characteristics, environmental impacts, and risk/uncertainty into economic decision-making. Emphasis is placed on using data and simple models to evaluate, compare, and select renewable energy projects under technical, economic, regulatory, and sustainability constraints.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="3">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Explain fundamental energy and power concepts (e.g., capacity factor, efficiency, energy yield) and relate them to the technical and cost structure of major renewable energy technologies.
PLO 4 Apply financial and economic tools (e.g., cash-flow analysis, net present value, internal rate of return, levelized cost of energy) to evaluate and compare renewable and conventional energy projects.
PLO 5 Assess environmental and safety aspects of different renewable energy options by using quantitative indicators (e.g., emission factors, lifecycle impacts) and integrating them into technology comparison.</td></tr>
</table>

	PLO 6 **Use** data and digital tools (e.g., spreadsheets, basic analysis software) to process energy and cost data, construct simple project models, perform sensitivity analysis, and visualize economic and environmental results. PLO 9 **Discuss** ethical and professional responsibilities related to renewable energy investment decisions, including transparency in assumptions, treatment of externalities, intergenerational equity, and communication of uncertainties to stakeholders.
7. Brief list of topics to be covered	

No	List of Topics	Contact Hours
1.	Introduction: Overview of Economic Aspects of Renewable Energy systems	3
2.	Energy mathematics and basics for each type of renewable energy	6
3.	Economics and environmental factors of each type of energy	6
4.	Cost Components of Renewable Energy Systems	3
5.	Time Value of Money and Project Cash Flow Analysis	6
6.	Levelized Cost of Energy (LCOE) and Cost Indicators	6
7.	Economic and Policy Instruments for Renewables	3
8.	Environmental and Safety Aspects in Economic Evaluation	3
9	Technology Specific Economic Characteristics	3
10	Uncertainty and Sensitivity Analysis	3
11	Ethical and Professional Issues in Renewable Energy Economics	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7181-ME-3	**Course Name**	Energy Comfort in Buildings
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	3/2		
3. Course Instructor	Dr.Salem Algarni		
4. Textbook, title, author, and year	**Textbook:** Energy Efficient Buildings, ISBN 978 – 51- 2875 – 5, Publisher: In Tech, 2017 **a. Other supplemental materials:** List Essential References Materials (Journals, Reports, etc.) Chen, Olivia , 2008,"Bamboo – Veiled Dormitory by Architecture BRIO", Inhabitat, Retrieved 2009. -Journal of Energy Comfort in Buildings		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the principles and quantitative methods needed to analyze energy use and comfort in buildings. Students learn how to characterize building energy consumption, calculate thermal and electrical loads, and evaluate energy efficiency measures in HVAC and lighting systems. The course covers indoor thermal comfort concepts, building envelope performance, refrigeration and air-conditioning efficiency, lighting design, power factor, and basic economic analysis of energy use. Students use simple models and digital tools to estimate energy demand, optimize operating costs under different tariffs, and assess energy-saving options while maintaining occupant comfort.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes
6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Explain** key concepts in building energy use and thermal comfort (e.g., heat transfer through the envelope, indoor environmental parameters, HVAC and lighting performance indicators) and relate them to overall energy consumption in buildings. PLO 3 **Calculate** building thermal loads (heating and cooling) and key electrical parameters (e.g., power factor, demand) using simplified models (e.g., ($Q = U A \Delta T$), internal gains, ventilation loads) and load profiles. PLO 4 **Evaluate** energy efficiency measures in refrigeration, air-conditioning, and lighting systems by estimating changes in energy use, COP/EER, and lighting efficacy, and **compare** alternatives based on quantitative performance indicators.		

	PLO 6 **Use** spreadsheets or basic simulation tools to process building energy data, estimate annual energy consumption and cost under different tariffs, and perform simple optimization of operating schedules or setpoints for cost reduction. PLO 7 **Prepare** a concise technical report or presentation for a selected building or space, summarizing energy use, comfort conditions, proposed efficiency measures, and cost–saving estimates, with clear documentation of assumptions, calculations, and limitations.
7. Brief list of topics to be covered	(see table below)
8. Any other information	**Course Assessment***

No	List of Topics	Contact Hours
1.	Introduction to Energy Use and Comfort in Buildings	3
2.	Building Envelope and Heat Transfer.	6
3.	Thermal Load Estimation	6
4.	HVAC Systems, Refrigeration, and Energy Efficiency	6
5.	Lighting Systems and Energy Use.	6
6.	Electrical Demand, Power Factor, and Load Profiles.	6
7.	Economic loading and operation of generation units.	6
8.	Use energy saving policies and use high economic equipment's and improve heat transfer processes.	3
9.	Tools for Building Energy Assessment	3
Total		**45**

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7182-ME-3</td><td>Course Name</td><td>Environmental Pollution</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">4/2</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Dr. Yunus Tatagar</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
Friis, Robert H. Essentials of Environmental Health. Jones and Bartlett, Inc., Sudbury, MA. ISBN No. 0-7637-4762-9.
a. Other supplemental materials:
Hill, Marquita K., Understanding Environmental Pollution, 2nd Edition. Cambridge University Press, Cambridge, UK. ISBN No. 0-5218-2024-3</td></tr>
<tr><td>5. Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course introduces the scientific and engineering principles of environmental pollution, focusing on air, water, and soil contamination. Students examine sources and types of pollutants, transport and transformation processes, and dispersion mechanisms in the atmosphere and aquatic/terrestrial environments. Quantitative tools such as mass balances, simple dispersion models, and concentration–dose relationships are used to assess pollution levels and compare them with standards and guidelines. The course also reviews control technologies, remediation strategies, and relevant regulations, emphasizing environmental risk, public health, and professional responsibility in pollution prevention and control.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="3">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Classify and describe major pollutants in air, water, and soil, including their key properties, sources, and typical concentration ranges in environmental and industrial contexts.
PLO 4 Evaluate pollution levels by comparing calculated or measured concentrations with national and international standards/guidelines, and prioritize control measures based on risk and exceedance magnitude.
PLO 5 Assess the environmental and public health impacts of selected pollutants and recommend appropriate prevention, control, or remediation options, considering sustainability and regulatory frameworks.</td></tr>
</table>

	PLO 6 **Use** basic quantitative tools (e.g., mass balances, simple box/plug-flow models, mixing and dilution calculations) and published data to **estimate** pollutant concentrations and loads in environmental media. PLO 9 Discuss ethical and professional responsibilities in environmental pollution control, including accurate reporting of data, precaution in dealing with health risks, and the engineer's role in protecting communities and ecosystems.
7. Brief list of topics to be covered	

No	List of Topics	Contact Hours
1.	Introduction to Environmental Pollution and Environmental Media	3
2.	Types and Sources of Pollutants	6
3.	Mass Balance and Fate and Transport Concepts	6
4.	Air Pollution and Atmospheric Dispersion	6
5.	Water Pollution and Mixing	3
6.	Soil and Land Pollution	3
7.	Pollution Control Technologies and Strategies	6
8.	Environmental Regulations, Standards, and Guidelines	6
9.	Risk, Health, and Impact Assessment Basics	3
10.	Emerging Technologies and Pollution Prevention	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7183-ME-3	**Course Name**	Energy Management
2. Credit hours	3	**Contact hours**	3L = 3 per week
Level / Year	4/2		
3. Course Instructor	Dr.Saleel		
4. Textbook, title, author, and year	**Textbook:** Energy Management Principles (Second Edition) , Applications, Benefits, Savings, Craig B. Smith and Kelly E. Parmenter ,ISBN: 978-0-12-802506-2 **a. Other supplemental materials:** Guide to Energy Management, Seventh Edition 7th Edition by Barney L. Capehart Ph.D. CEM , Wayne C. Turner Ph.D. PE CEM , William J. Kennedy Ph.D. PE		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This course introduces the principles, methods, and quantitative tools of energy management in buildings, industry, and infrastructure. Students learn how to characterize energy use in systems, construct energy balances, identify losses, and propose conservation measures. Topics include energy resources and conversion processes, energy auditing, efficiency improvement technologies, materials and systems for energy conservation and storage, and the environmental impacts of energy use (pollutants and greenhouse gases). Emphasis is placed on using data, simple models, and economic analysis to evaluate the technical and financial viability of energy management options, while considering their societal and environmental implications.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Elective	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes
6. Specific goals for the course	**a. Specific outcomes of instruction** *By the completion of the course the student should be able to:* PLO 1 **Explain** major energy resources, conversion processes, and end-use sectors, and **identify** key opportunities for energy management and conservation. PLO 3 **Develop** simplified energy flow models and balances for buildings or industrial systems, using systems-thinking to locate major losses and prioritize efficiency opportunities. PLO 4 **Apply** quantitative and economic tools (e.g., payback period, net savings, cost of conserved energy) to **evaluate** the cost-effectiveness of		

	different energy management and conservation measures. PLO 5 **Assess** the environmental impacts of energy use and efficiency measures—such as changes in fuel consumption, emissions, and pollutants—and relate them to sustainability and regulatory requirements. PLO 7 **Prepare and present** an energy management plan or audit report for a selected facility, demonstrating clear technical communication, professional conduct, and reflection on ethical responsibilities in energy use and environmental protection.
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Introduction to Energy Management and Conservation	3
2.	Principles and Organization of Energy Management	6
3.	Energy Auditing Methods	6
4.	Methods for evaluation of large and complex energy systems and Energy system modeling.	6
5.	Understanding about Energy and user behavior	6
6.	Energy Economics	3
7.	Energy portfolio sustainability management	6
8.	Business logics in modern energy systems	3
9.	Environmental and Regulatory Aspects of Energy Management	3
10.	Integrated Energy Management Plan	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

<table>
<tr><td>1. Course Number</td><td>7184-ME-3</td><td>Course Name</td><td>Desalination</td></tr>
<tr><td>2. Credit hours</td><td>3</td><td>Contact hours</td><td>3L = 3 per week</td></tr>
<tr><td>Level / Year</td><td colspan="3">4/2</td></tr>
<tr><td>3. Course Instructor</td><td colspan="3">Dr.Ali Anqi</td></tr>
<tr><td>4. Textbook, title, author, and year</td><td colspan="3">Textbook:
• Advances in Water Desalination, Noam Lior, ISBN:9780470054598, John Wiley & Sons, Inc. 2013
• Introduction to Desalination Systems, Processes, and Environmental Impacts, Fuad Nesf Alasfour, ISBN: 9783527811618, Wiley-VCH, 2020
a. Other supplemental materials:
Emerging Technologies for Sustainable Desalination Handbook, Veera Gnaneswar Gude, Butterworth-Heinemann, ISBN 978-0-12-815818-0, 2018
Desalination Engineering: Operation and Maintenance, NikolayVoutchkov, McGraw-Hill Education, 2014</td></tr>
<tr><td>5. Specific course information</td><td colspan="3">a. Brief description of the content of the course (catalog description)
This course covers the theory and practice of major desalination technologies, including thermal processes (multistage flash, multiple-effect, vapor compression) and membrane processes (reverse osmosis, nanofiltration, membrane distillation). Students apply thermodynamics, mass and energy balances, and transport principles to model and evaluate desalination systems, estimate performance indicators (recovery ratio, specific energy consumption, gain output ratio), and perform basic economic comparisons. Environmental and sustainability aspects (brine management, energy use, integration with renewables) are also addressed, and simple computational tools are used for process calculations and performance analysis.</td></tr>
<tr><td>b. Prerequisites</td><td colspan="3">Nil</td></tr>
<tr><td>Co-requisites</td><td colspan="3">Nil</td></tr>
<tr><td rowspan="2">c. Required, Elective, or Selected elective</td><td rowspan="2">Elective</td><td>Language of instruction</td><td>English</td></tr>
<tr><td>Hardware/software usage</td><td>For Blackboard, online quizzes</td></tr>
<tr><td>6. Specific goals for the course</td><td colspan="3">a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Explain the principles of operation, process configurations, and key components of major desalination systems (MSF, MED, VC, RO, NF, membrane distillation) and their typical applications.
PLO 3 Apply mass and energy balances and basic thermodynamic relations (e.g., first and second law, enthalpy balances, osmotic pressure) to model and analyze the performance of selected thermal and membrane desalination</td></tr>
</table>

	processes. PLO 4 **Calculate and compare** key performance and economic indicators—such as recovery ratio, specific energy consumption, gain output ratio (GOR), and simple cost per m^3 of product water—for alternative desalination technologies. PLO 5 **Assess** the environmental and sustainability implications of desalination projects, including brine management, chemical use, and energy source choices (e.g., fossil vs. renewable), and relate them to relevant regulations and best practices. PLO 6 **Use** spreadsheets or process modeling tools to perform process calculations, parametric studies (e.g., effect of temperature, pressure, recovery), and simple optimization for selected desalination systems, presenting results in clear tabular and graphical form.
7. Brief list of topics to be covered	(see table below)

No	List of Topics	Contact Hours
1.	Need for desalination, Composition of seawater, classification of desalination systems	3
2.	Desalination using renewable energy Sources Solar stills	6
3.	Humidification dehumidification (HDH) systems	6
4.	Single effect evaporation, process modeling (single effect, vapor compression both thermal; TVC, and mechanical; MVC)	6
5.	Multiple effect evaporation, process modeling	6
6.	Mass and Energy Balances in Desalination Systems	6
7.	Process Design Parameters and Performance Metrics	3
8.	Reverse Osmosis	3
9.	Membrane Distillation	3
10	Economic Analysis	3
Total		45

8. Any other information

Course Assessment*

Activity	**Assessment% (Marks)**
Mid Exams (Mandatory)	40% (40 Marks)
Quiz (Blackboard)	15% (15 Marks)
Project/Assignment/ Reports	15% (15 Marks)
Final Exam	30% (30 Marks)
Total	100% (100 Marks)

Mechanical Engineering Department

COURSE DESCRIPTION

1. Course Number	7185-ME-3	**Course Name**	Project
2. Credit hours	6	**Contact hours**	6L = 6 per week
Level / Year	3-4/2		
3. Course Instructor	Depends on topic		
4. Textbook, title, author, and year	**Textbook:** Energy Management Principles (Second Edition) , Applications, Benefits, Savings, Craig B. Smith and Kelly E. Parmenter ,ISBN: 978-0-12-802506-2 **a. Other supplemental materials:** Guide to Energy Management, Seventh Edition 7th Edition by Barney L. Capehart Ph.D. CEM , Wayne C. Turner Ph.D. PE CEM , William J. Kennedy Ph.D. PE		
5. Specific course information	**a. Brief description of the content of the course (catalog description)** This capstone course requires students to plan and execute an independent research or design project in the field of renewable energy and environment. Under faculty supervision, students identify a research problem or design challenge, review relevant literature, formulate research questions or design specifications, and develop appropriate experimental, analytical, and/or computational methodologies. The project involves data collection or model development, analysis and interpretation of results, and integration of engineering standards, sustainability principles, and realistic constraints (technical, economic, environmental, and societal). Students document their work in interim reports and a final written thesis/report, and defend their findings in an oral presentation, demonstrating readiness for professional practice or further study.		
b. Prerequisites	Nil		
Co-requisites	Nil		
c. Required, Elective, or Selected elective	Required	**Language of instruction**	English
		Hardware/software usage	For Blackboard, online quizzes

<table>
<tr><td>6. Specific goals for the course</td><td>a. Specific outcomes of instruction
By the completion of the course the student should be able to:
PLO 1 Analyze complex energy-environment interactions by applying integrated principles of thermodynamics, environmental science, and renewable energy technology to a practical project scenario.
PLO 2 Formulate and execute an independent research investigation on an energy-related topic, utilizing rigorous data collection methodologies and evidence-based analysis to draw valid conclusions.
PLO 3 Develop, model, and evaluate the performance of a renewable energy system (e.g., solar, wind, or hybrid) using industry-standard simulation tools to assess technical viability.
PLO 4 Evaluate the comprehensive feasibility of a proposed energy system by conducting multi-criteria decision analysis (MCDA) that balances technical, environmental, and economic metrics.
PLO 5 Incorporate sustainability frameworks, regulatory compliance standards, and public health impact assessments into the design and strategic planning of energy infrastructure projects.
PLO 6 Utilize advanced computational tools, such as Python or specialized energy modeling software, to optimize system performance, forecast energy output, and support data-driven decision-making.
PLO 7 Synthesize and communicate technical project findings and policy recommendations through formal written reports and professional oral presentations tailored for diverse technical and non-technical stakeholders.
PLO 8 Demonstrate effective leadership and project management capabilities within a multidisciplinary team, ensuring efficient resource allocation and cohesive collaboration to achieve project milestones.
PLO 9 Apply professional ethical standards and safety regulations throughout all phases of project development, ensuring that research data and engineering solutions are implemented with integrity and public responsibility.
PLO 10 Critically reflect on the project outcomes, identifying opportunities for innovation in renewable energy and developing a plan for continued professional development and lifelong learning.</td></tr>
<tr><td>7. Brief list of topics to be covered</td><td>
<table>
<tr><th>No</th><th>List of Topics</th><th>Contact Hours</th></tr>
<tr><td>1.</td><td>Choose a topic and formulate a specific research question</td><td>10</td></tr>
<tr><td>2.</td><td>Collecting the required information (theoretical and experimental) for the research problem</td><td>12</td></tr>
<tr><td>3.</td><td>Preparation of preliminary experiments or formulating the required mathematical and/or the computational models</td><td>12</td></tr>
</table>
</td></tr>
</table>

	4.	Incorporation of engineering standards, realistic constraints, and other design considerations	11
	5.	Preparing periodical reports that include an introduction about the project, its objectives, description of the experimental, mathematical, and/or computational models, and the obtained preliminary results	10
	6.	Conducting experiments, running and implementing the mathematical and/or the computational models	12
	7.	Analysis of the results and writing a complete final report	12
	8.	Communication and publication of the work	11
	Total		90
8. Any other information	**Course Assessment***		

Activity	**Assessment% (Marks)**
Semester work	40% (40 Marks)
Report	25% (25 Marks)
Oral Presentation	25% (25 Marks)
Article preparation for publication in the Journal	10% (10 Marks)
Total	100% (100 Marks)