بسم الله الرحمن الرحيم

جامعة الملك خالد

كلية الهندسة

قسم الهندسة الميكانيكية

جدول الخطة الدراسية

لبرنامج ماجستيرالعلوم في الهندسة الميكانيكية

تخصص: الطاقة المتجددة والبيئة

جدول الخطة الدراسية

المستوى	رمز المقرر	اسم المقرر	المتطلبات السابقة*	الساعات المعتمدة				ساعات الاتصال	نوع المتطلب جامعة /كلية	إجباري / اختياري
				نظري	عملي	تمارين	مجموع			
المستوى الأول	711همك-3	نظم الطاقة المتجددة	لا يوجد	3			3	3		إجباري
	712همك-3	البيئة و التنمية المستديمة	لا يوجد	3			3	3		إجباري
	713همك-3	انتقال حرارة متقدم	لا يوجد	3			3	3		إجباري
المستوى الثاني	721همك-3	الجوانب الاقتصادية للطاقة المتجددة	لا يوجد	3			3	3		إجباري
	7xxهمك-3	مقرر اختياري من القائمة 1	لا يوجد	3			3	3		إختياري
	7xxهمك-3	مقرر اختياري من القائمة 2	لا يوجد	3			3	3		إختياري
المستوى الثالث	7xxهمك-3	مقرر اختياري من القائمة3	لا يوجد	3			3	3		إختياري
	735همك-6	رسالة الماجستير	لا يوجد	3			3	3		إجباري
المستوى الرابع	7xxهمك-3	مقرر اختياري من القائمة4	لا يوجد	3			3	3		إختياري
	735همك-6	رسالة الماجستير	لا يوجد	3			3	3		إجباري

المقررات الاختيارية

يجب إختيار مقرر واحد من كل قائمة من القوائم التالية:

قائمة	رمز المقرر	اسم المقرر	المتطلبات السابقة*	الساعات المعتمدة				ساعات الاتصال	نوع المتطلب جامعة / كلية	إجباري / اختياري
				نظري	عملي	تدارين	مجموع			
قائمة 1	722همك-3	نظم الطاقة الفوتوفولطية	يوجد لا	3			3	3		إختياري
	723همك-3	الطاقة الحرارية الجوفية	يوجد لا	3			3	3		إختياري
	724همك-3	الطاقة الشمسية	يوجد لا	3			3	3		إختياري
	725همك-3	ميكانيكا موائع متقدمة	يوجد لا	3			3	3		إختياري
قائمة 2	726همك-3	طاقة الرياح	يوجد لا	3			3	3		إختياري
	727همك-3	كفاءة الطاقة	يوجد لا	3			3	3		إختياري
	728همك-3	تحويل الطاقة	يوجد لا	3			3	3		إختياري
	729همك-3	نظم تخزين الطاقة	يوجد لا	3			3	3		إختياري
قائمة3	731همك-3	النظم الكهربائية ذات الصلة بالطاقة	يوجد لا	3			3	3		إختياري
	732همك-3	سياسة الطاقة والتخطيط والتنمية	يوجد لا	3			3	3		إختياري
	733همك-3	نظم الطاقة الامثل	يوجد لا	3			3	3		إختياري
	734همك-3	رياضيات متقدمة	يوجد لا	3			3	3		إختياري
قائمة 4	741همك-3	طرق عددية	يوجد لا	3			3	3		إختياري
	742همك-3	المباني و الطاقة	يوجد لا	3			3	3		إختياري
	743همك-3	المباني الموفرة للطاقة	يوجد لا	3			3	3		إختياري
	744همك-3	ادارة الطاقة	يوجد لا	3			3	3		إختياري

Details of program courses to be taught in each semester

	Subject Code	Subject	Pre–Required	Credit Hours				Contact Hours	Univ/College	Mandatory/ Elective
				Theoretical	Tutorial	Exercises	Total			
Level 1	Renewable Energy Systems	711ME-3	None	3			3	3		Mandatory
	Environment And Sustainability	712ME-3	None	3			3	3		Mandatory
	Advanced Heat Transfer	713ME-3	None	3			3	3		Mandatory
Level 2	Economic Aspects Of Renewable	721ME-3	None	3			3	3		Mandatory
	ME Elective 1 (from list 1)	7XXME-3	None	3			3	3		Elective
	ME Elective 2 (from list 2)	7XXME-3	None	3			3	3		Elective
Level 3	ME Elective 3 (from list 3)	7XXME-3	None	3			3	3		Elective
	Thesis	735ME-6	None	3			3	3		Mandatory
Level 4	ME Elective 4 (from list 4)	7XXME-3	None	3			3	3		Elective
	Thesis (continued)	735ME-6	None	3			3	3		Mandatory

Elective Courses*

List	Subject Code	Subject	Pre–Required	Credit Hours				Contact Hours	Univ/College	Mandatory/ Elective
				Theoretical	Tutorial	Exercises	Total			
List 1	Photovoltaic Energy Systems	722ME-3	None	3			3	3		Elective
	Geothermal Energy	723ME-3	None	3			3	3		Elective
	Solar Energy	724ME-3	None	3			3	3		Elective
	Advanced Fluid Mechanics	725ME-3	None	3			3	3		Elective
List 2	Wind Energy	726ME-3	None	3			3	3		Elective
	Energy Efficiency	727ME-3	None	3			3	3		Elective
	Energy Conversion	728ME-3	None	3			3	3		Elective
	Energy Storage Systems	729ME-3	None	3			3	3		Elective
List 3	Electrical Systems Related To Renewable Energy	731ME-3	None	3			3	3		Elective
	Energy Policy, Planning And Sustainable Development	732ME-3	None	3			3	3		Elective
	Optimization Of Energy Systems	733ME-3	None	3			3	3		Elective
	Advanced Mathematics	734ME-3	None	3			3	3		Elective
List 4	Numerical Methods	741ME-3	None	3			3	3		Elective
	Energy Comfort In Buildings	742ME-3	None	3			3	3		Elective
	Low Energy Architecture	743ME-3	None	3			3	3		Elective
	Energy Management	744ME-3	None	3			3	3		Elective

*One course must be selected from each list.

Courses description

1. 711ME-3 Renewable energy systems

This course considers introduction to renewable energies. The course also covers solar radiation, solar angles, solar system, and solar collectors. It explains thermal compilation, and water heating. It demonstrates economics of solar energy, and high temperature solar collectors. Also, integrated solar systems, concentrators, and performance of solar systems in the long term are studied. In addition, indirect heating system, and energy storage control systems in the field of energy storage are well covered. Wind, geothermal energy, bio-energy, and tidal energy are introduced.

2. 712ME-3 Environment and sustainability

Introduction to Sustainability: Humanity and the Environment: An Introduction to Sustainability: Humanity and the Environment, What is Sustainability? Human Consumption Patterns and the Rebound Effect, Challenges for Sustainability.

The Evolution of Environmental Policy in KSA: The Evolution of Environmental Policy in KSA, Environmental Risk Management, Sustainability and Public Policy, Public Health and Sustainability

Climate and Global Change: Climate Processes; External and Internal Controls, Milankovitch Cycles and the Climate of the Quaternary, Modern Climate Change

Biosphere: Biogeochemical Cycles and the Flow of Energy in the Earth System, Biodiversity, Species Loss, and Ecosystem Function, Soil and Sustainability

Physical Resources: Water, Pollution, and Minerals: Water Cycle and Fresh Water Supply, Water Pollution, Mineral Resources: Formation, Mining, Environmental Impact.

Modern Environmental Management: Systems of Waste Management, Risk Assessment Methodology for Conventional and Alternative Sustainability Options.

Sustainable Energy Systems: Environmental Challenges in Energy, Carbon Dioxide, Air, Water and Land Use, Energy Sources and Carriers, Energy Uses, Applications of Phase Change Materials for Sustainable Energy.

Problem-Solving, Metrics, and Tools for Sustainability: Life Cycle Assessment, Derivative Life Cycle Concepts, Sustainability and Business.

Sustainability: Ethics, Culture, and History: The Human Dimensions of Sustainability: History, Culture, Ethics, and its Not Easy Being Green: Anti-Environmental Discourse, Behaviour, and Ideology, The Industrialization of Nature: A Modern History (1500 to the present), Sustainability Studies: A Systems Literacy Approach.

3. 713ME-3 advanced heat transfer

Free, forced and mixed convection - stable and unstable heat conduction types - heat transfer by laminar and turbulent convection-Heat transfer by radiation-Mass transfer by stable spread in gases, and fluids- laminar and turbulent mass transfer.

4. 721ME-3 Economic aspects of renewable energy

Energy supply and demand fundamentals, the national energy balance (which produces any kind of energy, where and from which source, and what is consumed and for what purpose), relevant power units, transfers and formulas, criteria and indicators of the concept of sustainable energy supply, trade, , The role of the private sector, decentralization, the standardization of functions and policy options for tariffs, laws, law enforcement, the distribution of labor between organizations, nutrition definitions, economic and social functions of tariffs, jobs and the structuring of public and private institutions in the energy sector at the national, regional and international

levels. The basic market related barriers, transaction costs will be introduced to implement energy efficiency, fixed costs, and split the incentive hypothesis.

5. 722ME-3 Photovoltaic energy systems

PV systems, photovoltaic systems, photovoltaic systems, the principles of operation of photovoltaic systems, the performance characteristics of photovoltaic systems as a function of environmental conditions, location assessment of PV systems, selection, design and installation of systems, installation of basic subsystems, inspection and maintenance of photovoltaic systems, safety considerations during Installation and use of photovoltaic systems. Photovoltaic systems: Standard photovoltaic systems, photovoltaic center, and innovative systems (PV + Thermal Collector). Use desert area, small and large plants.

6. 723ME-3 Geothermal energy

Theory and design of the three broad uses of geothermal energy: (i) heat pump applications, (ii) direct uses, and (iii) electrical energy generation. The majority of the course will focus on heat pump applications, with emphasis on ground heat exchanger simulation and design for buildings and other systems. Closed-loop, open-loop, and hybrid geothermal heat pump systems will be examined. Heating, cooling, and electricity generation applications using hot geothermal reservoirs will also be discussed. The course will expose students to the development and use of geothermal design and simulation tools. Most of the tools will be implemented in Excel, but such as Engineering Equation Solver (EES) or MATLAB. The course notes used to solve homework problems. Prerequisite (s): Undergraduate thermodynamics and heat transfer courses.

7. 724ME-3 Solar energy

Introduction to solar and solar radiation, thermodynamics and heat transfer, power station technologies, types of solar energy systems, including solar systems focused using parabolic surfaces, concentrated solar energy technology, and concentrated solar energy technology using Fresnel reflectors, Solar power towers and heat storage systems, hybridization, and use of secondary concentrated solar systems, operation and maintenance of solar energy systems, energy and quality control and network integration, project planning CSP station: economic considerations and Social and environmental assessment of the site.

8. 725ME-3 Advanced fluid mechanics

The course focuses on central theme of modern applied mathematics. Based on mathematical concepts of gradient, divergence, vortices and tensor, the basic properties normally ascribed to fluids such as density, compressibility and dynamic viscosity will be introduced. Introduction of compressible flow will be introduced then general equations, including continuous equation, momentum equation and energy equation are derived. In general, the motion of fluids is extremely complicated, including highly nonlinear phenomena like turbulence, and cannot be described exactly. Turbulent models will be introduced.

9. 726ME-3 Wind energy

Introduction - Types of wind turbines - Theory of the amount of motion and mass survival - Bates limits of the power factor of turbines' horizontal axis - Suction turbines and lifting turbines - Using a plant to increase the extracted capacity – properties of wind near the surface of the earth - generating electricity.

10. 727ME-3 Energy efficiency

Introduction to energy efficiency, analysis of energy production and consumption processes and related technical systems in maintaining energy efficiency.

Different thermal systems, complementing processes and energy-saving techniques. Suitable energy systems (conventional and advanced) and methods currently used for optimization and optimization of thermal equipment. Energy efficient systems, such as co-generation and tri-generation systems and ORC systems.

Efficiency of power station management. Planning and implementing technological modifications at stations to improve energy efficiency and BAT selection. Methods of energy diagnosis, criticalities in terms of the consumption of thermal and electrical energy.

11. 728ME-3 Energy conversion

Fossil energy, nuclear energy, and renewable energy resources. Conventional and emerging energy conversion technologies. Energy sources, energy needs and available sources of energy, petroleum, coal, oil shale and tar sands, natural gas and hydrogen, hydropower and biomass, principles of nuclear energy, solar energy, geothermal energy, wind, tides and power waves, conversion of chemical energy into thermal and electric energy using gas, Gas and steel combustion systems , conversion of thermal energy into mechanical energy using heat engines (internal and external combustion engines and turbines) and generators, conversion of thermal energy into electric energy using converters and fuel cells.

12. 729ME-3 Energy storage systems

Flywheels, compressed air, heat pumps, vacuum solar thermal collector, thermos-chemical storage, phase change materials, batteries, super capacitors, hydrogen storage, use of hydrogen, safety considerations.

13. 731ME-3 Electrical systems related to renewable energy

Overview of renewable energy system – Big picture in energy supply and demand, need for more energy – Renewable energy sources (hydro, solar, wind, tidal, waves) – Cost and environmental impact • Energy conversion – Solar cells technology (crystalline, amorphous) and characteristics – Wind turbine system configurations – Power converter topologies for solar and wind – Control of dc-dc converter and dc-ac inverters – Control of different types of generator-inverter systems – Fuel cell technology and characteristics and control • Grid Integration – Grid-connected and off-grid PV systems – Compliance with power quality and safety code for solar and wind systems. Wind and solar intermittency management (on technical side) – Distributed Generation – Micro grid.

14. 732ME-3 Energy policy, planning and sustainable development

Understanding the need of energy policy in creating a sustainable development of any country. Tools to evaluate the success or failure of development due to particular energy policy; planning and its implementation. The ingredients of business models related to energy and how the energy policy can drive the financial markets.

15. 733ME-3 Optimization of energy systems

Introduction to design and specifically system design. Morphology of design with a flow chart. Very brief discussion on market analysis, profit, time value of money, an example of discounted cash flow technique. Concept of workable design, practical example on workable system and optimal design.

System Simulation: Classification. Successive substitution method -examples. Newton Raphson method – one unknown - examples. Newton Raphson method - multiple unknowns - examples. Gauss Seidel method - examples. Rudiments of finite difference method for partial differential equations, with an example.

Regression and Curve Fitting: Need for regression in simulation and optimization. Concept of best fit and exact fit. Exact fit - Lagrange interpolation, Newton's divided difference - examples. Least square regression - theory, examples from linear regression with one and more unknowns -examples. Power law forms - examples. Gauss Newton method for non-linear least squares regression -examples.

Optimization: Introduction. Formulation of optimization problems – examples. Calculus techniques – Lagrange multiplier method – proof, examples. Search methods – Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search – numerical examples. Method of steepest ascent/steepest descent conjugates gradient method – examples. Geometric programming –examples. Dynamic programming – examples. Linear programming – two variable problem –graphical solution. New generation optimization techniques – Genetic algorithm and simulated annealing - examples. Introduction to Bayesian framework for optimization-examples.

16. 734ME-3 Advanced mathematics

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.

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.

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.

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.

17. 735ME-6 Thesis

The thesis is based on experimental (design, fabrication…), computational (programming, simulation…), or analytical research in the field of renewable energy and environment. The research topic of the thesis must be related to the field of renewable energy and determined by the main advisor and approved by the program chair.

18. 741 ME-3 Numerical methods

Introduction to numerical Analysis, Numerical Integration, Simpson's Rule and Gauss Quadrature Rules, Numerical Differentiation: Introduction to Linear Algebra, Determinants, Inverses, Gaussian Elimination and LU Decomposition, Schemes For Gaussian Elimination, Tridiagonal Matrices, Jacobi and Gauss-Seidel iteration methods, Interpolation techniques, Root finding techniques for polynomial,Numerical Solution of Ordinary Differential Equation, Initial and boundary Value Problems; Euler's Method, Runge-Kutta, Implicit, and Higher Order ODE's and Systems, Stability and Convergence, Stiff Systems, Numerical Solution of partial Differential Equation (PDE's), Finite Difference Method, Finite volume method, Refinement of Iterative Methods: Relaxation, Matlab Programming as a tool for Numerical Methods

19. 742ME-3 Energy comfort in buildings

Energy efficient buildings and the role they play in our efforts to address climate change, energy consumption and greenhouse gas emissions by considering buildings and the construction sector's unique position along a critical path to decarburization from a multi – perspective and holistic viewpoint.

Day lighting, building topology comparison, building envelope design, and zero energy homes in hot arid regions, life – cycle considerations and energy efficiency analysis to managing energy demand through equipment selection.

20. 743ME-3 Low energy architecture

Low energy principals for domestic buildings, sustainable design of dwellings and non-domestic buildings in different climatic regions, building regulations, Environmental methods, energy efficiency, requirements for zero carbon homes and buildings, Passive solar heating and cooling strategies, Psychometric and Givoni bioclimatic chart, Heating, cooling and air conditioning, Day lighting and energy efficient lighting.

21. 744ME-3 Energy management

System analysis, systems thinking and energy systems, methods for evaluation of large and complex energy systems and energy system modeling, people's understanding about energy and user behavior, energy economics, energy portfolio sustainability management, business logics in modern energy systems.