Faculty of Applied Sciences, Technology, and Engineering

Department of Engineering

Sustainable Energy Engineering Program

Contents:

Sustainable Energy Engineering

The sustainable energy engineering (SEEN) program deals with topics related to renewable energy sources, production, transmission, and distribution with high efficiency. Renewable energy sources are discussed as a permanent and environmentally friendly source. As SEEN is an interdisciplinary major, it also includes some main courses in mechanical engineering. In addition, as electronic circuits and logic circuits are main parts of energy systems, they are carefully treated in this major. Computer interfacing where electrical and mechanical parts of energy systems are interfaced with processors of these systems is also covered in SEEN. Electric machines like motors, generators, and transformers, along with their controls are studied in this program.

As an engineering program, SEEN follows a rigorous curriculum, requiring a minimum of 164 credit hours, which takes approximately 5 years to complete. All courses listed in the curriculum map for the catalog year of graduation must be completed to be eligible for graduation. To earn a Bachelor degree in SEEN from Bethlehem University a student must complete:

- The University requirements as listed below.
- The requirements as listed below with a minimum Grade Point Average (GPA) of 2.00.
- The Faculty requirements as listed below.
- A minimum cumulative GPA of 2.00 computed on all grades earned at Bethlehem University. The number of credits of the program is distributed following the table:

Summary of Credit Hours

Requirement	# of Credit Hours
University	34
Faculty	19
Program Core	102
Program Electives	9
Total	**164**

The program is offered with internship divided over two courses in summer semesters. The credit hours distributed over the 5 academic years are as follows:

Paradigm for Bachelor of Science in Sustainable Energy Engineering

First Year

■University ■Faculty ■Program core ■Program elective

Fall					Spring				
Course No	**Course Title**	**Lec**	**Lab**	**Cr**	**Course No**	**Course Title**	**Lec**	**Lab**	**Cr**
MATH141	Calculus & Analytic Geometry I	4		4	MATH142	Calculus & Analytic Geometry II	4		4
ENGL120	English Language Skills I	3		3	ENGL121	English Language Skills II	3		3
SEEN101	Engineering Design	3		3	SEEN103	Engineering Workshop	4		2
SEEN102	Engineering Programming I	3		3	CHEM131	General Chemistry I	3		3
PHYS131	General Physics I	3		3	CHEM113	Laboratory Practice		3	1
PHYS113	Laboratory Practice		3	1	PHYS132	General Physics II	3		3
LIBR101	Library Skills	0		0	PSED101	Physical Education	1		1
	Total			**17**		**Total**			**17**
Summer									
ARAB120	Arabic Language Skills I	3		3					
HIST120	Modern History of Palestine	3		3					
	Total			**6**					

Second Year

■University ■Faculty ■Program core ■Program elective

Fall					Spring				
Course No	**Course Title**	**Lec**	**Lab**	**Cr**	**Course No**	**Course Title**	**Lec**	**Lab**	**Cr**
ARAB121	Arabic Language Skills II	3		3	ENGL213	English Language Skills III	3		3
SEEN201	Electric Circuits I	3		3	SEEN202	Electric Circuits II	2		2
SEEN212	Introduction to Differential Equations and Linear Algebra	3		3	SEEN203	Electric Circuits Lab		3	1
SEEN207	Signals and Systems	3		3	SEEN208	Applied Mathematics for Engineers	3		3

SEEN205	Digital Logic Design	3		3	SEEN204	Electronics I	3		3
SEEN206	Digital Logic Design Lab		3	1	SEEN210	Renewable Energy	3		3
SEEN211	Electrical Drawing		3	1	SEEN209	Material Science	3		3
	Total			**17**		**Total**			**18**

Third Year

■University ■Faculty ■Program core ■Program elective

Fall					**Spring**				
Course No	**Course Title**	**Lec**	**Lab**	**Cr**	**Course No**	**Course Title**	**Lec**	**Lab**	**Cr**
CMSR101	Community Service	1		1	ARTI101	Art Appreciation	2		2
SEEN312	Thermofluid	3		3	SEEN303	Electromagnetics	3		3
SEEN301	Electric Machines	3		3	SEEN306	Power Electronics	3		3
SEEN302	Electric Machines Lab		3	1	SEEN307	Power Electronics Lab		3	1
SEEN310	Probability and Random Variables	3		3	SEEN308	Solar Energy	3		3
SEEN304	Electronics II	3		3	SEEN309	Solar Energy Lab		3	1
SEEN305	Electronics Lab		3	1	SEEN311	Microprocessor and Microcontroller Interfacing	3		3
BUSA210	Introduction to Business Management	3		3	ENTR320	Project Management	2		2
	Total			**18**		**Total**			**18**
Summer									
SEEN300	Internship I	1		1					
	Total			**1**					

Fourth Year

■University ■Faculty ■Program core ■Program elective

Fall					**Spring**				
Course No	**Course Title**	**Lec**	**Lab**	**Cr**	**Course No**	**Course Title**	**Lec**	**Lab**	**Cr**
RELS300	Cultural Religious Studies	3		3	ECON300	Basic Economics	3		3
SEEN401	Linear Control Systems	3		3	SEEN406	Wind Energy	3		3
SEEN402	Linear Control Systems Lab		3	1	SEEN407	Wind Energy Lab		3	1
SEEN403	Heat Transfer	3		3	SEEN408	Biomass and Geothermal Energy	3		3
SEEN404	Thermofluid Lab		3	1	SEEN409	Engineering Programming II	3		3
SEEN405	Environmental Engineering	3		3	Elective	Program Elective Course	3		3
Elective	Program Elective Course	3		3					
	Total			**17**		**Total**			**16**
Summer									
SEEN400	Internship II	1		1					
	Total			**1**					

Fifth Year

■University ■Faculty ■Program core ■Program elective

Fall					**Spring**				
Course No	**Course Title**	**Lec**	**Lab**	**Cr**	**Course No**	**Course Title**	**Lec**	**Lab**	**Cr**
PHIL302	Issues in Philosophy & Ethics	3		3	POLS300	Political Science (Or replacement)	3		3
SEEN501	Energy Economics	3		3	SEEN503	Graduation Project II	2		2
SEEN500	Seminar	2		2	Elective	Program Elective Course	3		3
SEEN502	Graduation Project I	2		2					
	Total			**10**		**Total**			**8**

Core Courses Description

SEEN101 - Engineering Design
3 Credit Hours **Pre-Requisite - None**
This course teaches students how to produce great designs, be a more effective engineer, and communicate with high emotional and intellectual impact. This project-based course gives students the ability to understand, contextualize, and analyze engineering designs and systems. By learning and applying design thinking, students will more effectively solve problems in any domain. The course will also teach students basics of AutoCAD and how to use for plotting some engineering design parts.

SEEN102 - Engineering Programming I
3 Credit Hours **Pre-Requisite - None**
Overview of computer hardware and software. Programming in Python with emphasis on basic program constructs: variables, assignments, expressions, decision structures, looping, functions, lists, files and exceptions; Introduction to objects and classes. Programming in C with emphasis on pointers and functions with output parameters. Simple multidisciplinary problem solving in science, engineering and business.

SEEN103 - Engineering Workshop
2 Credit Hours **Pre-Requisite - SEEN101**
This course intends to impart basic know-how of various hand tools and their use in different sections of manufacturing. Irrespective of branch, the use of workshop practices in day to day industrial as well domestic life helps to dissolve the problems. This course will mainly teach students skills in metal turning and welding. It will also teach them the necessary skills to design and conduct basic electrical home wiring.

SEEN201 - Electric Circuits I
3 Credit Hours **Pre-Requisites - MATH141 and PHYS132**
Basic laws: Ohm's, KVL, KCL. Resistive circuits. Circuit analysis techniques. Network theorems: Thevenin's Norton's, Source transformation, Superposition, Maximum power transfer. Op Amps. Energy storage elements. First and second order circuits. Phasor techniques for steady-state sinusoidal circuits.

SEEN202 - Electric Circuits II
2 Credit Hours **Pre-Requisite - SEEN201**
Mutual inductance. Introduction to Single-Phase Ideal and Linear Transformers. Important power concepts of AC circuits. Three phase circuits. Resonant circuits and *s*-domain analysis. Frequency selective circuits. Two-port networks.

SEEN203 - Electric Circuits Lab
1 Credit Hour **Co-Requisite - SEEN202**
Introduction to electric circuits simulation, Electric circuits fundamentals laws, Voltage and current dividers and superposition principle, equivalent source models and maximum power transfer, the Oscilloscope and function generator, Sinusoidal AC circuit analysis, Transient circuit analysis, Frequency selective circuit analysis, Two-port network, and Design project.

SEEN204 - Electronics I
3 Credit Hours **Pre-Requisite - SEEN201**
Op amp linear applications, PN junction and zener diodes, Diode basic circuit analysis and diode applications (rectifier and limiters), MOSFET and BJT (DC, small signal analysis), Amplifier configurations and characteristics, and CMOS digital circuits.

SEEN205 - Digital Logic Design
3 Credit Hours **Pre-Requisite - PHYS132**

Introduction to information representation and number systems. Boolean algebra and switching theory. Canonical forms: minterms and maxterms. Manipulation and minimization of completely and incompletely specified Boolean functions. Propagation delay, timing diagrams. Primitive and complex gates. Combinational circuits design. Multiplexers, decoders, encoders, comparators, adders. Sequential circuit analysis and design, basic flip-flops, clocking and timing diagrams. Registers, counters. Introduction to Verilog.

SEEN206 - Digital Logic Design Lab

1 Credit Hour **Co-Requisite - SEEN205**

Introduction to information representation, Signals and bits, Logic implementation using discrete logic components (TTL, CMOS). Introduction to Field Programmable Logic Arrays (FPGAs) design flow: design capture (schematic capture, HDL design entry, design verification and test, implementation (including some of its practical aspects), and debugging. Use of CAD tools to design, simulate and implement digital logic circuits on FPGA prototyping boards. Introduction to Verilog.

SEEN207 - Signals and Systems

3 Credit Hours **Pre-Requisite - MATH142**

Introduction to signals and systems. Time-domain analysis. Convolution. Fourier series and applications. Fourier transform and applications. Laplace transform and applications. Discrete-time signals and systems. Sampling. Difference equations and *z*-transform. Introduction to discrete time Fourier transform and its applications.

SEEN208 - Applied Mathematics for Engineers

3 Credit Hours **Pre-Requisite - MATH142**

Special functions. Multivariable functions. Bessel's functions and Legendre polynomials. Vector analysis including vector fields, divergence, curl, line and surface integrals, multi-integrals, Green's, Gauss' and Stokes' theorems. Sturm-Liouville theory. Laplace transforms. Fourier series and transforms. Introduction to partial differential equations and boundary value problems in rectangular, cylindrical, and spherical coordinates.

SEEN209 - Material Science

3 Credit Hours **Pre-Requisite - PHYS132**

The course will introduce the student to the fundamental concepts of Materials Science and Engineering which will be used as background knowledge for the understanding of specialized design for the applications in the field of energy engineering. Thus, this course provides an introduction to the type of materials, structure, properties, characteristics and applications, with special emphasis on the relationships between internal structure and properties.

SEEN210 - Renewable Energy

3 Credit Hours **Pre-Requisite - PHYS132**

This course offers a comprehensive introduction to the following: principles of energy and energy conversion, energy units and energy carriers, renewable and non-renewable resources, hydropower, wind energy, solar photovoltaic (PV), concentrating solar power (CSP), geothermal, biomass, sustainable energy systems and their environment impact, solar energy in building applications, energy management and efficiency, energy auditing, and relevant standards and management tools.

SEEN211 - Electrical Drawing

1 Credit Hour **Pre-Requisite - SEEN101**

This lab teaches students how to do electrical wirings for house both on papers and using AutoCAD. This also includes learning how to read house wiring diagrams and translating them to electronic drawings. Adequate illumination values of different areas of houses like bedrooms, kitchens, bathrooms, etc. The lab will also teach students how to efficiently distribute lighting units, outlets, etc. on various area of houses.

SEEN212 - Introduction to Differential Equations and Linear Algebra

3 Credit Hours **Pre-Requisite - MATH142**

Systems of linear equations. Vector spaces Rn: subspaces, bases, dimensions. Rank of matrices. Eigenvalues and eigenvectors. Similar matrices. Diagonalizable matrices. Matrix exponential. First order differential equations: separable, linear, exact, substitutions methods. Applications to linear models of first order. The homogeneous differential equations with constant coefficients. Wronskian. Nonhomogeneous differential equations. Methods of undetermined coefficients and variation of parameters. Systems of differential equations. Non-homogeneous systems. Series. This is essential as a prerequisite course to the applied mathematics for engineers' course AND the engineering programming course.

SEEN300 - Internship I

1 Credit Hour **Pre-Requisite - University and Department Requirements**

In this course, the student spends a continuous period of 8 weeks in the industry working in any of the electrical engineering fields. During this period, the student is exposed to the profession of electrical engineering through facing and resolving practical engineering issues. The course also aims to enhance the student skills, creative thinking, and team work involvement. The student is required to submit and present a formal written report of his conducted tasks and achieved goals at the end of his training.

SEEN301 - Electric Machines

3 Credit Hours **Pre-Requisite - SEEN202**

Fundamentals of electric energy systems. Electric energy conversion. Components of electric energy systems. Transformers (1 and 3 phases). AC machine fundamentals. Synchronous and Induction machines. DC machine fundamentals. Overhead transmission lines and underground cables.

SEEN302 - Electric Machines Lab

1 Credit Hour **Co-Requisite - SEEN301**

Introduction to lab software and lab safety measures and guidelines, Three-phase and two-wattmeters method, Magnetic circuits characteristics, Equivalent circuit and performance evaluation of single-phase transformer, Three-phase transformers, DC generator characteristics, DC motor characteristics, Determination of parameters of three phase synchronous generators and equivalent circuit, Performance and torque-speed characteristics of 3-phase induction motors.

SEEN303 - Electromagnetics

3 Credit Hours **Pre-Requisites - PHYS132 and SEEN312**

Review of vector analysis, Stokes' theorem and divergence theorem, electrical field intensity, Gauss's law and electrical field theorems, magnetic field theorems, Faraday's law, Maxwell's equations, solutions to electric and magnetic field problems, engineering applications.

SEEN304 - Electronics II

3 Credit Hours **Pre-Requisite - SEEN204**

Differential amplifiers, multistage amplifiers, Amplifier frequency response (for single stage, multistage, and op amp), Passive and active filters, Feedback: circuit topologies and analysis, Oscillators, and Introduction to A/D and D/A.

SEEN305 - Electronics Lab

1 Credit Hour **Co-Requisite - SEEN304**

Linear applications of op amp, Semiconductor diodes characteristics and applications (rectifier), BJT I-V characteristics, biasing, and gain analysis (CE). MOS I-V characteristics, biasing, gain analysis (CS), and frequency response, MOS differential amplifier biasing, gain analysis, and frequency response, simulation analysis using SPICE or Multisim for diodes and MOS differential amplifier, Frequency response of multistage amplifier (CS-CD), Various types of first-order and second order active filters, Sinusoidal oscillators, and Active signal generators.

SEEN306 - Power Electronics

3 Credit Hours **Pre-Requisites - SEEN204 and SEEN301**

Power electronic devices. DC and AC power electronics converters. Fundamental of power quality

and system harmonics effects and mitigation. Power quality standards.

SEEN307 - Power Electronics Lab
1 Credit Hour **Pre-Requisite - SEEN302 and Co-Requisite - SEEN306**
Introduction to MATLAB simulation applied to half-wave rectifiers, Introduction to Lab Software and hardware equipment applied to half-wave rectifiers, Three-phase bridge rectifier, Single-phase controlled bridge rectifier, Three-phase controlled bridge rectifier, Single-phase AC voltage controller, DC-DC converters, Buck/Boost converters, Single-phase voltage source inverter, and Three-phase voltage source inverter (Matlab).

SEEN308 - Solar Energy
3 Credit Hours **Pre-Requisite - SEEN210**
This course offers the following: Solar energy principles, photoelectric conversion fundamentals, charge excitation, conduction, separation, collection, commercial and emerging PV technologies, conversion efficiencies, loss mechanisms, characterization, manufacturing, systems, reliability, life-cycle analysis, risk analysis, and photovoltaic technology advancements.

SEEN309 - Solar Energy Lab
1 Credit Hour **Co-Requisite - SEEN308**
The course will focus on an understanding of the practical applications of solar energy utilization. A variety of subject matter encompassing concepts from different fields such as architecture and design, physics, geosciences, mathematics engineering and the social sciences will be presented helping students to integrate previously acquired knowledge and experience with new knowledge. Learning activities have been structured so that students can investigate and apply new knowledge toward the identification and possible solution of issues and problems surrounding the solar field.

SEEN310 - Probability and Random Variables
3 Credit Hours **Pre-Requisite - SEEN207**
Fundamentals of probability theory: single and two discrete and continuous random variables. Probability density function. Gaussian and other distributions. Functions of one and two random variables. Joint and conditional probabilities. Moments and statistical averages. Central limit theorem. Introduction to random process. Concept of stationarity and ergodicity. Correlation function. Power spectrum density. Response of linear systems to random signals.

SEEN311 - Microprocessor and Microcontroller Interfacing
3 Credit Hours **Pre-Requisites - SEEN102 and SEEN205**
In the Microprocessor and Microcontroller Interfacing course, students explore a wide array of topics essential for understanding the integration of these vital components with external devices. They begin with a foundational understanding of microprocessor and microcontroller architecture, distinguishing between their respective roles and applications. Memory interfacing is extensively covered, encompassing addressing modes and organization schemes such as RAM, ROM, and EEPROM, alongside practical techniques for interfacing with memory devices. Input/output (I/O) interfacing techniques are thoroughly examined, including both parallel and serial protocols like UART, SPI, and I2C, with a focus on interfacing devices such as keyboards and displays. Communication interfaces like RS-232 and RS-485 are discussed, along with their practical applications in networking and device communication.

SEEN312 - Thermofluid
3 Credit Hours **Pre-Requisites - SEEN208 and CHEM131**
Basic fluid and thermodynamics properties. The first law of thermodynamics. The second law of thermodynamics. Basic heat transfer. Fundamentals of fluids and fluid statics. General description of fluid in motion and flow measurement.

SEEN400 - Internship II
1 Credit Hour **Pre-Requisite - SEEN300**
This is the second course of internship, where the student again spends a continuous period of 8 weeks in the industry working in various electrical engineering fields. Here, the student should be

more focused and should do most of his training on issues related to his area of specialization. Going into details of systems and processes is required. Conducting critical thinking and finding solutions for practical problems or needs in the student field is a must at this stage. At the end of his training course, the student is required to submit and present a formal written report of his conducted tasks and achieved goals.

SEEN401 - Linear Control Systems
3 Credit Hours **Pre-Requisite - SEEN207**
Introduction to feedback control systems. Block diagram and signal flow graph representation. Mathematical modeling of physical systems. Stability of linear control systems. Time-domain and frequency-domain analysis tools and performance assessment. Lead and lag compensatory design. Proportional, integral, and derivative control.

SEEN402 - Linear Control Systems Lab
1 Credit Hour **Co-Requisite - SEEN401**
Introduction to the computer aided design package MATLAB & Lab Safety Measures and Guidelines, Introduction to SIMULINK and simulation of a speed control system, ServoTrainer: Familiarization, Experimental Determination of the servo-trainer DC Motor Model, Model-based Investigation of the Effect of Tuning Parameters on a Servo Motor Response and Mode Transition, Speed Control Servo with Proportional + Integral Control, Servo Motor Position Control Using Position and Speed feedback, Position Control Servo-system Error Cancellation Using Proportional-Integral (PI) Controllers and Effect of lead and lag RC circuits on the performance of Servo-motor.

SEEN403 - Heat Transfer
3 Credit Hours **Pre-Requisite - SEEN312**
An introduction to heat transfer by conduction, radiation and convection. Steady-state analysis of heat transfer through composite plane, cylindrical and spherical walls with convection and radiation boundary conditions, internal energy generation and extended surfaces (fins). Significance of multi-dimensional effects. Unsteady heat transfer in plates, cylinders and spheres. Numerical solution of heat conduction problems. Practical analysis of convection with application to heat exchangers. Blackbody and graybody radiation systems.

SEEN404 - Thermofluid Lab
1 Credit Hour **Co-Requisite - SEEN403**
Experimentation of the fundamental elements of theory and practice in fluid mechanics and heat transfer. Uncertainty analysis; flow measurements; pipelines and energy losses; hydraulic systems; temperature measurements; heat transfer by conduction, convection and radiation; heat exchanger design and performance evaluation.

SEEN405 - Environmental Engineering
3 Credit Hours **Pre-Requisites - CHEM131 and SEEN210**
This course presents a broad introduction to Environmental Engineering. A set of fundamental principles that serves as the foundation for the entire field of environmental engineers will be overviewed. These principles are based on scientific fundamentals: chemistry, biology, physics, and mathematics. This course explores how these fundamental principles are applied. Applications are selected from water quality engineering, air quality engineering, and hazardous waste management. The main elements of assessing environmental impacts of human activities, projects and plans will be explained. Students will conduct an environmental impact assessment and apply environmental design techniques for a specific problem definition.

SEEN406 - Wind Energy
3 Credit Hours **Pre-Requisite - SEEN301**
This course offers the following: An overview of industrial wind turbine operation and maintenance, rotor design and aerodynamics, tower and turbine safety, instrumentation and control systems, turbine testing, operation, routine maintenance of electro-mechanical systems, environmental considerations, current and future trends in wind turbine design.

SEEN407 - Wind Energy Lab

1 Credit Hour **Co-Requisite - SEEN406**

The course explores how wind turbines can be used to generate electricity. It intends to teach students how to use electricity generated by a wind turbine to light a LED. Build and understand basic circuits. Verify that energy is transferred by electric currents.

SEEN408 - Biomass and Geothermal Energy

3 Credit Hours **Pre-Requisite - SEEN403**

The course introduces students to geothermal energy: deep and shallow systems, occurrence, heat transport mechanisms, free and forced convection, conduction processes, deep geothermal systems, tectonics, geological context, geothermal gradient, high-temperature geothermal systems, sustainability, challenges, shallow geothermal systems, low-temperature systems, open systems, closed systems, heat pumps, and conflicting use of groundwater.

SEEN409 - Engineering Programming II

3 Credit Hours **Pre-Requisite - SEEN102**

A hands-on introductory level course on data science techniques and applications. Preliminary statistics, programming, and SQL. Basic data acquisition, cleaning, manipulation and pre-processing. Emphasis on: Data understanding and preparation; Exploratory data analysis and visualization. Implementing and validating linear and penalized regression, basic classification and basic clustering methods. Introduction to big data analysis.

SEEN500 - Seminar

2 Credit Hours **Pre-Requisite - None**

Students in the last year will prepare a seminar to engage in valuable and relevant engineering design projects in the field of energy engineering and student will give a presentation in front of the faculty members and specialized people.

SEEN501 - Energy Economics

3 Credit Hours **Pre-Requisite - ECON300 or ENTR300**

This course builds understanding of the global energy situation, energy and climate policies, and the market outlook for various energy carriers. Coverage includes conventional power generation, wind power, solar energy, oil and natural gas. Drivers of demand, supply and price formation will be explored, including their relationship to resource scarcity, technology and innovation, economic factors, and policy variables. Finally, the course explores the macro-economics of energy market developments for importers and exporters of energy resources.

SEEN502 - Graduation Project I

2 Credit Hours **Pre-Requisite - None**

This is the first of two courses for the graduation project leading to BSc. Degree in SEEN will be arranged between a student, a faculty member, and an external company (could be governmental). The aim of the project must be the following: application of new scientific methods for solving different energy engineering problems, including analysis and investigation of opening new research areas in this field. Teams will be formed, projects will be defined, and project management discussed. The course will also give an introduction to engineering design. The engineering design cycle. Carrying a literature survey. Formulation of practical engineering problems. Customer needs analysis. Brainstorming in design projects. Arduino programming in engineering design projects. Modeling, implementation, and evaluation in engineering design. Report writing, presentation skills, professional ethics, and teamwork.

SEEN503 - Graduation Project II

2 Credit Hours **Pre-Requisite - SEEN502**

This is the second of two courses for the graduation project. Teams undertake product definition, generation of conceptual designs, product development, and presentation of final products. Students integrate knowledge acquired from prior courses into novel renewable energy-related projects with multiple constraints and use engineering standards while further developing their communication skills and life-long learning techniques.

BUSA210 - Principles of Management

3 Credit Hours **Pre-Requisite - None**

This course involves a review of the principles of management. It aims to provide a framework for the orderly presentation of basic facts in business management, utilizing the functions of the manager with respect to planning, organizing, staffing, directing, and controlling.

ENTR320 - Project Management

2 Credit Hours **Pre-Requisite - BUSA210**

This course guides students through fundamental project management concepts and behavioral skills needed to successfully launch, lead, and realize benefits from projects in profit and non- profit organizations. Successful project managers skillfully manage their resources, schedules, risks, and scope to produce a desired outcome. In this course, students explore project management with a practical, hands-on approach through case studies and class exercises. A key and often overlooked challenge for project managers is the ability to manage without influence—to gain the support of stakeholders and access to resources not directly under their control. Special attention is given to critical success factors required to overcome resistance to change. We will review causes of project failure and how to mitigate risks through proper planning in the early phases of a new initiative.

Elective Courses Description

SEEN410 - Smart Grids

3 Credit Hours **Pre-Requisite - SEEN301**

Smart Grids Fundamentals and Components, Smart grid Control and Automation Technologies, Power Electronics and Energy Storage, Information and Communication Technologies, Demand Side Management, Energy Efficiency, Overview of Typical Pilot Projects in the World.

SEEN411 - Industrial Manufacturing

3 Credit Hours **Pre-Requisite - SEEN301**

The course is an introduction to manufacturing systems and manufacturing processes including assembly, machining, injection molding, casting, thermoforming, and more. Emphasis on the relationship between physics and randomness to quality, rate, cost, and flexibility. Attention to the relationship between the process and the system, and the process and part design. Project (in small groups) requires fabrication (and some design) of a product using several different processes.

SEEN412 - Computer Graphics and Multimedia

3 Credit Hours **Pre-Requisite – SEEN102**

Basic principles and techniques for computer graphics on modern graphics hardware. Students will gain experience in interactive computer graphics using the OpenGL API. Topics include: 2D viewing, 3D viewing, perspective, lighting, and geometry.

SEEN413 - Materials for Energy

3 Credit Hours **Pre-Requisite - SEEN209**

This course is intended as a review of the challenges facing materials scientists working in sustainable energy and sustainability science and technology. It aims to give the student a birds-eye view of the current topics in energy harvesting and storage materials. The potential of various energy harvesting approaches will be discussed in the context of energy needs facing the world. This will be done with particular focus on materials innovations required to improve the state of the art. After this thorough introduction, the course will discuss solar power and electrochemical energy storage in more depth.

SEEN414 - Energy Conservation and Efficiency

3 Credit Hours **Pre-Requisite - SEEN210**

This course offers the following: Energy conversion fundamentals, energy efficiency methods, reducing energy consumption in the built environment, analyzing residential and commercial facilities, employing energy-saving measures, energy monitoring equipment, measuring equipment for energy auditing, calculating energy savings, and determining environmental impacts.

SEEN415 - Energy Storage

3 Credit Hours **Pre-Requisites - CHEM131 and SEEN210**

This course covers the following: Historical developments in energy storage, basic concepts (electrodes, electrolytes, redox reactions), electrochemical thermodynamics, kinetics, electrode processes, electrochemical cells (galvanic and electrolytic), electrical energy storage systems (components, architectures, storage types, operating states), battery technologies, fuel cells, efficiencies and applications, corrosion mechanisms and prevention strategies, electrochemical sensors, monitoring techniques and control, modeling considerations, design and testing, safety, operation and maintenance.

SEEN416 - Special Topics in Sustainable Energy

3 Credit Hours **Pre-Requisite - SEEN210**

The course gives an overall introduction to energy issues as they relate to generation, delivery, conversion and efficiency. Topics include efficiencies of both new and established energy generation and conversion methods; electricity generation by fossil fuels, nuclear, solar, wind and hydro-power; and alternative energy technologies. Other topics include space heating and cooling by traditional methods and by solar, transportation energy in automobiles, mass transit and freight. Topics are evaluated quantitatively by modeling and using principles of fluid mechanics, thermodynamics and

heat transfer. The environmental consequences of energy choices on local, national and global scales, including toxic emissions, greenhouse gases and resource depletion are also discussed and integrated throughout the course.

SEEN417 - Bioenergy Systems

3 Credit Hours **Pre-Requisites - CHEM131 and SEEN210**

The course provides an introductory understanding to biomass, biomass to low-carbon energy systems including bio-power, bio-heat and biofuels, with a scientific examination of feedstocks, conversion technologies and scale up for industrial production, end products, and their applications. The course will also provide entry level understanding of the concepts of sustainability, systems thinking and Life Cycle Analysis (LCA) and incorporation of these concepts into bioenergy systems. The class will explore the potential advantages of low-carbon energy in developing a low-carbon economy and society. The class may also include a tour of the EcoComplex," Clean Energy Innovation Center and Business Incubator".

SEEN418 - Applied Machine Learning for Engineers

3 Credit Hours **Pre-Requisite - SEEN409**

Fundamentals of machine learning, toolboxes in machine learning, supervised learning, unsupervised learning, applications of machine learning in various engineering disciplines.

SEEN419 - Energy Web Technologies

3 Credit Hours **Pre-Requisite – SEEN102**

The aim of the course is to give students basic knowledge of central energy technologies. This includes how the systems function, how they can be evaluated quantitatively, what they cost and what is their benefits for or effects on the natural environment. A secondary aim is to give the students an overview of the contexts in which these systems are used and developed today and in the future.

SEEN504 - Energy Legislation

3 Credit Hours **Pre-Requisite - ECON300**

The primary objective of the class includes providing a high-level survey of laws and policies related to the generation, transmission, sale, and use of energy resources, with a particular focus on electricity and state jurisdictional boundaries.

SEEN505 - Scientific Research Methods

3 Credit Hours **Pre-Requisite - None**

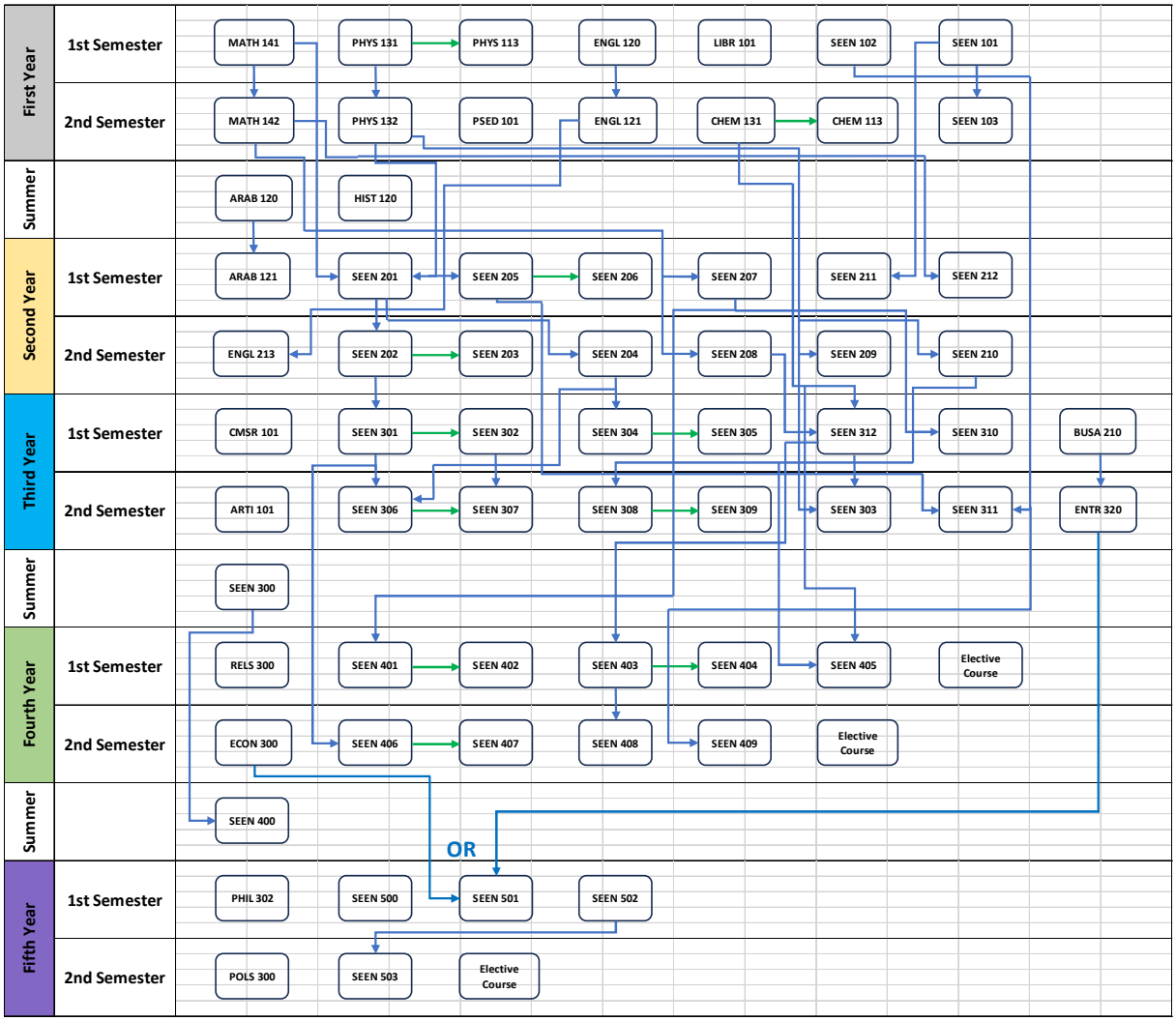
The course covers concepts of science, scientific research, basics of scientific approach, and literature review. It introduces how research problems and hypotheses are selected, defined, stated and evaluated. It also presents the main components of proposal writing. The course then focuses on experimental research approach and experimentation as a tool for obtaining data. In addition, it demonstrates the main route of descriptive approach and its tools including observation and questionnaire.

SEEN506 - Pumping Machinery

3 Credit Hours **Pre-Requisite - SEEN312**

Terminology and description of typical pump machinery. Momentum and energy transfer between fluid and rotor; Performance characteristics of centrifugal and axial flow fans, compressors and pumps; Various types of losses; Axial and radial thrust in dynamic pumps and thrust balancing devices; Common problems in centrifugal pump operation; Positive displacement pumps; Water hammer problems in pump systems; Special problems in pump design and applications.

Paradigm as Flow Chart



→	Prerequisite
→	Co-requisite