SPRINGFIELD RESEARCH UNIVERSITY

Bachelor of Engineering
Electrical Engineering

Bachelor of Engineering: Electrical Engineering

MISSION

The mission of the SRU Bachelor of Engineering – Electrical Engineering is aimed to impact knowledge, skill and process behind the production and distribution of electricity.

Electrical Engineering at SRU is about more than just learning the theories behind the discipline. It is about putting those theories into practice to solve problems. The students will learn the skills necessary to make useful products and to provide quality services by spending time on experiments in laboratory classes and designing projects.

PROGRAM OBJECTIVES

Graduates should be able to:

- Learn to design, develop and supervise the manufacture, installation, operation and maintenance of electrical systems.

- Work on systems for the generation, distribution, utilization and control of electric power, electronic and control systems used for various domestic and industrial applications.

- Develop high-level technical and design skill and focus on a specialist area such as energy conversions, power systems, renewable energies and high-voltage equipment.

PROGRAM LEARNING OUTCOMES

The program learning outcomes have been aligned with recognized standards for Bachelor of Engineering degrees.

1. **Knowledge and Skill Base**
   1.1. Comprehensive, theory-based understanding of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline.

   1.2. Conceptual understanding of mathematics, numerical analysis, statistics and computer and information sciences which underpin the engineering discipline

1.3. In-depth understanding of specialist bodies of knowledge within the engineering discipline.

1.4. Discernment of knowledge development and research directions within the engineering discipline.

1.5. Knowledge of contextual factors impacting the engineering discipline.

1.6. Understanding of the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline.

2. Engineering Application Ability

2.1. Application of established engineering methods to complex engineering problem solving.

2.2. Fluent application of engineering methods techniques, tools and resources.

2.3. Application of systematic engineering synthesis and design processes.

2.4. Application of systematic approaches to the conduct and management of engineering projects.

3. Professional and Personal Attribute

3.1. Ethical conduct and professional accountability.

3.2. Effective oral and written communication in professional and lay domains.

3.3. Creative, innovative and pro-active demeanour.

3.4. Professional use and management if information.

3.5. Orderly management of self, and professional conduct.

3.6. Effective team membership and team leadership.

CAREER OPPORTUNITIES

Electrical Engineers work on the systems for the generation, distribution, utilization and control of electrical power systems. They drive the transition to alternative and renewable sources.

After graduating you may work in areas of the industry such as:

- Power Generation and Distribution
- Mining Sources

- Renewable Energies
- Industrial Systems Design
- Consumer Product Design
- Process Control Industries
- Electrified Transformation
- Manufacturing
- Automotive
- Défense

CAREER PATHWAYS AND PROSPECTS

- Electrical Engineering
- Grid Maintenance and Stability Contractor
- Industry Power Supply Engineer
- Control Engineer
- Projects Engineer
- Test Engineer
- Design Engineer
- Communications Engineer
- Systems Engineer
- Aeronautical Engineer
- Electronic Engineer

ENTRY REQUIREMENTS

The student must have 6 passes in SGCSE/IGSCE O'Level including a pass with Grade C or better in English Language and Mathematics and any other two from Biology, Chemistry, Physics, Physical Science and or Human and Social Biology. Faculty may self-mature entry requirements subject to approval by the Senate.

Year 1: Semester I

- BEE 100 Introduction to Professional Engineering Practice – 12 Credits
- BEE 101 Digital Fundamentals - 12 Credits
- BEE 102 Introduction to Electrical and Electronic Engineering – 12 Credits
- BEE 103 Engineering Mathematics

Semester II

- BEE 104 Engineering Science - 12 Credits
- BEE 105 Creative Engineering CAD – 12 Credits
- BEE 106 Advance Manufacturing and Mechatronics – 12 Credits
- BEE 107 Foundations of Artificial Intelligence for STEM – 12 Credits

Year 2: Semester III

- BEE 108 Mathematics for ECE – 12 Credits
- BEE 109 Electronical Engineering 1 – 12 Credits
- BEE 110 Electronics – 12 Credits
- BEE 111 Introduction to Embedded Systems – 12 Credits

Semester IV

- BEE 112 Engineering Design 2 – 12 Credits
- BEE 113 Signals and Systems 1 – 12 Credits
- BEE 114 Engineering Computers 1 – 12 Credits
- BEE 115 Network Fundamentals and Applications – 12 Credits

Year 3: Semester V

- BEE 116 Engineering Design 3 – 12 Credits
- BEE 117 Power System Analysis and Control – 12 Credits
- BEE 118 Control Systems – 12 Credits
- BEE 119 Electrical Plant – 12 Credits

Semester VI

- BEE 120 Electrical Energy Conversion – 12 Credits
- BEE 121 Research Methods for Engineers – 12 Credits
- BEE 122 Industrial Automation – 12 Credits
- BEE 123 Communication Engineering I – 12 Credits

Year 4: Semester VII

- BEE 124 Engineering Capstone Project Part A – 12 Credits
- BEE 125 Variable Speed Drives – 12 Credits
- BEE 126 Advanced Control Systems – 12 Credits
- BEE 127 Real Time Estimation and Control – 12 Credits

Semester VIII

- BEE 128 Engineering Capstone Projects Part B – 12 Credits
- BEE 129 Power Electronic Converters – 12 Credits
- BEE 130 Protection and High Voltage Engineering – 12 Credits
- BEE 131 Renewable Electrical Energy Systems – 12 Credits

Course Descriptions

INTRODUCTION TO PROFESSIONAL ENGINEERING

Introduction to Professional Engineering Practice provides a foundation for your ongoing professional development, first as a student engineer, and later as a professional engineer. The course caters around learning and applying engineering design, while developing the complimentary skills required to practice competently, ethically, and safely. Course topics will be learnt through lectures, briefings and tutorials as well as self-guided learning. The course will prepare you for subsequent, discipline-specific courses in engineering design, research, management and sustainability.

DIGITAL FUNDAMENTALS

This course is focused on digital literature for engineers and will equip you with the ability to apply a problem-solving methodology to common engineering problems. Using a problems-based approach, students will develop the skills to design, write, test and debug programs that improve the world we live in. You will be presented with various types of engineering problems which you will then work through from problem identification and algorithm design through to the implementation phase. As part of the course you will also be introduced to the syntax and development environment of engineering software tool MATLAB/Simulink.

INTRODUCTION TO ELECTRICAL AND ELECTRONIC ENGINEERING

The aim of this course is to make you competent in analyzing electrical circuits and performing basic electrical measurements to verify circuit concepts experimentally. In this course, you will be introduced to the concepts and definition of charges, currents, voltages, power and energy. You will learn the voltage-current relationships of basic circuit elements-resistors, inductors, capacitors, dependent and independent voltage and current sources; apply Kirchhoff's current and voltage laws to circuits in order to determine voltage, current and power branches of any circuit excited by DC voltage and current sources. Applying simplifying techniques to solve DC circuit problems using basic circuit theorems and structured methods like node voltage and mesh current analysis. The goal also includes derivation of the transient responses of RC and RL circuits, steady state response of circuits to sinusoidal excitation in time domain, application of phasors to circuit analysis, introduction to non-liners electronic devices such as diodes.

ENGINEERING MATHEMATICS

This course provides a broad introduction to the fundamental mathematical tools used by engineers. These include mathematical techniques such as single variable differentiation or integration and mathematical objects such as vectors, complex numbers, and differential

equations. The course builds on the foundations laid in secondary school mathematics and in turn helps to prepare students from more advanced mathematics in later study, and to give students the skills needed to understand the application of mathematics to engineering in real time. Topics include vectors, complex numbers, differentiation with applications, functions and their derivations methods of integration and their application.

ENGINEERING SCIENCE

Through a multidisciplinary approach, this course aims to introduce and contextualize the fundamental science that underpins engineering. This comprises three key areas of introductory physical chemistry, kinematics, and electronic circuits. Introducing physical chemistry will cover nomenclature, molecular structure and stoichiometric reactions. In kinematics you will develop an understanding of work and of conservation energy. Electronic circuits will introduce you to Ohm's Law, hence the consideration of electrical potential, current, resistance and capacitance.

CREATIVE ENGINEERING CAD

Computer Aided Design (CAD) is a significant contributor in transforming a concept into a tangible reality in order to test-with confidence tangible realities by simulating real world conditions. In this course you will develop fundamental CAD skills in both the 2D realm (e.g. building plans or circuit design) and 3D realm (e.g. using fully manipulable animated models that are invaluable tools for visualizing complex mechanisms. You will also improve your skills and knowledge in drawing techniques, learn to use specific tools and learn about the design process. You will learn about how international standards define the common language of graphic communication. These graphically presented virtual realities will also extend to the realm of augmented reality, in which simulations and real-world combine for totally immersive design,

ADVANCED MANUFACTURING AND MECHATRONICS

In this course you will learn about the operating principles, advantages, limitations and physical applications of various manufacturing process including:

- Solidification processes (casting, injection moulding) material removal processes (conventional and non-traditional machining) deformation process (forging, rolling, extension) as well as additive manufacturing techniques (3D printing).

You will also learn about key principles which support effective manufacturing systems including:

- Manufacturing Economics

- Quality Control Techniques and:
- Basic Principle of Manufacturing process automations through an introduction to G-code Computer Numerical Control (CNC) programming.

Furthermore, the course will cover the principles of mechatronic systems design in hands-on design classes, focusing on the following topics:

- Basic Mechatronics
- Embedded Programming
- Repetition and Digital processing
- Selection and Analog Processing
- Function and Pulse Width Modulation

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE STEM

This course introduces the foundation of Artificial Intelligence (AI) tailored to students from a range of health, science, technology, engineering, and math disciplines. AI is a branch of Computer Science devoted to devoted to developing intelligent hardware and Software Systems. Applications of AI are now widespread in the world of work. It is therefore increasingly important for all health, science, technology, engineering, and math disciplines graduate to understand the foundations and applications of the field of AI relevant to their own discipline. This course will also challenge you to consider the impact and ethics of AI on your future profession and society.

MATHEMATICS FOR ELECTRICAL AND COMPUTER ENGINEERING

Mathematics for Electrical and Computer Engineering is a core component of the Electrical and Computer Engineering Bachelors degrees. It provides an opportunity to develop the requisite range skills relevant to a wide range of sub-discipline existing within the field of Electrical and Computer Engineering. In this course you will be introduce to a range of mathematical concepts identified as fundamental to enhance your progress in studying related Engineering Courses. You will develop the mathematical maturity required to become a well-grounded engineer.

ELECTRICAL ENGINEERING I

You will learn about the dangers involved in the use of electricity, and existing precautionary standards and good practices for mitigating them. You will learn steady-state analysis techniques to deal with circuits that contain one or more sinusoidal voltage and current sources

(4C Circuits), Solve AC circuits involving magnetically coupled circuits elements(transformers). You will then extend AC circuit analysis concepts to define frequency transfer functions in the context of systems subjected to sinusoidal input of varying frequency. You will explore the basic principles of electromechanical energy conversion.

ELECTRONICS

The major of objective of this course is to make you competent in analyzing and designing electronic circuits which all perform some specific tasks. Topics covered are fundamental building blocks for further studies in electronic engineering. In this course, you will learn:

- Basic electronic device characteristics
- Analysis and design of basic amplifies circuits
- Amplifier frequency response analysis
- Feedback amplifier types

Theoretical analysis and design will be augmented by computer simulation and experiment verification.

INTRODUCTION TO EMBEDDED SYSTEMS

This course provides an introduction to Embedded Systems.

Through the use of simulation software and hardware interfaced to a physical embedded system, you will develop competence in microprocessor-based digital systems design. Particular topics investigated will include:

- Introduction to Digital Hardware Technologies
- Introduction to Computer Systems and Architectures
- Introduction to Assembler-Level Firmware for Embedded Systems
- Introduction on Interfacing Computer Systems to External Hardware
- Use of C/C++ programming language to implement functionality in embedded hardware.

ENGINEERING DESIGN 2

You will learn the principles and practice of designing, constructing, and debugging an electronic circuit as a case study. The lecture will present the theory of the case study circuit, the process of the design, the concept of simulation to circuit performance and the process of proceeding from a circuit schematic to a Printed Circuit Board. The lectures will also discuss practical design issues such as component selection, thermal rating, mechanical footprint, and a number of other issues that need to be considered part of the overall design process. The laboratory of the experiments will provide a physical forum to develop the practical skills of electronic circuit design. The first experiments will provide you with the opportunity to gain experience in circuit schematic capture and simulation using Altium Circuit Designer. The overall focus of the course is to present an integrated and coherent approach to the design and construction process of an electronic circuit, which can be applied to more complex system design tasks.

SIGNALS AND SYSTEMS I

The focus of this course is to introduce you to the fundamental concepts and techniques used in both analogue and digital signal processing (ASP and DSP). Initially you will be introduced o the basic concept of signals and systems and learn about the important mathematical techniques commonly used in the analysis of these (this include both time-and frequency-domain analysis techniques). You will then examine signal processing systems to determine how these can be classified as casual, stable and linear, time invariant (LTI). This will then allow you to utilize time and frequency domain techniques to analyze the behavior of systems from their transfer functions, impulse responses, frequency responses and z-transforms (for discrete-time systems). This course will also introduce you to the methods used to convert continuous -time signals to discrete -time (and vice-versa) and how to assess appropriate criteria to use to prevent signal distortion.

ENGINEERING COMPUTING I

This course provides a foundation in the basic building blocks of complete systems with a particular emphasis on programming to control hardware. You will be expected to develop applications in an Integrated Development Environment (IDE) that can be used to interface with external hardware. Aspects of the underlying hardware are highlighted which are relevant to the overall system and programming constraints.

Particular topics to be investigated will include:

- Introduction to C++
- Data Types and Operators in C++
- Program Control Statements in C++
- Arrays, Strings, and Pointers in C++
- Introduction to Functions on C++
- More Data Types and Operators

NETWORK FUNDAMENTALS AND APPLICATIONS

This course provides an introduction to telecommunication network fundamentals. The lectures start with a broader introduction to connected devices that form a network and the 051 7- Layer model for standardizing networking functionalities. The course mainly covers Layer1, Layers 2, Layer 3 and Layer4 of the OSI model with example networks such as the internet Wi-Fi access network, cellular access and core networks (3G,4G,5G Networks), and the optical fibre transport network. Tele traffic engineering is introduced in the courses by covering some basic traffic theories and their design implications on networks for providing the expected quality of service (PoS) and optimizing the network resources. The lab sessions will cover network design and performance analysis using a network simulator.

ENGINEERING DESIGN 3

Studying Engineering Design 3, you will acquire knowledge and skill that are expected from engineering graduates of the 21st Century. This semester you will work in a team to develop a product proposed by of team members. For the duration of the course your team will be assigned an academic staff member, who will act as your teams' mentor. Engineering Design 3, will engage you in individual activities in team-based project work. Team work will help you to refine you analytical and practical design skill acquired during the first two and half years of study.

POWER SYSTEM ANALYSIS AND CONTROL

The course provides the theoretical background required to model and analyze larger power systems. This includes modelling of transmission lines for steady-state and transient conditions, balanced and unbalanced power systems fault analysis, the basic power quality indices and power quality analytical techniques. In addition, this course deals with the voltage control techniques used for renewable rich distribution feeder. Particular topics to be investigated will include:

1. Per-unit Calculations
2. Transmission Line Modelling and Analysis
3. Transmission Line Surge Propagation
4. Distribution Feeder Voltage Control
5. Balanced Faults
6. Theory of Symmetrical Components and Unbalanced Faults
7. Power Quality in distribution Networks.

CONTROL SYSTEMS

This subject will introduce you to the principles and practice of feedback control systems and outlines their role in modern society. You will learn about dynamic system modelling and controller synthesis as two key elements in the development of a modern control in the development of a modern control system, and the subject will emphasis the usage of transform theory to facilitate both of these elements. This subject will also introduce techniques for the practical implementation of the synthesized controller. Topics that are covered in this subject include: introduction to feedback, system modelling using Laplace transform and state space representatives, non-linear system models, siso control, prototype controllers based on proportional and integral and derivative elements, root locus techniques, Nyquist and Bode techniques, compensation strategies, feed-forward and cascaded loops, and practical realization issues.

ELECTRICAL PLANT

The course develops the analysis of balanced three-phased systems and its application is predicting the performance of power devices such as transformers, induction motors and synchronous machines. This includes basic principles of motor construction, various modes of operation, and their role in electrical drives for various industrial applications. In addition, the course deals with the safety aspects of installations and enhances the awareness of possible adverse effects of electro-technology on the environment.

ELECTRICAL ENERGY CONVERSION

The course introduces you to the principles of conversion of electronic power from one form to another, e.g. from DC to AC of variable frequency. The most common power electronic system used for such conversion are the main topics of the course, with the focus on the principle of operation of each system, the basic design calculations and practical applications. You will have an opportunity to test each system in the laboratory.

RESEARCH METHODS FOR ENGINEERS

Research methods are critical aspects of engineering professional practice and scholarship. This course will give an overview with applied exercises of best practice in addressing an engineering challenge in a systematic manner, evaluating background literature, adhering to ethics, documentation strategies, and communication in the form of both concise as well as detailed written reports, and oral and written communication of complex engineering concepts to a general audience.

INDUSTRIAL AUTOMATION

This course introduces you to practical methods of automatic control machines, processes and systems. All major parts of a modern industrial control system will be described and theur

principles explained. These include the Programmable Logic Controller (PLC) as the system 'brain', various filed devices, which allow the system to 'sense' and 'affect' the controlled environment, and communication between the system components. The principles of developing PLC Programs and practical example of control systems will be also presented. The course provided individual hands-on experience in PLC programming.

COMMUNICATION ENGINEERING I

The course provides an introduction to both elementary and modern forms of Communication Engineering. Communication Engineering can be defined as the reliable transmission and reception of information. The course will develop your skills in the basic theory and methods associated with Communication Engineering, including:

- An introduction to Information Representation and Processing
- Familiarization with the basics of classical and modern communication systems
- Hands on experience with communication devices and system hardware

Special topics covered include:

- The representation of all forms of information in different domains. Time-domain and the real-frequency domain are emphasized.
- Analogue communications, particularly Amplitude Modulation (AM) and Frequency Modulation (FM). These techniques have been used for several decades in the field of communications.
- Digital communication, with emphasis on baseband signaling, basic digital modulation techniques, inter-symbol interference and error rates.
- Optical fibres and optical communication systems and devices.

ENGINEERING CAPSTONE PROJECT PART A

This course is the first half of a research and development (R&D) project that comprises two sequential courses (Part A and Part B) and is the capstone for all engineering programs. In this culminating academic experience, you will apply your technical knowledge and further develop your research, design and professional skills. The authentic project may be industry based and focuses on producing well-managed practical and pertinent solutions to either discipline specific or cross disciplinary engineering problems, through robust research and established engineering design processes. This first part of the project (Part A) focuses on:

- Articulation of the project requirements, challenge, need, problem or feasibility .

- Establishment of design criteria and constraints
- Project planning
- The critical appraised of all the relevant published material by way of a comprehensive literature search and review.
- Benchmarking of all related and relevant solutions
- And hence well-informed consideration of possible solutions.

After successfully passing this course you will undertake the required companion course 'Engineering Capstone Project Part B' which will result in the fulfillment of the final project deliverable.

VARIABLE SPEED DRIVES

The course introduces the student to the principles of electronic motor drives and various method of their control. Topic areas include principle and characteristics of different types of drive, methods of speed variation, dynamic and thermal consideration drive systems and automatic control of electric drives.

ADVANCED CONTROL SYSTEMS

This course introduces you to the theories and tools in advanced Control Systems. You will learn about the concept the of controllers such as PID and pole-assignment controllers which are widely used in the process and manufacturing industries. The state-space design methods including state feedback and state observer are also introduced in the later part of the course. Topics that are covered in this course include:

- Introduction to mathematical modelling and control system.
- Understanding PID controller design and implementation issues
- Understanding pole-assignments controller design methods
- Understanding frequency response analysis
- Step response testing

REAL TIME ESTIMATION AND CONTROL

This course is meant to familiarize you with the model predictive control technologies that include multivariable control systems, constrained control and process optimization. It will

impact the skills of application of established engineering methods to complex engineering problem solving.

ENGINEERING CAPSTONE PROJECT PART B

This course includes a work integrated learning experience in which your knowledge and skills will be applied and assessed in a real or simulated workplace context, and where feedback from industry and/or community is integral to your experience. This second half of the Capstone Engineering Research and Development (R&D) project concludes a culminating experience that applies your technical knowledge, research, design and professional engineering skills. It maybe industry based and aims to produce well-managed practical and pertinent solution to either discipline specific, or cross disciplinary engineering problems, though robust research and established engineering design process. This part of the (Part B) focuses on:

- Summarizing the outcomes of your "Engineering Capstone Project (Part A)
- Clearly stimulating a plan including milestones and responsibilities
- The application of methodical design process for the systematic optimization and embodiment of an engineering solution.
- The manufacture of a tangible deliverable (where appropriate)
- The test and verification of the solution
- A comprehensive suite of relevant project documentation (such as reports and drawings)

POWER ELECTRONIC CLUSTERS

The course will introduce you to the principles and practice of smart electrical energy conversion. The fundamental power electronical converter topologies are introduced and you will learn about modulation processes (i.e. switching) and control techniques for these systems. The course emphasizes digital strategies appropriate for implementation using digital signal processors.

Topics that are covered in this course include:

- Elementary switching cells
- Single and three phase topologies
- Multilevel converters

- Career based pulse width modulation, space vector modulation, multilevel pulse width modulation
- Closed loop DC AND AC current regulation, linear regulation, on linear hysteresis regulators converter application (e.g. motor drives and renewable energy).

PROJECTION AND HIGH VOLTAGE ENGINEERING

This course explores various aspects of the design and operation of modern power systems. The focus will be on the area of Protection in Power Systems and High Voltage Engineering. In the laboratory classes, you will work with some state-of -the-art equipment used in industry for protection and measurement in power systems., the course will introduce students to the principle of high voltage test system in AC, DC and impulse voltage test system, breakdown mechanism in solid and gas insulating medium and non-intrusive test methods to evaluate the performance of electrical insulation system. In addition, we will introduce topics such as protection system using overcurrent relay, distance relay and directional relay.

RENEWABLE ELECTRICAL ENERGY SYSTEMS

The course will introduce to you to renewable electrical energy systems, their characteristics, design procedure and economic analysis. Renewable energy sources such as solar PV, wind, fuel, cell, marine and hydro will be covered in this course. The emphasis is on the design analysis of practical renewable electrical energy systems as well as on the distributed generation, recent grid codes and economic analysis of renewable energy sources in the context of smart grid.