SCE
الهيئة السعودية للمهندسين
SAUDI COUNCIL OF ENGINEERS

المركز الوطني للقياس
National Center for Assessment

Engineering Fundamentals Exam

Electrical Engineering Standards

Introduction

Engineering standards are the set of knowledge, abilities, and professional attributes necessary to practice the engineering profession [3-5]. Every Engineering Standard is linked to a number of indicators. These indicators can be viewed as instruments that measure the examinee fulfillment of the corresponding standard. In other words, a Standard is a broad statement about a specific topic, whereas, the Indicators are specific requirements extracted from the Standard and directly linked to the exam question.

Some of these first level standards are drawn from the completion of a Bachelor of Engineering degree from an accredited engineering college. An accredited engineering degree program usually has the breadth of understanding of a wide range of technologies and applications. It also usually has sufficient depth in at least one specific area of practice to develop competence in handling technically complex problems [6].

The knowledge part of the first level standards include, generally, knowledge of science and engineering fundamentals, in-depth technical competence in an engineering discipline, knowledge of theoretical and experimental techniques, knowledge of basic business and project management practices, and broad general knowledge.

The ability part of the first level standards include, generally, the ability to identify, formulate, and solve problems, ability to understand environmental and social issues, ability to deal with ambiguity and complex problems, ability to perform engineering design, and an ability to interpret and visualize data [3-5].

The professional Attributes part of the first level standards are the sets of skills often sought by employers for hiring engineers either fresh graduates or experienced. They are sometimes called “soft” or “general” skills. They include capacity for effective communication [7] with the engineering team and costumers, capacity for effective work within multidisciplinary and multicultural teams, capacity for lifelong learning and professional development, self-drive and motivation, creativity and innovation, leadership, and capacity to maintain a professional image in all circumstances [3-5].

Electrical Engineering Standards

The Engineering Standards for the Electrical Engineering Discipline are structured around nine core Topics:

1. Electrical circuits
2. Power systems
3. Electromagnetics
4. Control systems
5. Communications
6. Signal Processing
7. Electronics
8. Digital systems
9. Computer systems

Each Indicator is projected onto three Learning Levels (obtained by combining every two consecutive levels in the revised Bloom's taxonomy into one level)

1. Remembering and Understanding
2. Applying and Analyzing
3. Evaluating and Creating

Standards are coded EE-TJ where:

- EE denotes Electrical Engineering
- TJ denotes Topic Number J

Indicators are coded EE-TJ-K (where K denotes the Indicator number).

Example

Topic:	**T1:** Circuits
Standard:	**EE-T1**: Electrical engineers should possess the ability to identify electrical circuit components and write the relationships governing voltages and currents in simple circuits as well as employ theorems and equivalent relationships to solve and assess the performance of electrical circuits.
Indicator:	**EE-T1-05**: Express voltage-current relationships and perform node and loop analysis of electrical circuits
Learning Level:	Applying and Analyzing (AA)

T1: Circuits (16%)

EE-T1 Electrical engineers should possess the ability to identify electrical circuit components and write the relationships governing voltages and currents in simple circuits as well as employ theorems and equivalent relationships to solve and assess the performance of electrical circuits. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T1-Indicators

EE-T1-01	Write equations, express and apply fundamental circuit theorems, including KCL, KVL, to simple electrical circuits
EE-T1-02	Derive and employ series/parallel equivalent circuits to simplify electrical circuits
EE-T1-03	Model and calculate impedance of various electrical elements and components
EE-T1-04	Derive and apply transfer functions for electrical systems
EE-T1-05	Express voltage-current relationships and perform node and loop analysis of electrical circuits
EE-T1-06	Analyze electrical circuits using Thevenin / Norton theorems
EE-T1-07	Apply 2-port theory to analyze and investigate performance of electrical circuits
EE-T1-08	Use frequency/transient response to analyze and investigate electrical circuits
EE-T1-09	Select and apply Laplace transforms to analyze electrical circuits
EE-T1-10	Utilize frequency/transient response in the design of electrical circuits
EE-T1-11	Apply resonance principles in the design of electrical circuits
EE-T1-12	Conduct design and assess performance of passive Filters
EE-T1-13	Demonstrate familiarity with the practical aspects and implications of resonance

T2: Power (14%)

EE-T2 Electrical engineers should be able to model and analyze 3-phase power systems as well as analyze and assess performance of basic electrical machines, transformers, and power electronic devices. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T2-Indicators

EE-T2-01	Compute 3-phase voltage, current, and power quantities for electrical systems
EE-T2-02	Model and calculate parameters of transmission lines
EE-T2-03	Draw and compute phasor quantities representing electrical systems
EE-T2-04	Perform delta-wye transformation in the analysis of three-phase power networks
EE-T2-05	Evaluate and analyze power factor and investigate its impact on system performance
EE-T2-06	Conduct performance analysis of electrical motors
EE-T2-07	Analyze and investigate power electronics circuits and devices
EE-T2-08	Analyze and assess performance of transformers
EE-T2-09	Employ voltage regulation concepts in the design of power systems
EE-T2-10	Apply optimal performance requirements in the design of electrical motors
EE-T2-11	Apply optimal performance requirements in the design of transformers
EE-T2-12	Recognize and distinguish various types of motors and demonstrate familiarity with their operation in practice
EE-T2-13	Recognize different types of transformers and their functions in practical applications

T3: Electromagnetics (6%)

EE-T3 Electrical engineers should be able to model, analyze and assess performance of various electrostatic and magnetostatic components and devices as well as interpret and apply basic wave propagation principles. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T3-Indicators

EE-T3-01	Model various electrostatics/magnetostatics components and derive the associated basic relationships
EE-T3-02	Analyze and investigate electrostatics/magnetostatics systems using vector analysis
EE-T3-03	Conduct electromagnetic analysis using wave propagation concepts
EE-T3-04	Analyze performance of high frequency transmission lines
EE-T3-05	Conduct design of high frequency transmission lines
EE-T3-06	Demonstrate awareness and knowledge of wave propagation in real life communications applications

T4: Control Systems (10%)

EE-T4 Electrical engineers should possess the ability to model and analyze control systems, build block diagrams, design and assess performance of controllers as well as investigate the stability of various control systems. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T4-Indicators

EE-T4-01 Interpret process flow and construct associated feed forward and feedback block diagrams

EE-T4-02 Interpret and formulate basic concepts of stability of engineering systems

EE-T4-03 Analyze performance and evaluate steady-state errors of control systems subjected to various input signals

EE-T4-04 Apply root locus and Bode plots to analyze and investigate performance of control systems

EE-T4-05 Analyze controller performance in regard to gain, PID parameters, and steady-state errors

EE-T4-06 Apply design principles to optimize controller performance in regard to gain, PID parameters, and steady-state errors in control systems

EE-T4-07 Explore and apply concepts of stability to design stable control systems

EE-T4-08 Describe and explain usage and importance of stability in practical electrical engineering applications

T5: Communications (10%)

EE-T5 Electrical engineers should be able to model and analyze various communication components, including modulation/demodulation devices as well as interpret and apply multiplexing principles to design and assess performance of communication systems. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T5-Indicators

EE-T5-01 Model and apply basic modulation/demodulation concepts, including AM, FM, and PCM

EE-T5-02 Model and apply concepts of multiplexing in communication systems

EE-T5-03 Employ design principles of computer networks, including OSI model

EE-T5-04 Apply concepts of Pulse-Position Modulation (PPM), Phase-shift keying (PSK) and Quadrature Amplitude Modulation (QAM) in the design of communication systems

EE-T5-05 Demonstrate awareness of implementing basic modulation/demodulation concepts, including AM, FM, and PCM in real life applications

T6: Signal Processing (8%)

EE-T6 Electrical engineers should be able to apply various signal processing techniques such as analog/digital conversion algorithms as well as employ various signal processing methods in the design and performance assessment of electrical systems. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T6-Indicators

EE-T6-01 Write and apply basic formulas and relationships of analog/digital conversion

EE-T6-02 Apply Z-transforms in the analysis of electrical systems

EE-T6-03 Apply Fourier transforms/Fourier series to analyze and process signals

EE-T6-04 Analyze and investigate performance of communication systems using sampling theorem

EE-T6-05 Apply Fast Fourier Transform (FFT) and Discrete Fourier Transform (DFT) in processing signals

T7: Electronics (14%)

EE-T7 Electrical engineers should be able to model, analyze, and design various electronic components and devices, including discrete devices, operational amplifiers, differential amplifiers, active filters, etc. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T7-Indicators

EE-T7-01 Model and apply basic solid-state fundamentals, including tunneling, diffusion/drift current, energy bands, doping bands, and p-n theory

EE-T7-02 Model components and derive relationships governing active filters

EE-T7-03 Analyze components and formulate relationships of discrete devices, including diodes, transistors, BJT, and CMOS

EE-T7-04 Analyze and investigate performance of discrete devices and assess their performance

EE-T7-05 Apply bias circuits in the analysis and investigation of electronic systems

EE-T7-06 Analyze and assess performance of differential amplifiers

EE-T7-07 Apply design concepts to optimize performance of operational amplifiers

EE-T7-08 Design optimal performance active filters

EE-T7-09 Explain practical applications of active filters and demonstrate familiarity with their operation in practice

EE-T7-10 Demonstrate awareness of instrumentation aspects, including measurements, data acquisitions, and transducers, as well as explain their functions in practice

T8: Digital Systems (12%)

EE-T8 Electrical engineers should possess the ability to model, analyze, and apply digital system components and devices, including counters, flip-flops, programmable logic devices and gate arrays. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T8-Indicators

EE-T8-01	Formulate and apply numbering systems
EE-T8-02	Model and apply counters
EE-T8-03	Employ Boolean logic in the analysis of digital systems
EE-T8-04	Analyze and investigate performance of digital systems using state tables/diagrams
EE-T8-05	Apply logic minimization using SOP, POS, and Kamaugh maps in the analysis and investigation of digital systems
EE-T8-06	Apply timing diagrams to analyze digital systems
EE-T8-07	Apply and perform data path/control system design
EE-T8-08	Design and assess performance of flip-flops
EE-T8-09	Apply design principles to build programmable logic devices and gate arrays
EE-T8-10	Design and assess performance of logic gates and circuits
EE-T8-11	Recognize and distinguish various types of programmable logic devices and gate arrays and demonstrate familiarity with their operation in real life applications

T9: Computer Systems (10%)

EE-T9 Electrical engineers should have the ability to recognize modern computer system components as well as model, investigate, and design computer system related components, including microprocessors, memory, etc. They should also have the ability to apply modern software design methods and optimize performance for computer systems. The following *Indicators* are addressed in the *Test Questions* on this *Topic Area*:

T9-Indicators

EE-T9-01 Describe and model components of computer systems architecture, including pipelining, and cache memory

EE-T9-02 Model and derive basic relationships governing microprocessors

EE-T9-03 Analyze interfacing mechanisms in computer systems

EE-T9-04 Apply memory technology in the analysis of computer systems

EE-T9-05 Analyze and assess performance of microprocessors

EE-T9-06 Apply design principles to optimize performance of microprocessors

EE-T9-07 Use memory technology and systems in the design of computer systems

EE-T9-08 Apply software design methods (structured, top-down, bottom-up, object-oriented design) to optimize performance for computer systems

EE-T9-09 Describe and explain usage and importance of microprocessors in practice

EE-T9-10 Demonstrate knowledge and awareness of software implementation (structured programming, algorithms, data structures) techniques in real life applications

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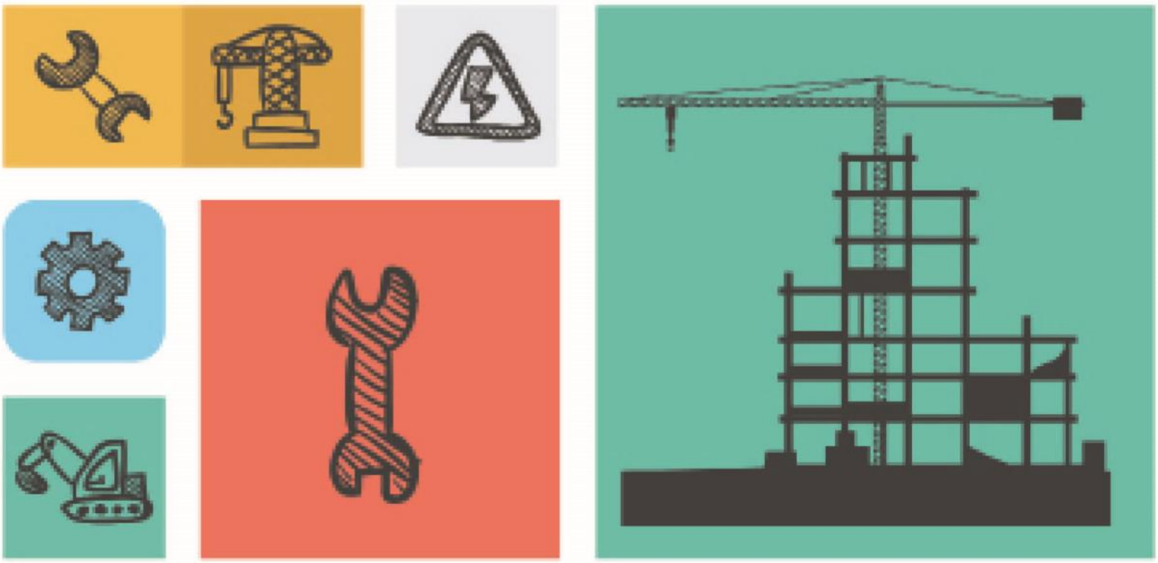

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