Engineering Fundamentals Exam

Civil Engineering Standards

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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].

Civil Engineering Standards

The Engineering Standards for the Civil Engineering Discipline are structured around ten core Topics:

1. Structural Analysis
2. Structural Design
3. Materials
4. Geotechnical Engineering
5. Water Resources Engineering
6. Environmental Engineering
7. Transportation Engineering
8. Construction Management
9. Surveying

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 CE-TJ where:

- CE denotes Civil Engineering
- TJ denotes Topic Number J

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

Example

Topic: **T1:** Structural Analysis

Standard: **CE-T1:** Civil Engineers are expected to demonstrate knowledge and skill in analyzing and modeling structural components or processes of buildings, bridges, and other structural systems.

Indicator: **CE-T1-08**: Evaluate displacements and slopes in beams and frames using numerical and energy methods

Learning Level: Applying and Analyzing (AA)

Topic T1: Structural Analysis (14%)

CE-T1 Civil Engineers are expected to demonstrate knowledge and skill in analyzing and modeling structural components or processes of buildings, bridges, and other structural systems.

T1-Indicators

CE-T1-01 Describe axial and torsional stresses in different structural members

CE-T1-02 Describe normal, bending, and shear stresses

CE-T1-03 Evaluate stresses and strains for multi-loading conditions

CE-T1-04 Determine stresses and strains for buckling problems

CE-T1-05 Determine various types of loads (dead, live, and wind) according to code provisions

CE-T1-06 Analyze the internal forces in determinate beams and frames

CE-T1-07 Analyze the internal forces in trusses

CE-T1-08 Apply influence lines for beams and trusses

CE-T1-09 Evaluate displacements and slopes in beams and frames using numerical and energy methods

CE-T1-10 Evaluate joint deformations in trusses using numerical and energy methods

CE-T1-11 Analyze indeterminate beams and frames using different methods

T2: Structural Design (14%)

CE-T2 Civil Engineers are expected to demonstrate knowledge and skill in the design of components and elements of buildings, bridges, and other civil engineering systems.

T2-Indicators

CE-T2-01 Compute design loads within code constraints of safety, serviceability, and economy

CE-T2-02 Design and evaluation of strength of reinforced concrete beams according to code provisions

CE-T2-03 Design reinforced concrete columns considering slenderness and stability

CE-T2-04 Design different types of slabs to satisfy design criteria and code provisions

CE-T2-05 Evaluate the strength of different concrete elements; slabs, beams, and columns for flexural and shear resistances

CE-T2-06 Design different types of footings and staircases according to code provisions

CE-T2-07 Design different steel elements and evaluate their serviceability requirements according to code provisions

CE-T2-08 Evaluate the strength of different steel elements; beams, columns, connections, and tension members

CE-T2-09 Comply with code requirements of durability for the design and construction of concrete and steel structures

CE-T2-10 Recognize the importance of building codes and their role in the design process

T3: Materials (8%)

CE-T3 Civil Engineers are expected to have knowledge and skill in the description, analysis, and practice of Civil Engineering materials which are used for construction, i.e., cement, steel, concrete, and its ingredients (aggregates, sand, supplementary cementing materials, etc

T3-Indicators

CE-T3-01 Describe engineering properties of constituent materials of concrete (cement, aggregates, etc.)

CE-T3-02 Describe fresh and hardened properties of concrete

CE-T3-03 Describe the mechanical properties of concrete, steel, and other structural materials

CE-T3-04 Practice the method of testing according to standards and specifications and interpretation of test results

CE-T3-05 Analyze testing results of concrete and other construction materials

CE-T3-06 Design concrete mixes to satisfy certain design criteria related to strength, specific performance, and economical constraints

CE-T3-07 Recognize various factors that affect different material strength and durability

CE-T3-08 Apply statistical tools for quality control of concrete

CE-T3-09 Practice mixing, handling, placing, and curing of concrete

T4: Geotechnical Engineering (14%)

CE-T4 Civil Engineers are expected to demonstrate knowledge and skill in analyzing and modeling geotechnical components or processes of civil engineering systems.

T4-Indicators

CE-T4-01 Describe the basics of engineering geology

CE-T4-02 Recognize the importance of geological phenomenon such as weathering, erosion, and soil transportation processes

CE-T4-03 Describe the basic physical/engineering properties of soils, soil classification

CE-T4-04 Describe the stresses and strains in rock mass

CE-T4-05 Analyze In-situ stress, seepage, and shear strength of soils/rocks

CE-T4-06 Analyze In-situ consolidation, lateral earth pressure, and stability of side slopes of soils/rocks

CE-T4-07 Estimate stress distribution in ground

CE-T4-08 Describe the principles of soil compaction and its effect on improving the soil behavior under loads

CE-T4-09 Assess the bearing capacity and behavior of soils/rocks under loads for both shallow and deep foundations

CE-T4-10 Analyze and estimate the total and rate of settlement of soils/rocks

CE-T4-11 Design conventional retaining walls according to the site and structure characteristics

CE-T4-12 Design the various types of shallow foundation

CE-T4-13 Comply with code specifications and procedures regarding lab/field testing, analysis and design of shallow foundations and retaining walls

T5: Water Resources Engineering (14%)

CE-T5 Civil engineers should be able to deal with hydraulics and hydrologic Systems. Civil Engineers should have knowledge and skill in analyzing and designing pipelines, canals, dams, and other related systems.

T5-Indicators

CE-T5-01 Describe fluid properties and hydrostatic pressure, drag and lift forces

CE-T5-02 Describe fluid dynamics and the concepts of conservation of mass, momentum, and energy

CE-T5-03 Analyze pressurized flows (pipelines, pipe networks, pumps)

CE-T5-04 Analyze and compute flow in open channels

CE-T5-05 Model hydrological and hydraulics processes

CE-T5-06 Examine surface and groundwater hydrological processes and systems

CE-T5-07 Assess stability of submerged and floating bodies

CE-T5-08 Analyze the results of lab experiments on different flow phenomena

CE-T5-09 Design rigid-boundary channels

CE-T5-10 Design pipe networks and hydraulic structures

CE-T5-11 Model surface and groundwater hydrological processes and systems

CE-T5-12 Comply with code specifications and procedures related to design and construction of hydraulic and hydrologic systems

T6: Environmental Engineering (12%)

CE-T6 Civil engineers should be able to deal with water supply system, sewage system, wastewater treatment facilities, solid waste management and processes for control and management of environmental pollution. Therefore, Civil Engineers should have the knowledge and skill of designing and analyzing such systems and processes:

T6-Indicators

CE-T6-01 Describe the nature of environmental pollution and human health

CE-T6-02 Identify sources of pollutants and their environmental pathways

CE-T6-03 Identify the limits and the different technologies for pollution control

CE-T6-04 Describe ecosystems, sustainable development practices, and environmental impact assessment procedures

CE-T6-05 Evaluate different parameters of water supply

CE-T6-06 Determine parameters of wastewater reclamation, recycling, and reuse

CE-T6-07 Analyze test results for water, wastewater, and air quality

CE-T6-08 Design water supply and networks systems

CE-T6-09 Design wastewater treatment facilities

CE-T6-10 Select suitable engineered water and wastewater treatment technologies

CE-T6-11 Apply practical procedures and specifications for water supply, wastewater treatment facilities, and networks systems

CE-T6-12 Establish water, sanitary, and storm systems requirements

T7: Transportation Engineering (12%)

CE-T7 Civil engineers should be able to deal with the planning, design, construction and maintenance of roads, airports, highways, pavements and signalization and traffic.:

T7-Indicators

CE-T7-01 Describe vehicle's and driver's characteristics, including: rectilinear and curvilinear motion, breaking, and aspects of human sensory

CE-T7-02 Describe traffic flow characteristics, including speed flow, density, headway, and safety considerations

CE-T7-03 Evaluate highway transportation costs and its environmental impact

CE-T7-04 Identify basic procedures for highway capacity and level of service analysis

CE-T7-05 Analyze pavement layers using elastic and viscoelastic theories

CE-T7-06 Analyze pavement materials: soil, aggregates and asphalt, field test and construction quality assurance tests

CE-T7-07 Compute traffic loads (ESALs) over design period

CE-T7-08 Design highway geometric elements

CE-T7-09 Design intersections and interchanges

CE-T7-10 Design bituminous mixtures and flexible and rigid highway pavement

CE-T7-11 Select appropriate traffic control device, intersection signalization and traffic loads

CE-T7-12 Install and operate traffic data acquisition and traffic calming and control systems

CE-T7-13 Identify elements of transportation systems and recognize basic transport modes

CE-T7-14 Calculate the future demand for transportation, including, trip generation, trip distribution, mode choice and traffic assignment.

T8: Construction Management (8%)

CE-T8 Civil Engineers are expected to demonstrate knowledge and skill in managing construction projects. A civil engineer makes sure that work in progress conforms to the plans and specifications. The following *Indicators* should be addressed in the *Test Questions* on this *Topic Area*:

T8-Indicators

CE-T8-01 Describe fundamentals of engineering economics

CE-T8-02 Describe construction cost estimates and scheduling

CE-T8-03 Assess construction contracts, bidding, and contract process

CE-T8-04 Solve problems related to resource allocation, resource leveling

CE-T8-05 Identify the causes of deviations in time and cost control, disputes, and claims

CE-T8-06 Establish bidding procedures according to the selected project delivery method

CE-T8-07 Design concrete formwork for beam, slab, column, and footings

CE-T8-08 Organize charts, precedence diagramming methods, and time-scaled network time planning techniques for a project

CE-T8-09 Formulate an appropriate resource allocation, resource leveling, and type of equipment and construction safety program

CE-T8-10 Monitor engineering projects for purpose of time and cost control

CE-T8-11 Forecast the cash-in and cash-out of the engineering project

CE-T8-12 Resolve conflicts between contract drawings and specifications

CE-T8-13 Conduct economic feasibility study of the project and decision-making on real world projects.

T9: Surveying (4%)

CE-T9 Civil Engineers are expected to demonstrate knowledge and skill in conducting surveying and levelling for all types of civil engineering projects.

T9-Indicators

CE-T9-01 Describe linear measurements basic surveying

CE-T9-02 Describe photogrammetry principles

CE-T9-03 Describe remote sensing and GPS principles

CE-T9-04 Compare and compute cross-sectional areas

CE-T9-05 Compare and compute volumes

CE-T9-06 Compute vertical and horizontal curves

CE-T9-07 Develop planimetric maps, contour maps and coordinate system

CE-T9-08 Comply with leveling, construction surveying, underground surveying and total station surveying procedures.

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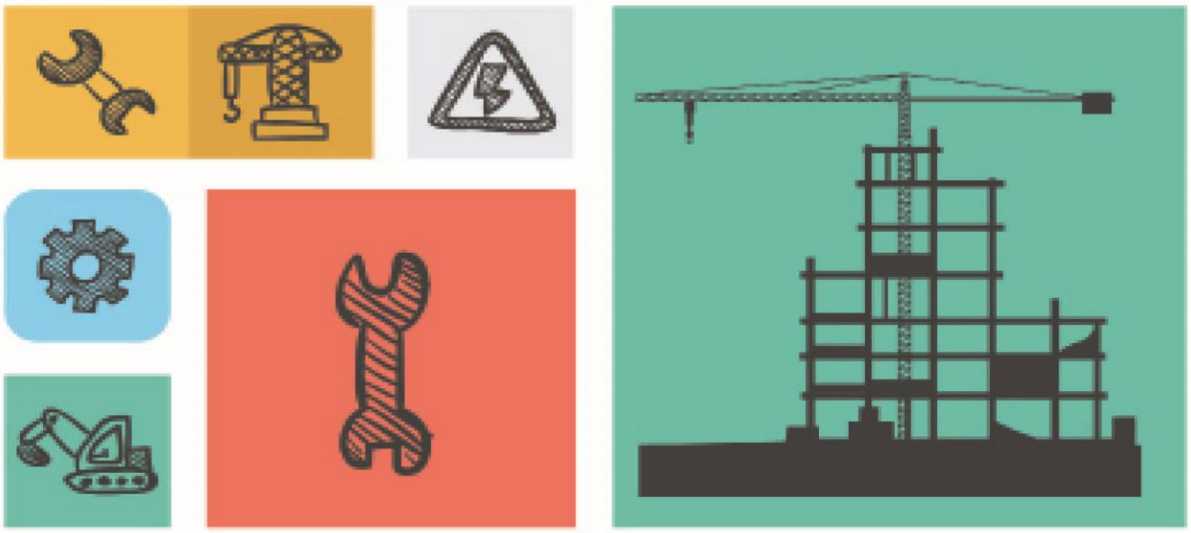

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