

## Contents of Optional Subjects for the Second Step of the PE Examination

(English translation approved by Japan APEC Engineer Monitoring Committee on March 28, 2019)

<b>Disciplines</b>	
Optional Subjects	Contents of Optional Subjects
<b>1. Mechanical Engineering</b>	
Mechanical Design Engineering	Design engineering, comprehensive mechanical engineering, machine elements, computer aided design (CAD), computer aided engineering (CAE), product lifecycle, management and other items related to Mechanical Design Engineering.
Strength of Materials & Reliability	Strength of materials, fracture mechanics, structure analysis and design, machine material, surface engineering, tribology, safety and reliability engineering and other items related to Strength of Materials and Reliability.
Machine Dynamics & Control	Dynamics of machines, Control engineering, mechatronics, robotics, transportation and logistics machine, construction machine, information and precision mechanical equipment, measuring instrument and other items related to Machine Dynamics and Control.
Heat, Power & Energy System	Thermal engineering (thermodynamics, heat transfer, combustion), heat exchanger, air conditioner, Refrigerating machinery and apparatus, refrigerator, internal combustion engine, external combustion engine, boiler, solar power, fuel cell and other items related to Heat, Power and Energy System.
Fluid Equipment	Fluid engineering, fluid machinery (pump, blower, compressor and so on), Wind power, hydraulic turbine, hydraulic equipment and other items related to Fluid Equipment.
Processing, Production System, Industrial Machinery	Processing technology, production system, production facility and industrial robot, industrial machinery, production planning and other items related to Processing, Production System, Industrial Machinery.

## 2. Marine & Ocean

Marine & Ocean	Function, design, structure, performance and construction for ships. Floating marine structure and related equipment.
----------------	--

## 3. Aerospace

Aerospace Systems	Aerodynamics, structural dynamics, control, propulsion, equipment, testing and sensing technology for aircraft and spacecraft (launch vehicle, orbital transportation system, artificial satellite, space station and the like). Reliability and safety for aircraft and spacecraft. Aerospace facility (airport, navigation, rocket launch facility and control, tracking system and the like) for aircraft and spacecraft.
-------------------	--

## 4. Electrical & Electronics Engineering

Electrical Power & Energy System	Power generation, transmission, distribution, substation and other relevant system. System planning, facility planning, construction planning and construction equipment for power generation, power transmission and electricity consumption, and facilities and technology relating to those operation.
Electric Power Applications	Electric apparatus, actuator, power electronics, electric drive applications, electrical railway, light source/lighting and static electricity application. Electric materials and materials for electric applications.
Electronics Applications	Radio frequency, ultrasonic, light/electron beam application equipment, electronic circuit devices, electronic devices and equipment of those applications, computer and other electronics application systems. System such as measurement/control, remote control, radio navigation system and electromagnetic environment. Materials for semiconductors and other items related to electronics applications and materials of communication wires.
Information & Communications	Configuration of the transporting network architecture for Information/communication system on wire, wireless, optical communication including broadcasting. Configuration and control of information and communication network including virtualization, application of information and communication, and security. Planning, designing, implementation, operation and management of information and communication network.
Electrical Facilities	System planning, facility planning, construction planning, construction equipment and operation of electrical facilities for the building, utility and factory.

<b>5. Chemistry</b>	
Inorganic Chemistry & Ceramics	Inorganic chemical products such as hydrogen and ammonia, electrochemical related products including fuel cells, solar cells and lithium ion batteries, functional products such as nanomaterials, semiconductor materials, functional ceramics, bio-ceramics, fine ceramics for construction, cement, glass, ceramics, refractory, abrasive material, inorganic fibers, and their manufacturing methods, equipment, as well as their application technology.
Organic Chemistry & Fuel	Organic Fine chemical products such as organic polymerization intermediates, surfactants, medicines, agrochemicals, cosmetics, pigments, liquid crystals, electric conductors, other organic chemical products such as solvents, paints, polysaccharides, cellulose, pulp, paper, oil & fat, leather, solid or liquid or, gaseous fuels and lubricating oils, and methods related to the manufacturing and processing thereof and equipment (excluding those related to spinning), as well as chemical management, toxicology, analytical chemistry.
Polymer Chemistry	Manufacturing process & its equipment, reaction mechanism, characteristics, analysis method for synthetic or natural resin, rubber and other polymer products, as well as molding methods, applications and recycle methods (excludes those related to spinning).
Chemical Engineering	Chemical equipment, facility and process planning, layout, analysis and operation for flow, thermal transfer, distillation, absorption, extraction, crystallization, membrane separation, grinding, filtering, dust collection, reaction, combustion, as well as other chemical processing and energy transformation.

<b>6. Fiber &amp; Textiles</b>	
Fiber Spinning & Textured Yarn, and Yarn Spinning & Fabric Manufacturing	Spinning process, equipment and the characteristic evaluation including high performance, high functions, and high sensitivity fiber for clothing, industry (i.e. geotextile, vehicles, airplanes) and medical textile. Manufacturing process - equipment and the characteristic evaluation for textured yarn, yarn spinning, knitting, weaving, non-wovens and leather.
Textile Processing & Textile Products	Process and equipment and the characteristic evaluation for scouring, bleaching, dyeing, finishing and other functional processing for textile and textile products, including processing treatment agents. Planning, design, preparation, sewing, patterning, finishing, inspection and scientific consumer evaluation and equipment for apparel and other secondary textile products. Evaluation of safety, resource and energy conservation of manufacturing process for textile products.

<b>7. Metals</b>	
Metallic Materials & Manufacturing System	Production process and refining process, equipment and management for ferrous and nonferrous materials. Components design, composition, material testing, analysis, metallographic observation and other items related to structural materials/functional materials.
Metal Surface Treatment	Metal plating, thermal spray, CVD, PVD, corrosion control, cleaning, non-metallic coating, anti-corrosion and other items related to metal surface treatment.
Metal Working	Casting, forging, plastic forming, welding, heat treatment, hard-facing, powder sintering, micro fabrication and other items related to metal working.

<b>8. Mining</b>	
Development & Production on Resources	<p>Matters concerning the technical matters, the management of production systems and environmental protection for next items as follows; exploration, evaluation and mining of underground resources such as metal minerals, coal, limestone, crushed stone.</p> <p>Matters concerning the technical matters, the management of production systems and environmental protection for next items as follows; exploration, evaluation and mining of underground liquid resources of such as petroleum and natural gas.</p>
Resources Recycle & Environmental Security	<p>Matters concerning the technical matters and the management for next items as follows; resources operation, physical sorting for recycling of waste, wet treatment and appropriate disposal of waste.</p> <p>Matters concerning the technical matters and the management for next items as follows; water environment, atmospheric environment, soil, geological environment.</p>

<b>9. Civil Engineering</b>	
Soil Mechanics & Foundation	Soil investigation, and planning, investigation, design, construction and maintenance of earth structure, foundation and earth retaining structure.
Materials & Structures	Planning, design, construction and maintenance of steel structure, concrete structure and composite structure, and construction materials such as steel, concrete, etc.
Urban & Regional Planning	National planning, urban planning (including land use, urban transportation system, park and green and urban development and improvement), and regional planning and other items relating to urban and regional planning.
River, Coastal & Ocean Engineering	Planning, investigation, design, construction and maintenance/renewal of flood-control/water utilization, flood-control/water utilization facilities and river structures, and river information, sabo, and other items relating to river engineering. Items relating to landslide prevention. Planning, Investigation, design, construction and maintenance/renewal of coastal protection, coastal facilities, and coastal and ocean structures, and other items relating to coastal and ocean engineering. Items relating to comprehensive sediment control engineering.
Port, Harbor & Airport Engineering	Planning, Investigation, design, construction and maintenance/renewal of port and harbor, port and harbor facilities and structures, and other items relating to port and harbor. Planning, Investigation, design, construction and maintenance/renewal of airport, airport facilities and structures, and other items relating to airport.
Electric Power Civil Engineering	Planning, Investigation, design, construction and maintenance/renewal of electrical power development, power development facilities, water intake/discharge and conduits, and other items relating to electric power civil engineering.
Road Engineering	Planning, Investigation, design, construction and maintenance/renewal of road, road facilities and structures, road information, and other items relating to road engineering.
Railway Engineering	Planning, investigation, design, construction and maintenance/renewal of Shinkansen, conventional railway and special railway, and other items relating to railway engineering.
Tunnel Engineering	Planning, Investigation, design, construction and maintenance/renewal of tunnel, tunnel facilities, underground structure, tunneling method and other items relating to tunnel engineering.
Construction Planning, Management & Cost Estimation	Construction planning, construction management, construction facilities, equipment and ICT, and other items relating to construction planning. Items relating to cost estimation and construction management.
Environmental Assessment & Management for Construction	Preservation and creation of natural environment and living environment from construction project, and other items relating to environmental impact assessment.

<b>10. Water Supply &amp; Sewerage</b>	
Water Supply & Industrial Water Supply	Water supply planning, industrial water planning, water resource environment, water intake, raw water transmission, water treatment, water distribution, water supply, water quality management, asset management and other items related to water supply and industrial water supply.
Sewerage	Sewerage system planning, watershed management, sewage collection and drain, sewerage water treatment, rain water management, resource and energy usage, asset management and other items related to sewerage.

<b>11. Environmental Engineering</b>	
Water Quality Management	Test, analysis, evaluation and water treatment for water quality improvement and management and other items related to Water Quality Management.
Waste Management & Material Cycles	Waste (garbage, human waste and industrial waste etc.) disposal and its facilities. Planning for waste reducing, waste processing facilities and environmental impact assessment.
Building Utilities & Air Quality Management	Cooling, heating, ventilation, constant temperature control, clean room and other items related to Comfortable and Industrial Air Conditioning and, water supply and drainage, lighting, fire extinguishing, acoustics and other items related to Building facilities.

<b>12. Agriculture</b>	
Livestock Industry	Animal improvement and reproduction, animal bio-technology, animal nutrition, Companion animal nutrition, Grassland establishment, forage crop, Animal hygiene, Livestock industry's environmental improvement, Animal products, Livestock farming and other items related to livestock industry.
Agriculture & Food	Crop cultivation and breeding, horticulture, fertility management, fertilizer quality, Good Agricultural Practice, postharvest handling, farming, food chemistry, fermentation, food processing, biochemistry, food safety, food distribution and other items related to Agriculture and Food Industry.
Irrigation, Drainage & Rural Engineering	The research, planning, design, construction and management of irrigation and drainage facilities, farmlands, farm roads, farmland preservation and disaster prevention as well as the research, planning, design, and implementation of water usage related to rural development, environmental impact assessment and environmental consideration and other items related to Irrigation, Drainage & Rural Engineering.
Rural Development & Resources Planning	Land utilization program for agricultural community, farming program, economic evaluation, rural development planning as well as the preservation and restoration planning of resources such as soil, water and biology, the recycle planning of unutilized resources, wild bird and beast damage prevention and other items related to Rural Development & Rural Resources Planning.
Plant Protection	Agricultural pest control, weed control, agricultural pest monitoring and forecasting, disease diagnosis, plant protection products and other items related to Plant Protection.

<b>13. Forest</b>	
Forestry & Forest Products	Forest planning and management, re/afforestation, forestry production and other items related to Forestry. Woody material, woody structure, forest product chemistry, woody biomass, non-wood forest products and other products related to Forest Products.
Forest Civil Engineering	The study, planning, design and implementation related to soil and water conservation, forest road construction, forest conservation and other items related to Forest Civil Engineering.
Forest Environment	Preservation/conservation, creation and environmental impact assessment for forest and its surrounding area.

<b>14. Fisheries</b>	
Fishery Resources & Aquatic Environment	Fishing gear, fishing method, fishing equipment, fishing boat, use of fishing port, use of fishing ground, aquaculture techniques including disease control and genetic management, fishery resource management and other relevant topics concerning fishery resources. Environment evaluation, conservation, creation, restoration and wise use of water and aquatic ecosystem and other relevant topics concerning fishery aquatic environment.
Seafood Production, Processing and Distribution	Freezing, refrigeration, canning, drying, paste products, fish food and feeding for aquaculture, food science, functional oil, waste treatment and other relevant topics concerning seafood production and processing. Food hygiene management, HACCP, keeping seafood freshness, seafood distribution system, traceability and other topics concerning distribution of fish and seafood.
Fisheries Civil Engineering	Facility planning and design about fishing port, coastal fishing grounds, environmental improvement, propagation of fishery resources, aquaculture and other civil engineering for fishery and aquaculture.



<b>15. Industrial Engineering</b>	
Production, Logistics & Packaging Management	Production planning & management, Quality management & planning, Logistics (including packaging and distribution processing) planning & management, Supply chain management, Information system for production, Planning, management & improvement of QCDES (Quality, Cost, Delivery, Environment, Safety) & 4M (Man, Material, Machine, Money) and Mathematical & information technology for them.
Service Management	Planning and management of service provision (including process design and system design), Planning, management and improvement of quality management, project management, Information system for service, Planning, management & improvement of QCDES (Quality, Cost, Delivery, Environment, Safety) & 4M (Man, Material, Machine, Money) and Mathematical & information technology for them.

<b>16. Information Engineering</b>	
Computer Engineering	Digital logic, computer architecture and configuration, circuit design, digital signal processing, operating systems, embedded systems (design, implementation, evaluation, maintenance, etc.).
Software Engineering	Requirements engineering, software modeling and analysis, software design, construction and evolution, testing (theory, verification and validation, automation etc.), software process and quality, software metrics, project management.
Information Systems	System theory, organizational issues and solutions, system life cycle, information system design, information system operation, data management and database, human-computer interaction, program management.
Information Infrastructure	Network communication technology (transmission theory, encryption etc.), network and system management, information assurance and security, system integration technology, infrastructure construction and architecture, Web systems and related technology.

<b>17. Applied Science</b>	
Physics & Chemistry	Mechanics, Optics, Electromagnetism, Thermal Physics, Atomic & Quantum Physics, Physical & Chemical measurements, Science of Materials, Rheology, Chemical Analysis, Instrumental Analysis and other items related to applications of Physics and Chemistry.
Geophysics & Geochemistry	Meteorology, Seismology, Volcanology, Geo-electromagnetism, Limnology, Glaciology, Oceanology, Atmospheric science, Geodesy, Geophysical exploration, Geochemical prospecting and other items related to applications of Geophysics and Geochemistry.
Geology	Geology for construction (Roads, Railways, Dams, Tunnels, Ground and etc.), Geology for natural resource development (Mineral resources, Fuel resources and etc.), Geology for slope disasters, Environment Geology (Hydraulics, Hydrology, Geohydrology and etc.), Information Geology (Remote sensing, Geographical information systems and etc.), Geothermal and Hot springs, Disaster prevention, Applied Mineralogy, Paleontology, Archaeological surveys and other items related to application of Geology Geophysical exploration, Geochemical prospecting, Drillings and other items related to applications of Geology.

<b>18. Biotechnology &amp; Bioengineering</b>	
Biofunctional Engineering	Genetic engineering, omics analysis, genome engineering, genome-based drug discovery, cellular engineering, functional food technology, reproduction engineering, tissue engineering, protein engineering, glycoengineering, bioinformatics, screening technology for microorganism, animal and plant cells, breeding technology for microorganism, animal and plant cells, immune engineering and other items related to biofunctional engineering.
Bioprocess Engineering	Application technology of environmental microorganisms, inspection & diagnostic technology, enzyme engineering, analysis technology of biogenic substances, separation and purification technology of biogenic substances, biomaterials engineering, bioconversion technology, metabolic engineering, drug delivery systems, nanobiotechnology, biosensor, design and validation of bioprocess, biopolymer & bioplastic, technology of biomass conversion, biomaterial, bioreactor, bioremediation, fermentation technology, culture technology for microorganism, animal and plant cells and other items related to bioprocess engineering.

<b>19. Environment</b>	
Environmental Conservation Planning	Situation analysis on environment and future forecast, evaluation, information gathering and sorting, analysis and exhibit and other items related to the planning for conservation and sustainable use of the environment. (except items exclusively related to another discipline)
Environmental Measurement	Planning for environmental measurement, environmental measurement analysis, environment monitoring and data analysis and evaluation.
Natural Environment Conservation	Conservation, restoration and remedy of ecosystem and landscape, composed of wild animals and plants, geography, water and others, biodiversity conservation and invasive species management, nature education, close contact with nature and facilities construction for it. (except items exclusively related to another discipline)
Environmental Impact Assessment	Environmental assessment and planning, evaluation for nature conservation. (except items exclusively related to another discipline)

<b>20. Nuclear &amp; Radiation</b>	
Nuclear Reactor System & Facility	Reactor physics; design, manufacturing, construction, operation, maintenance, inspection, quality assurance and ensuring and/or improving safety of reactor and/or plant; aging and/or plant lifetime management; severe accident management; nuclear security; decommissioning reactor facilities including those damaged through severe accident. Design and installation of nuclear fusion reactor and other nuclear system.
Nuclear Fuel Cycle, and Treatment & Disposal of Radioactive Waste	Enrichment and fabrication of nuclear fuel; reprocessing, transportation, storage of used nuclear fuel; treatment and disposal of radioactive waste; safeguards; nuclear security; ensuring and/or improving safety of nuclear fuel cycle system; decommissioning; severe accident management; treatment and disposal of nuclear material and radioactive waste that experienced severe accident, and other items related to nuclear fuel cycle and treatment and disposal of radioactive waste.
Radiation Protection & Application	Physics, chemistry and biological effects, measurement relating to radiation; Radiation shielding; dose assessment; handling of radioactive materials; prevention of radiation health hazards and exposure reduction, and other items of radiation protection; Industrial, agricultural and medical application of radiation; accelerator system and other items of radiation use.

<b>21. Engineering Management</b>
-----------------------------------