ENGINEERS BOARD OF KENYA

Enhancing Professionalism

BASIC TRAINING PLAN FOR GRADUATE ENGINEERS

Mechanical Engineering Discipline

EBK/CBA/GEIP/13

VERSION: A

REVISION: 01

	NAME	DESIGNATION	DATE	SIGNATURE
Approved by:				

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PREAMBLE

Foreword

It is with great pleasure that I present the Basic Training Plan developed by the Engineers Board of Kenya. This initiative marks a significant step in our commitment to professional growth of our graduate engineers in Kenya. Rule 3(1)(iii) of the Engineers Rules 2019 stipulates that person who wishes to be registered as a professional engineer under section 17 of the Engineers Act 2011 shall demonstrate achievement of practical experience in engineering field for a period of not less than three years as a graduate engineer. This Training Plan (TP) serves as a critical tool in fulfilling this requirement, ensuring that our engineers are well-prepared to meet professional standards and excel in their careers.

The purpose of the TP is to provide graduate engineers, employers and mentors with a detailed guide on the scope and content of the training necessary for preparing graduate engineers for registration as professional engineers. The creation of this TP was a collaborative effort of experts from academia and industry who worked diligently to develop this plan. This collaborative approach ensures that the TP is both rigorous and relevant to the needs of the industry.

This training plan aligns with the strategic intent of the EBK to register 10,000 professional engineers by 2027. By providing a clear and structured training pathway, we are not only enhancing the skills and capabilities of our engineers but also contributing to the national goal of increasing the number of qualified professionals in the engineering sector.

I extend my sincere gratitude to all those who contributed to the development of this plan. Your dedication and expertise have been instrumental in creating a valuable resource that will greatly benefit our graduate engineers and the engineering profession as a whole.

Eng. Margaret Ogai
Registrar/CEO
Engineers Board of Kenya

PREFACE

The practice of engineering is critically important in all sectors of the Kenyan. To ensure professionalism and upholding of ethical behavior in the engineering practice, the Government of Kenya and other keystakeholders have established various structures and institutions which are legally mandated to provideoversight and related services to all strategic players in the economy.

The Engineers Board of Kenya is a statutory body established under Section 3(1) of the Engineers Act, 2011. The Board is responsible for the registration of engineers and engineering firms, regulation of engineering professional services, setting of standards, development and general practice of engineering.

The Act allows only registered engineers to engage in professional engineering work and/or services. Registration is thus a license and the only way of ensuring that one is professionally qualified to practice engineering. To qualify for registration in the categories of professional engineer one has to acquire adequate professional competence and experience in areas specified by the Board.

One of the functions of the Board is to promote and provide opportunities and facilities for the study of, and for professional training in engineering. Thus, in order to help graduate engineers acquire sufficient professional competence within a period of two years, the Board has conceived and designed a structured professional training programme known as the Graduate Engineers Internship Programme (GEIP).

The programme is designed to enable young graduates to gain hands-on professional experience under close supervision by senior registered professional members of the profession. Under the Programme trainee engineers will undergo professional training, following training guidelines specific to one's field of engineering practice and on non-technical areas. GEIP is, therefore, intended to ensure that trainee engineers are equipped to pursue their professional careers with precision and confidence thereby becoming competitive and able to effectively play their roles in national development. GEIP is astructured internship program for engineers.

Purpose of the Training Plans

The TP aim to equip graduate engineers, employers, and mentors with a clear and detailed guide on the training required for preparing graduate engineers for registration as professional engineers. This plan outlines the essential areas of knowledge, practical skills, and professional competencies that graduate engineers need to develop during their three-year training period. By adhering to this structured approach, graduate engineers will gain the technical proficiency, hands-on experience, and professional judgment necessary to meet the rigorous standards of the engineering profession.

For employers and mentors, the TP serves as a valuable resource in designing and implementing effective training programs. It provides a comprehensive framework that details key training objectives, performance benchmarks, and assessment criteria, ensuring that the training is thorough and aligned with industry best practices. This guidance helps employers and mentors offer targeted support and mentorship, creating an environment where graduate engineers can develop and excel. By bridging the gap between academic knowledge and practical application, the BTP ensures that graduate engineers are well-prepared to contribute significantly to their fields and progress toward becoming registered professional engineers.

Preparation of the Training Plans

The TP was developed through a collaborative effort involving a task force of experts from academia and industry. These professionals worked diligently to create a comprehensive and effective plan. This approach ensured that the TP is both rigorous and relevant to the industry's needs. The collective expertise and experience of the task force members contributed to a robust framework designed to meet the high standards required for professional engineering registration.

List of Training Plans

a. The Board has developed Training Plans in the following disciplines:
b. Agricultural and Biosystems Engineering
c. Mechanical Engineering
d. Civil Engineering
    i. Water,
    ii. Building & Structures
    iii. Highways
e. Electrical Engineering

Acknowledgement

The Engineers Board of Kenya (EBK) sincerely thanks Eng. Otieno Arowo, Eng. Eliud Wanyonyi, Eng. Lameck Mwambi, Eng. Andrew Walume, Eng. Stephen Gichini, Eng. Nixon Oloo and Eng. Collins Juma for their invaluable contributions to developing the Training Plan for Mechanical Engineering. Their expertise, dedication, and collaborative efforts have been crucial in creating high-quality training plans that align with Board's mission to enhance engineering standards and practices in Kenya.

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ACRONYMS

EBK	Engineers Board of Kenya
GEIP	Graduate Engineers Internship Programme
OSHA	Occupational Safety and Health Act
TP	Training Plan

ACCWM
SUS304
TEMEC

CHAPTER 1 – INTRODUCTION

1.1 Background

The Engineers Board of Kenya (EBK) is a statutory body established under Section 3(1) of the Engineers Act, 2011. The Board is responsible for the registration of engineers and engineering firms, regulation of engineering professional services, setting of standards, development and general practice of engineering.

According to Section 7(1)(o) of the Engineers Act 2011, he Board is mandated to 'establish a school of engineering and provide facilities and opportunities for learning, professional exposure and skills acquisition. Section (1)(r) mandates the Board to collaborate with engineering training institutions, professional associations, engineering organizations and other relevant bodies in matters relating to training and professional development of engineers.

The Government of Kenya has developed Vision 2030 whose main objective is to turn Kenya into a globally competitive and prosperous nation with a high quality of life by the year 2030. Vision 2030 is anchored on three key pillars: Economic, Social and Political. Each pillar has a number of strategies designed to deliver different components of the Vision. Engineers are expected to play a key role in the delivery of the vision, especially in the realization of the necessary infrastructure, the industrialization process, and development of new technologies led by the ICT sector. All these activities will be key serving as a catalyst for wealth creation in 'Kenya's quest to become a middle-income country by 2030.

Professional registration is practiced by various countries around the world to primarily protect the safety, well-being and interests of the public. In Kenya, professional registration allows one to 'offer his professional engineering services to the public for gain or reward or by way of trade or for employment in the engineering discipline or category in which he is registered.' There is therefore a need to provide structured training for graduate engineers to enable them gain the requisite training and experience before transitioning to professional engineers.

Graduate engineers are expected to have several desirable attributes that may be expressed in terms of:

- Technical competencies
- Non-technical competencies.

The technical competencies may be categorized into two distinct areas – the science of engineering, and the practice of engineering. The 'science of engineering is the set of mathematical and scientific tools used to solve engineering problems, while the practice of engineering is the recognition and formulation of a problem and its solution.'

Mentorship in these two key areas will enable the graduate engineers to enter the job market with greater confidence and apply for professional status within the shortest time possible.

Consequently, the Board has developed the Training Plan (TP) to guide the process of structured of graduate engineers over a period of thirty-six months as required by the Engineers Rules 2019.

1.2 Objectives

The objectives of the TP are to: -

i) Provide structured training for the graduate engineers to enable them gain professional competencies in preparation for registration as professional engineers.

ii) Guide mentors and supervisors on areas of training for graduate engineers.
iii) Facilitate job rotation by employers

1.3 Target users

This TP is expected to be used by graduate engineers and their supervisors and mentors in the discipline of Mechanical Engineering. The TP is intended to support a programme of training and experience incorporating good practice elements.

This guide applies to persons who have:

i) Completed the education requirements by obtaining an accredited BEng-type qualification, or a Washington-Accord Recognized qualification or through evaluation/assessment;
ii) Registered as Graduate Engineers by the Engineers Board of Kenya.

1.4 Programme Duration

The programme shall be conducted over a period of not less than 36 months. The estimated periods through the training cycle shall be as indicated in the matrix below (Table 1).

Table 1: Estimated duration of the technical training cycle.

S/ No	Training Areas	Mechanical Engineering Consultancy Services	Industrial Manufacturing	Workshop Practice And Materials Engineering	Plant / Utilities / Facility Management	Mechanical Engineering Management	Academia / Research
		This involves Design, procurement and supervision of Mechanical works in projects e.g Building Services	This involves management of Industrial production processes for industrial products such as food, cement, packaging materials.	This Involves production of components and machines from various materials using workshop equipment. e.g. NMC, Factory workshops, university workshops	This involves management of plant Utilities such as power plants, water supply and treatment plants, Port facilities etc	Energy audit climate change QMS, EMS, Organizations: KEBS, SGS, Energy Audit firms	Lecturers in Uni, TVET, Researcher
1	Induction	1	1	1	1	1	1
2	Planning	2	5	5	5	6	2
3	Mechanical Engineering Design	9	6	6	8	6	6
4	Procurement / Financing	3	2	3	4	6	3
5	Contract management / Project Supervision	12	4	12	3	6	6
6	Operation management / maintenance	6	12	6	12	2	6
7	Engineering management	3	6	3	3	9	0
8	Lecturing / Teaching						12
		36	**36**	**36**	**36**	**36**	**36**

CHAPTER 2 – COMPETENCY STANDARDS

2.1 Professional Competence

A professionally competent person has the attributes necessary to perform activities within the profession to the standards expected in professional employment or independent practice. The Board's Competency Standard gives insight into the elements of competency necessary for competent performance that the graduate engineer is expected to demonstrate in a holistic way at the stage of application for transitioning from graduate to professional registration.

To meet the minimum standard of competence, the graduate engineers must demonstrate that they are able to practice competently in their practice area to the standard expected of a reasonable Professional Engineer. The extent to which the person can perform each of the elements in their practice area will be taken into account in assessing whether or not they meet the overall standard.

2.2 Expected Outcomes

The desired outcomes of the engineering activities undertaken by the candidate are classified under four (4) categories:

- Category I: Engineering Problem Solving;
- Category II: Managing Engineering Activities;
- Category III: Evaluation of Impacts of Engineering Activities; and
- Category IV: Upholding Professional Practice.

2.3 Category I Outcomes: Engineering Problem-Solving

This group of outcomes requires the candidate to apply appropriate theoretical and practical methods to identify, analyze and solve engineering problems.

2.3.1 Outcome 1: Identification and Definition of an Engineering Problem

This outcome is concerned with the discerning, understanding, contextualizing and judgement of a problem. Engineering problems require in-depth, fundamental, and specialized engineering knowledge that facilitates an analytical approach from first principles.

Engineering problems should be high level problems that require judgement in decision-making in uncertain contexts and include components parts or sub problems and should demonstrate the inclusion of one or more of the following:

a. Solutions to engineering problems that are not obvious and require abstract thinking or originality in analysis to formulate suitable models.

b. Engineering problems that are outside the scope of standards and codes.

c. Engineering problems that require information from a variety of sources that is complex, abstract or incomplete.

d. Complex engineering problems that involve wide-ranging or conflicting issues such as technical and engineering issues and interested or affected parties.

The engineering problem may be:

i. A design requirement,
ii. An applied research and development requirement
iii. A maintenance requirement or
iv. A problematic situation in an existing component, system or process.

2.3.2 Outcome 2: Design / Development of Engineering Solution

This Outcome 2 is concerned with the solution. The solution may be the design of a component, system or process or a recommendation of the remedy to a problematic situation. The design or developed solution will be evidenced by the following indicators: -

i) Identified and analyzed design/ planning requirement and drawn up detailed requirements specification;
ii) Synthesized a range of potential solutions to problem or approaches to project execution;
iii) Evaluated the potential approaches against requirements and impacts outside requirements;
iv) Fully developed design of selected option; and
v) Produced design documentation for implementation.

2.3.3 Outcome 3: Application of Advanced Knowledge

Outcome 3 involves the comprehension and application of advanced knowledge including principles underpinning good practice, specialist knowledge, jurisdictional knowledge and local knowledge. Applicable knowledge includes:

i) Specialist knowledge that has depth in the practice area and is underpinned by the fundamental knowledge of an engineering discipline or cross-disciplinary area. In-depth specialist knowledge in the practice area supports a fundamentals-based, first-principles analytical approach and develops models as required;
ii) A working knowledge of interacting disciplines (engineering and other) to underpin teamwork; and
iii) Jurisdictional knowledge that includes legal and regulatory requirements in addition to locally relevant codes of practice.

2.4 Category II Outcomes: Managing Engineering Activities

This group of outcomes requires the candidate to demonstrate technical leadership and effective interpersonal skills.

2.4.1 Outcome 4: Management of Engineering Activities

This outcome requires the candidate to demonstrate their capability to manage part or all of one or more engineering activities. Management is directed at achieving engineering results through the management of people, resources, processes, systems and money. Management involves:

iv) Planning engineering activities;
v) Organizing engineering activities;
vi) Coordinating engineering activities;
vii) Leading engineering activities; and
viii) Controlling engineering activities.

2.4.2 Outcome 5: Communication

The candidate is required to demonstrate their capacity to communicate effectively and clearly with others in the course of the engineering activities including:

i) Communication: strategic, managerial, technical and wider impacts of engineering work.
ii) Material communication: concepts, analyses, proposals and informative subjects.
iii) The audience: peers, superiors, persons implementing designs and other work, persons in other disciplines, clients and wider stakeholders.
iv) Communication functions

2.5 Category III Outcomes: Evaluation of Impacts of Engineering Activity

This group of outcomes requires the candidate to demonstrate recognition of an obligation to society, the profession and the environment, to make an evaluation of the outcomes and impacts of engineering activities and to make a commitment to abide by the Professional Code of Conduct.

2.5.1 Outcome 6: Recognition of Obligations to Society

The candidate is expected to be able to recognize and address the reasonably foreseeable social, cultural and environmental effects of engineering activities including:

i) Recognition that protection of society is the highest priority
ii) Due regard for the principles of sustainability
iii) Direct, indirect, immediate and long-term effects of engineering solutions

2.5.2 Outcome 7: Legal and Regulatory Requirements

Meet all legal and regulatory requirements and protect the health and safety of persons during his/her complex engineering activities, including:

i) Impacts and regulatory requirements
ii) Regulatory requirements that are explicit for the context and are generally applicable.

2.5.3 Outcome 8: Judgement in Decision Making

Exercise sound judgement during execution of engineering activities. Judgement in decision-making involves consideration of:

i) Diverse and wide-ranging risk factors.
ii) Significant consequences in a range of contexts; and
iii) Wide ranges of interested and affected parties with widely varying needs.

2.5.4 Outcome 9: Responsibility

The outcome requires the candidate to be responsible for the decision-making for part or all of the engineering activities. It encompasses responsibility exercised for outcomes of significant parts of one or more engineering activities.

2.6 Category IV Outcomes: Upholding Good Professional Practices

This group of outcomes requires a candidate to conduct uphold the code of ethics and conduct for engineers in undertaking engineering activities.

2.6.1 Outcome 10: Upholding Code of Ethics and Conduct

Conduct engineering activities ethically. Ethical behavior of no less than that defined by the Code of Conduct.

2.6.2 Outcome 11: Continuing Professional Development

This outcome requires a candidate to demonstrate a commitment to lifelong learning. And to undertake sufficient professional development activities to maintain and extend competence. Professional development includes:

i) Planning own professional development strategy;
ii) Selecting appropriate professional development activities; and
iii) Recording of professional development strategy and activities while displaying independent learning ability.

CHAPTER 3 – PROGRAMME COMPONENTS

3.1 Mechanical Engineers

Mechanical engineering is a field of engineering that deals with the design, manufacture, operation, maintenance and management of mechanical plant, installations, systems and equipment. This requires knowledge of materials, processes and ability in planning, organizing and communicating effectively. They also need development of the right attitudes towards work, including safety, cost and efficiency. Professional engineers must have analytical capabilities, adaptability to varying situations, ability to identify, rectify problems and design solutions, management capabilities, communication skills, ability to optimize resources and adherence to the professional ethics.

Mechanical engineering covers a diverse specialization and therefore demands that the engineer should attain high qualifications, wide exposure and professional experience before one can be trusted to undertake independent work. Mechanical engineering graduates need skills in using equipment, machines and tools; knowledge of materials and processes; and ability to plan, organize and communicate effectively. They also need to develop the right attitudes towards work, including safety, cost and efficiency.

The employment opportunities available for mechanical engineers are in manufacturing industries, power generation, plant operation and maintenance, equipment design, transport, building services, medical engineering, systems construction and installations etc.

The main thrust of the professional training of Mechanical Engineers is on knowledge, understanding of subject matters, analysis and methods so as to enable the trainees acquire sufficient specific skills/ expertise to become reliable and competitive professionals in the field.

3.2 The Mechanical Engineering Training Curriculum

The detailed Mechanical Engineering training curriculum is presented in Table 2.

Table 2: The Training plan

S/No	Training	Sub-Topic	Objectives & Area to be covered
1	Induction		**Knowledge of organisational structures** **Labour management and staff relations** • Labour law • Industrial law **Workplace OSHA, HSE policies** **Control of health and safety issues** **Process/product/service overview** **Training of soft skills** • Presentation skills • Report writing • Conflict Management • Interpersonal Skills • Customer Service • Communication • Time Management

S/No	Training	Sub-Topic	Objectives & Area to be covered
2	Planning		▪ Problem definition ▪ Feasibility studies ▪ Client Briefs ▪ Product planning ▪ Confirmation of budgets ▪ Stakeholders' management ▪ Implementation process ▪ Public Participation ▪ Corporate planning ▪ Project modelling ▪ Risk Mitigation and Planning ▪ Relevant legislation ▪ Procurement planning ▪ HSE Policy applicable ▪ Maintenance Planning ▪ Procurement and Stores & inventory management ▪ Project Scoping ▪ Communication Planning-Notices, Sites instructions
2	Mechanical Engineering Design	Mechanical Systems design e.g., Building services, Factory, and plant utilities (boilers, compressed air systems, Water supply and treatment, oil and Gas systems, power generation facilities, hydraulics and lubrication), Engineering control systems, Material handling equipment's e.g., cranes, cooling systems and heating systems	▪ Problem definition and project Scoping ▪ Data collection ▪ Codes and standards **Application of relevant standards and codes of practice** **Design manuals** ▪ Relevant Engineering design software's ▪ Preliminary design-Preliminary drawing, Budget estimates ▪ Presentation of preliminary design documentation to the client and approval of the client. ▪ Simulation and modelling ▪ Detailed design drawings ▪ Detailed Bills of Quantities and cost estimates. ▪ Detailed Specifications for materials, equipment and works.
		Components and machines design	▪ Problem definition ▪ Identification and analysis of mechanical engineering operating principles ▪ Relevant codes and standards applicable ▪ Schematic representation of the design ▪ Mechanical engineering design calculations ▪ Materials selection ▪ Preparation of design drawings ▪ Selection of fabrication methods and processes to be used (welding, milling, casting etc) ▪ Selection of machines to be used for fabrication. ▪ Preparation of bill of qualities ▪ Prototype ▪ Production processing.
		Process design	▪ Project definition and scoping ▪ Relevant design codes, standards and manuals used in process design ▪ Process design control parameters ▪ Process concept designs ▪ Process flow sheet and diagram ▪ Sizing of equipment and associated pipework and fittings ▪ Preparation of P&ID drawings. ▪ Selections of materials and equipment ▪ Preparation of process design drawings

S/No	Training	Sub-Topic	Objectives & Area to be covered
3	Contract management and Construction supervision.		**Procurement of Mechanical Engineering Goods Services, equipment and works** ▪ **Iden**tification of requirements ▪ Procurement planning ▪ Determining procurement methods ▪ Procurement tender processing ▪ Preparation and publication of tender documents ▪ Bids/Proposal submission of tender documents ▪ Bids/proposal evaluation ▪ Contract award recommendation ▪ Contract negotiation ▪ Contact signing **Quality Assurance** ▪ Approval of samples ▪ Approval of Works ▪ Approval of Materials ▪ Carrying out all necessary inspections and tests. ▪ Commissioning of mechanical works **Contract management** ▪ Control of time schedule ▪ Preparation of interim payment certificate ▪ Cost Control ▪ Dispute resolution ▪ Various types of Conditions of contracts (FIDIC, JBC etc) ▪ Project closure **Management of defect liability period** **HSE, OSHA and EMS processes in projects**
4	Operation and Maintenance		▪ Introduction of operation and maintenance manuals As-Built drawings ▪ Operating procedure of various component of plant ▪ Maintenance schedules ▪ Types of maintenance ▪ Inventory management ▪ Plant process improvement ▪ Instrumentation and control engineering ▪ Plant overhauls ▪ Quality controls ▪ Management of contracted maintenance ▪ Parts catalogue ▪ M&E of Environmental management systems ▪ Routine monitoring of plant performance, fault diagnosis and service techniques ▪ Specification, selection, installation, testing and commissioning of machinery and plant. ▪ Implementation of HSE ▪ Assessment of plant infrastructure condition
5	Manufacturing	Industry	**Production planning and control** ▪ Budgeting ▪ Supply of materials for production ▪ Storing and handling ▪ Allocation and control of labour ▪ Availability of Equipment/Plant ▪ Production process management ▪ Scheduling of maintenance/service/cleaning of equipment/Plant ▪ Production process management ▪ Quality Control ▪ Procurement and stores & inventory management ▪ Process monitoring and control. ▪ Supervision of works and services. ▪ Condition monitoring and inspection **Material and product handling/procedures SOPs** **Familiarisation of HSE policy**

S/No	Training	Sub-Topic	Objectives & Area to be covered
		Workshop practise	▪ Work order management ▪ Material forming; including forging. Plate and pipe bending, sheet metal work and press work. ▪ Material removal includes the use of common hand tools and machine tools for turning, shaping, milling, drilling, and grinding. ▪ Jointing and welding; includes riveting, bolting, welding, brazing and soldering ▪ Casting processes; includes some experience of pattern making. ▪ Heat and surface treatment of materials; includes tempering, annealing, cleaning and plating. ▪ Metrology and testing; including the use of gauges and measuring instruments in marking out, inspection and other workshops processes. ▪ Computer application in manufacturing systems such as 3D printing ▪ Parts inspection and site acceptance tests ▪ Process automation design ▪ Production planning, manufacture and control (ergonomic) of industrial products, tools, jigs and fixtures, dies and patterns. ▪ Maintenance of logbooks, machinery repair and maintenance records ▪ OSHA, EMS and QMS ▪ Procurement and stores & inventory management ▪ Quality control ▪ Instrumentations and control engineering ▪ Carpentry and joinery work ▪ Mansory and Kiln building ▪ Maintenance and repairs including inspection, disassembly, repairs and assembly. ▪ Report writing
6	Engineering management		▪ Audit ▪ Energy Audit ▪ Water Audit ▪ Carbon Footprint analysis ▪ Process optimization ▪ Process audit ▪ ISO processes ▪ QMS processes ▪ Process management processes e.g TPM

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