



REPUBLIC OF KENYA

COMPETENCY BASED CURRICULUM

FOR

CIVIL ENGINEERING TECHNOLOGY

LEVEL 6



TVET CDACC
P.O. BOX 15745-00100
NAIROBI

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FOREWORD

The provision of quality education and training is fundamental to the Government's overall strategy for social economic development. Quality education and training will contribute to achievement of Kenya's development blueprint and sustainable development goals.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution and this resulted to the formulation of the Policy Framework for Reforming Education and Training (Sectional Paper No. 4 of 2016). A key feature of this policy is the radical change in the design and delivery of the TVET training. This policy document requires that training in TVET be competency based, curriculum development be industry led, certification be based on demonstration of competence and mode of delivery allows for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed.

It is my conviction that this curriculum will play a great role towards development of competent human resource for the Building and Construction sector.

**PRINCIPAL SECRETARY
VOCATIONAL AND TECHNICAL TRAINING
MINISTRY OF EDUCATION**

PREFACE

Kenya Vision 2030 aims to transform the country into a newly industrializing, “middle-income country providing a high-quality life to all its citizens by the year 2030”. Kenya intends to create a globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through life-long education and training. TVET has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET).

The Technical and Vocational Education and Training Act No. 29 of 2013 and Sectional Paper No. 4 of 2016 on Reforming Education and Training in Kenya, emphasized the need to reform curriculum development, assessment and certification. This called for a shift to CBET in order to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) in conjunction with Construction Sector Skills Advisory Committee (SSAC) have developed this curriculum.

This curriculum is designed and organized with an outline of learning outcomes; Suggested Methods of Instruction, training/learning resources and methods of assessing the trainee’s achievement. The curriculum is competency-based and allows multiple entry and exit to the course.

I am grateful to the Council members, Council Secretariat, Construction SSAC, expert workers and all those who participated in the development of this curriculum.

**CHAIRPERSON
TVET CDACC**

ACKNOWLEDGEMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support was received from various organizations.

I recognize with appreciation the role of Construction Sector Skills Advisory Committee (SSAC) members for their contribution to the development of this curriculum.

I also thank all stakeholders in the construction sector for their valuable input and all those who participated in the process of developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that workers in the Construction industry acquire competencies that will enable them to perform their work more efficiently.

**COUNCIL SECRETARY/CEO
TVET CDACC**

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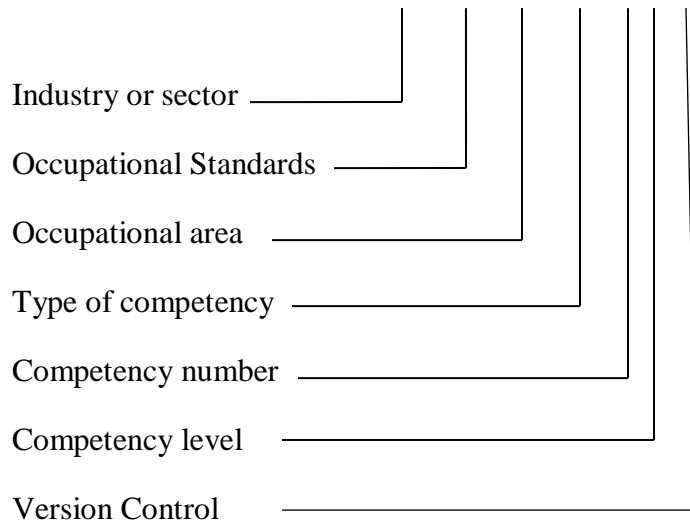
ABBREVIATION AND ACRONYMS

CBET	: Competency Based Education and Training
CDACC	: Curriculum Development Assessment and Certification Council
CU	: Curriculum
OSHA	: Occupation Safety and Health Act
PPE	: Personal Protective Equipment
SSAC	: Sector Skills Advisory Committee
ENG	: Engineering
MAR	: Civil
BC	: Basic Competency
CC	: Common Competency
CR	: Core Competency

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KEY TO UNIT CODE

CON/CU/CET/BC/01/6/A



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COURSE OVERVIEW

Brief description of the course:

The present curriculum presents a coherent and significant set of competences to acquire in order to perform the occupation of a **Civil Engineering** level 6. The competency-based approach, used to design the curriculum, is industry driven and has considered the training needs, the work situation, as well as the goals and the means to implement training units of competencies.

The units of competencies, within the present curriculum, include a statement, description and a set of expected outcomes and results at the end of the training of each unit. It also clearly mentioned the training contents, the methods of training delivery, the methods of assessment, a list of main materials/tools/equipment needed and a list of recommended resources for each of the units.

The description of elements, methods of delivery and assessment and the lists of materials/tools and equipment will have a direct influence on the choice of the theoretical and/or practical learning activities and their respective timing. The competences are the targets of training: the acquisition of each is required for certification.

The present curriculum consists of the following units of competencies:

Basic Units of Learning:

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factor
ENG/CU/CET/BC/01/6/A	Communication Skills	40	4
ENG/CU/CET/BC/02/6/A	Digital Literacy	60	6
ENG/CU/CET/BC/03/6/A	Entrepreneurial Skills	100	10
ENG/CU/CET/BC/04/6/A	Employability Skills	80	8
ENG/CU/CET/BC/05/6/A	Environmental literacy	40	4
ENG/CU/CET/BC/06/6/A	Occupational Safety and Health Practices	40	4
TOTAL NUMBER OF HOURS		360	36

Common units of Learning:

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factor
ENG/CU/CET/CC/01/6/A	Applied Mathematics	80	8
ENG/CU/CET/CC/02/6/A	Technical Drawing	60	6
ENG/CU/CET/CC/03/6/A	Structural Design and Analysis	70	7
ENG/CU/CET/CC/04/6/A	Material Science	90	9
ENG/CU/CET/CC/05/6/A	Workshop Technology Practices	130	13
ENG/CU/CET/CC/06/6/A	Measurement Of Works and Cost Estimation	80	8
ENG/CU/CET/CC/07/6/A	Water And Wastewater Technology	120	12
ENG/CU/CET/CC/08/6/A	Water Resources, Water Services and Sanitation Management Principles	120	12
TOTAL NUMBER OF HOURS		750	75

Core Units of Learning:

Unit of Learning Code	Unit of Learning Title	Duration in Hours	Credit Factor
ENG/CU/CET/CR/01/6/A	Material Testing	150	15
ENG/CU/CET/CR/02/6/A	Highway Survey	190	19
ENG/CU/CET/CR/03/6/A	Designing Pavement Structures	120	12
ENG/CU/CET/CR/04/6/A	Road Construction Works	150	15
ENG/CU/CET/CR/05/6/A	Design Of Engineering Structures	220	22
ENG/CU/CET/CR/06/6/A	Building Drawings	200	20
ENG/CU/CET/CR/07/6/A	Building Works	200	20
ENG/CU/CET/CR/08/6/A	Water Resource Quality Management	60	6
ENG/CU/CET/CR/09/6/A	Design Of Wastewater Collection and Treatment Infrastructure	200	20
ENG/CU/CET/CR/10/6/A	Construction Of Wastewater Infrastructure	180	18

ENG/CU/CET/CR/11/6/A	Designing Onsite Sanitation Facilities	80	8
ENG/CU/CET/CR/12/6/A	Construction Of Onsite Sanitation Facilities	80	8
ENG/CU/CET/CR/13/6/A	Civil Engineering Project Management	120	12
	Industrial Attachment	480	48
Total		2430	243
Grand Total		3540	354

1. Entry Requirements

An individual entering this course should have any of the following minimum requirements:

- a) Kenya Certificate of Secondary Education (K.C.S.E.) with a minimum mean grade of C- (C minus)

Or

- b) Level 5 certificate in Civil Engineering with **one** year of continuous work experience

Or

- c) Equivalent qualifications as determined by Kenya National Qualifications Authority (KNQA)

2. Trainer qualification

A trainer for this course should have a higher qualification than the level of this course.

3. Assessment

The course will be assessed at two levels: internally and externally. Internal assessment is continuous and is conducted by the trainer who is monitored by an internal accredited verifier while external assessment is the responsibility of TVET CDACC.

4. Certification

A candidate will be issued with a record of Achievement on demonstration of competence in a unit of competency. To attain the qualification national certificate in Textile Technology Level 6, the candidate must demonstrate competence in all the units

of competency as given in qualification pack. TVET CDACC will issue these certificates in conjunction with training provider.

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BASIC UNITS OF LEARNING

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COMMUNICATION SKILLS

UNIT CODE: CON/CU/CET/BC/01/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Demonstrate Communication Skills

Duration of Unit: 40 hours

Unit Description

This unit covers the competencies required to demonstrate communication skills. It involves, meeting communication needs of clients and colleagues; developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

Summary of Learning Outcomes

1. Meet communication needs of clients and colleagues
2. Develop communication strategies
3. Establish and maintain communication pathways
4. Promote use of communication strategies
5. Conduct interview
6. Facilitate group discussion
7. Represent the organization

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Meet communication needs of clients and colleagues	<ul style="list-style-type: none">• Communication process• Modes of communication• Medium of communication• Effective communication• Barriers to communication• Flow of communication• Sources of information• Organizational policies• Organization requirements for written and electronic communication methods• Report writing	<ul style="list-style-type: none">• Interview• Written texts

	<ul style="list-style-type: none"> • Effective questioning techniques (clarifying and probing) • Workplace etiquette • Ethical work practices in handling communication • Active listening • Feedback • Interpretation • Flexibility in communication • Types of communication strategies • Elements of communication strategy 	
2. Develop communication strategies	<ul style="list-style-type: none"> • Dynamics of groups • Styles of group leadership • Openness and flexibility in communication • Communication skills relevant to client groups 	<ul style="list-style-type: none"> • Interview • Written texts
3. Establish and maintain communication pathways	<ul style="list-style-type: none"> • Types of communication pathways 	<ul style="list-style-type: none"> • Interview • Written texts
4. Promote use of communication strategies	<ul style="list-style-type: none"> • Application of elements of communication strategies • Effective communication techniques 	<ul style="list-style-type: none"> • Interview • Written texts
5. Conduct interview	<ul style="list-style-type: none"> • Types of interview • Establishing rapport • Facilitating resolution of issues • Developing action plans 	<ul style="list-style-type: none"> • Interview • Written texts
6. Facilitate group discussion	<ul style="list-style-type: none"> • Identification of communication needs • Dynamics of groups • Styles of group leadership 	<ul style="list-style-type: none"> • Interview • Written texts

	<ul style="list-style-type: none"> • Presentation of information • Encouraging group members participation • Evaluating group communication strategies 	
7. Represent the organization	<ul style="list-style-type: none"> • Presentation techniques • Development of a presentation • Multi-media utilization in presentation • Communication skills relevant to client groups 	<ul style="list-style-type: none"> • Interview • Written texts

Suggested Methods of Instruction

- Discussion
- Role playing
- Simulation
- Direct instruction

Recommended Resources

- Desktop computers/laptops
- Internet connection
- Projectors
- Telephone

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DIGITAL LITERACY

UNIT CODE: CON/CU/CET/BC/02/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Demonstrate Digital Literacy

Duration of Unit: 60 hours

Unit Description

This unit describes competencies required to demonstrate digital literacy. It involves in identifying computer software and hardware, applying security measures to data, hardware, software in automated environment, computer software in solving task, internet and email in communication at workplace, desktop publishing in official assignments and preparing presentation packages.

Summary of Learning Outcomes

1. Identify computer software and hardware
2. Apply security measures to data, hardware, software in automated environment
3. Apply computer software in solving tasks
4. Apply internet and email in communication at workplace
5. Apply desktop publishing in official assignments
6. Prepare presentation packages

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Identify computer hardware and software	<ul style="list-style-type: none">• Concepts of ICT• Functions of ICT• History of computers• Components of a computer• Classification of computers	<ul style="list-style-type: none">• Written tests• Oral presentation
2. Apply security measures to data, hardware, software in automated environment	<ul style="list-style-type: none">• Data security and control• Security threats and control measures• Types of computer crimes• Detection and protection against computer crimes	<ul style="list-style-type: none">• Written tests• Oral presentation• Project

	<ul style="list-style-type: none"> • Laws governing protection of ICT 	
3. Apply computer software in solving tasks	<ul style="list-style-type: none"> • Operating system • Word processing • Spread sheets • Data base design and manipulation • Data manipulation, storage and retrieval 	<ul style="list-style-type: none"> • Oral questioning • Project
4. Apply internet and email in communication at workplace	<ul style="list-style-type: none"> • Computer networks • Network configurations • Uses of internet • Electronic mail (e-mail) concept 	<ul style="list-style-type: none"> • Oral questioning • Written report
5. Apply desktop publishing in official assignments	<ul style="list-style-type: none"> • Concept of desktop publishing • Opening publication window • Identifying different tools and tool bars • Determining page layout • Opening, saving and closing files • Drawing various shapes using DTP • Using colour pellets to enhance a document • Inserting text frames • Importing and exporting text • Object linking and embedding • Designing of various publications • Printing of various publications 	<ul style="list-style-type: none"> • Oral questioning • Written report • Project

<p>6. Prepare presentation packages</p>	<ul style="list-style-type: none"> • Types of presentation packages • Procedure of creating slides • Formatting slides • Presentation of slides • Procedure for editing objects 	<ul style="list-style-type: none"> • Oral questioning • Written report • Project
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Suggested Methods of Instruction

- Instructor led facilitation of theory
- Demonstration by trainer
- Practical work by trainee
- Viewing of related videos
- Project
- Group discussions

Recommended Resources

- Computers
- Printers
- Storage devices
- Internet access

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ENTREPRENEURIAL SKILLS

UNIT CODE: CON/CU/CET/BC/03/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Demonstrate Entrepreneurial Skills

Duration of unit: 100 hours

Unit Description

This unit covers the competencies required to demonstrate understanding of entrepreneurship. It involves demonstrating understanding of an entrepreneur, entrepreneurship and self-employment. It also involves identifying entrepreneurship opportunities, creating entrepreneurial awareness, applying entrepreneurial motivation and developing business innovative strategies.

Summary of Learning Outcomes

1. Demonstrate understanding of who an entrepreneur
2. Demonstrate knowledge of entrepreneurship and self-employment
3. Identify entrepreneurship opportunities
4. Create entrepreneurial awareness
5. Apply entrepreneurial motivation
6. Develop business innovative strategies
7. Develop Business plan

Learning Outcome	Content	Suggested Assessment Methods
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<p>1. Demonstrate knowledge of entrepreneurship and self-employment</p>	<ul style="list-style-type: none"> • Importance of self-employment • Requirements for entry into self-employment • Role of an Entrepreneur in business • Contributions of Entrepreneurs to National development • Entrepreneurship culture in Kenya • Born or made entrepreneurs 	<ul style="list-style-type: none"> • Individual/group assignments • Projects • Written tests • Oral questions • Third party report
<p>2. Identify entrepreneurship opportunities</p>	<ul style="list-style-type: none"> • Business ideas and opportunities • Sources of business ideas • Business life cycle • Legal aspects of business • Assessment of product demand • Business environment • Factors to consider when evaluating business environment • Technology in business 	<ul style="list-style-type: none"> • Individual/group assignments • Projects • Written tests • Oral questions • Third party report • Interviews
<p>3. Create entrepreneurial awareness</p>	<ul style="list-style-type: none"> • Forms of businesses • Sources of business finance • Factors in selecting source of business finance • Governing policies on Small Scale Enterprises (SSEs) • Problems of starting and operating SSEs 	<ul style="list-style-type: none"> • Individual/group assignments • Projects • Written tests • Oral questions • Third party report • Interviews

4. Apply entrepreneurial motivation	<ul style="list-style-type: none"> • Internal and external motivation • Motivational theories • Self-assessment • Entrepreneurial orientation • Effective communications in entrepreneurship • Principles of communication • Entrepreneurial motivation 	<ul style="list-style-type: none"> • Case studies • Individual/group assignments • Projects • Written tests • Oral questions • Third party report • Interviews
5. Develop business innovative strategies	<ul style="list-style-type: none"> • Innovation in business • Small business Strategic Plan • Creativity in business development • Linkages with other entrepreneurs • ICT in business growth and development 	<ul style="list-style-type: none"> • Case studies • Individual/group assignments • Projects • Written tests • Oral questions • Third party report • Interviews
6. Develop Business Plan	<ul style="list-style-type: none"> • Business description • Marketing plan • Organizational/Management plan • Production/operation plan • Financial plan • Executive summary • Presentation of Business Plan 	<ul style="list-style-type: none"> • Case studies • Individual/group assignments • Projects • Written tests • Oral questions • Third party report • Interviews

Suggested Methods of Instruction

- Direct instruction
- Project
- Case studies
- Field trips
- Discussions
- Demonstration

- Question and answer
- Problem solving
- Experiential
- Team training

Recommended Resources

- Case studies
- Business plan templates
- Computers
- Overhead projectors
- Internet
- Mobile phone
- Video clips
- Films
- Newspapers and Handouts
- Business Journals
- Writing materials

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EMPLOYABILITY SKILLS

UNIT CODE: CON/CU/CET/BC/04/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Demonstrate Employability Skills

Duration of Unit: 80 hours

Unit Description

This unit covers competencies required to demonstrate employability skills. It involves conducting self-management, demonstrating interpersonal communication, critical safe work habits, leading a workplace team, planning and organizing work, maintaining professional growth and development, demonstrating workplace learning, problem solving skills and managing ethical performance.

Summary of Learning Outcomes

1. Conduct self-management
2. Demonstrate interpersonal communication
3. Demonstrate critical safe work habits
4. Lead a workplace team
5. Plan and organize work
6. Maintain professional growth and development
7. Demonstrate workplace learning
8. Demonstrate problem solving skills
9. Manage ethical performance

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Conduct self-management	<ul style="list-style-type: none">• Self-awareness• Formulating personal vision, mission and goals• Strategies for overcoming life challenges• Managing emotions• Emotional intelligence	<ul style="list-style-type: none">• Written tests• Oral questioning• Interviewing• Portfolio of evidence• Third party report

	<ul style="list-style-type: none"> • Assertiveness versus aggressiveness • Expressing personal thoughts, feelings and beliefs • Developing and maintaining high self-esteem • Developing and maintaining positive self-image • Setting performance targets • Monitoring and evaluating performance • Articulating ideas and aspirations • Accountability and responsibility • Good work habits • Self-awareness • Values and beliefs • Self-development • Financial literacy • Healthy lifestyle practices • Adopting safety practices 	
<p>2. Demonstrate interpersonal communication</p>	<ul style="list-style-type: none"> • Meaning of interpersonal communication • Listening skills • Types of audience • Public speaking • Writing skills • Negotiation skills • Reading skills • Meaning of empathy • Understanding customers' needs • Establishing communication networks • Assertiveness 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report

	<ul style="list-style-type: none"> • Sharing information 	
3. Demonstrate critical safe work habits	<ul style="list-style-type: none"> • Stress and stress management • Time concept • Punctuality and time consciousness • Leisure • Integrating personal objectives into organizational objectives • Resources mobilization • Resources utilization • Setting work priorities • Developing healthy relationships • HIV and AIDS • Drug and substance abuse • Managing emerging issues 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report
4. Lead a workplace team	<ul style="list-style-type: none"> • Leadership qualities • Power and authority • Team building • Determination of team roles and objectives • Team parameters and relationships • Individual responsibilities in a team • Forms of communication • Complementing team activities • Gender and gender mainstreaming • Human rights • Developing healthy relationships 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report

	<ul style="list-style-type: none"> • Maintaining relationships • Conflicts and conflict resolution • Coaching and mentoring skills 	
5. Plan and organize work	<ul style="list-style-type: none"> • Functions of management • Planning • Organizing • Time management • Decision making concept • Task allocation • Developing work plans • Developing work goals/objectives and deliverables • Monitoring work activities • Evaluating work activities • Resource mobilization • Resource allocation • Resource utilization • Proactive planning • Risk evaluation • Problem solving • Collecting, analysing and organising information • Negotiation 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report
6. Maintain professional growth and development	<ul style="list-style-type: none"> • Avenues for professional growth • Training and career opportunities • Assessing training needs • Mobilizing training resources • Licenses and certifications for professional growth and development • Pursuing personal and 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report

	<p>organizational goals</p> <ul style="list-style-type: none"> • Managing work priorities and commitments • Recognizing career advancement 	
7. Demonstrate workplace learning	<ul style="list-style-type: none"> • Managing own learning • Mentoring • Coaching • Contributing to the learning community at the workplace • Cultural aspects of work • Networking • Variety of learning context • Application of learning • Safe use of technology • Taking initiative/proactivity • Flexibility • Identifying opportunities • Generating new ideas • Workplace innovation • Performance improvement • Managing emerging issues • Future trends and concerns in learning 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report
8. Demonstrate problem solving skills	<ul style="list-style-type: none"> • Critical thinking process • Data analysis tools • Decision making • Creative thinking • Development of creative, innovative and practical solutions • Independence in identifying and solving problems • Solving problems in teams • Application of problem-solving strategies • Testing assumptions 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Interviewing • Portfolio of evidence • Third party report

	<ul style="list-style-type: none"> Resolving customer concerns 	
9. Manage ethical performance	<ul style="list-style-type: none"> Meaning of ethics Ethical perspectives Principles of ethics Ethical standards Organization code of ethics Common ethical dilemmas Organization culture Corruption, bribery and conflict of interest Privacy and data protection Diversity, harassment and mutual respect Financial responsibility/accountability Etiquette Personal and professional integrity Commitment to jurisdictional laws Emerging issues in ethics 	<ul style="list-style-type: none"> Written tests Oral questioning Interviewing Portfolio of evidence Third party report

Suggested Methods of Instruction

- Demonstrations
- Simulation/Role play
- Group Discussion
- Presentations
- Assignments
- Q&A

Recommended Resources

- Computers
- Stationery
- Charts
- Video clips

- Audio tapes
- Radio sets
- TV sets
- LCD projectors

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ENVIRONMENTAL LITERACY

UNIT CODE: CON/CU/CET/BC/05/6/A

Relationship to Occupational Standards:

This unit addresses the Unit of Competency: Demonstrate Environmental Literacy

Duration of Unit: 40 hours

Unit Description

This unit describes the competencies required demonstrate environmental literacy.it involves controlling environmental hazard, controlling environmental pollution, complying with workplace sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs, monitoring activities on environmental protection/programs, analysing resource use and developing resource conservation plans.

Summary of Learning Outcomes

1. Control environmental hazard
2. Control environmental Pollution
3. Demonstrate sustainable resource use
4. Evaluate current practices in relation to resource usage
5. Identify Environmental legislations/conventions for environmental concerns
6. Implement specific environmental programs
7. Monitor activities on Environmental protection/Programs
8. Analyze resource use
9. Develop resource conservation plans

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Control environmental hazard	<ul style="list-style-type: none">• Purposes and content of Environmental Management and Coordination Act 1999	<ul style="list-style-type: none">• Written questions• Oral questions

	<ul style="list-style-type: none"> • Storage methods for environmentally hazardous materials • Disposal methods of hazardous wastes • Types and uses of PPE in line with environmental regulations • Occupational Safety and Health Standards (OSHS) 	
2. Control environmental Pollution control	<ul style="list-style-type: none"> • Types of pollution • Environmental pollution control measures • Types of solid wastes • Procedures for solid waste management • Different types of noise pollution • Methods for minimizing noise pollution 	<ul style="list-style-type: none"> • Written questions • Oral questions • Role play
3. Demonstrate sustainable resource use	<ul style="list-style-type: none"> • Types of resources • Techniques in measuring current usage of resources • Calculating current usage of resources • Methods for minimizing wastage • Waste management procedures • Principles of 3Rs (Reduce, Reuse, Recycle) • Methods for economizing or reducing resource consumption 	<ul style="list-style-type: none"> • Written questions • Oral questions • Role play
4. Evaluate current practices in relation to resource usage	<ul style="list-style-type: none"> • Collection of information on environmental and resource 	<ul style="list-style-type: none"> • Written questions

	<p>efficiency systems and procedures,</p> <ul style="list-style-type: none"> • Measurement and recording of current resource usage • Analysis and recording of current purchasing strategies. • Analysis of current work processes to access information and data • Identification of areas for improvement 	<ul style="list-style-type: none"> • Oral questions • Role play
5. Identify Environmental legislations/conventions for environmental concerns	<ul style="list-style-type: none"> • Environmental issues/concerns • Environmental legislations /conventions and local ordinances • Industrial standard /environmental practices • International Environmental Protocols (Montreal, Kyoto) • Features of an environmental strategy 	<ul style="list-style-type: none"> • Written questions • Oral questions
6. Implement specific environmental programs	<ul style="list-style-type: none"> • Community needs and expectations • Resource availability • 5s of good housekeeping • Identification of programs/Activities • Setting of individual roles /responsibilities • Resolving problems /constraints encountered • Consultation with stakeholders 	<ul style="list-style-type: none"> • Written questions • Oral questions • Role play
7. Monitor activities on Environmental protection/Programs	<ul style="list-style-type: none"> • Periodic monitoring and Evaluation of activities 	<ul style="list-style-type: none"> • Oral questions • Written tests • Practical test

	<ul style="list-style-type: none"> • Gathering feedback from stakeholders • Analyzing data gathered • Documentation of recommendations and submission • Setting of management support systems to sustain and enhance the program • Monitoring and reporting of environmental incidents to concerned /proper authorities 	
8. Analyze resource use	<ul style="list-style-type: none"> • Identification of resource consuming processes • Determination of quantity and nature of resource consumed • Analysis of resource flow through different parts of the process. • Classification of wastes for possible source of resources. 	<ul style="list-style-type: none"> • Written tests • Oral questions • Practical test
9. Develop resource Conservation plans	<ul style="list-style-type: none"> • Determination of efficiency of use/conversion of resources • Causes of low efficiency of use of resources • Plans for increasing the efficiency of resource use 	<ul style="list-style-type: none"> • Written tests • Oral questions • Practical test

Suggested Methods of Instruction

- Instructor led facilitation of theory
- Practical demonstration of tasks by trainer
- Practice by trainees
- Observations and comments and corrections by trainers

Recommended Resources

- Standard operating and/or other workplace procedures manuals
- Specific job procedures manuals
- Environmental Management and Coordination Act 1999
- Machine/equipment manufacturer's specifications and instructions
- Personal Protective Equipment (PPE)
- ISO standards
- Company environmental management systems (EMS)
- Montreal Protocol
- Kyoto Protocol

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OCCUPATIONAL SAFETY AND HEALTH PRACTICES

UNIT CODE: CON/CU/CET/BC/06/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Demonstrate Occupational Safety and Health Practices

Duration of Unit: 40 hours

Unit Description

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risk, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

Summary of Learning Outcomes

1. Identify workplace hazards and risk
2. Control OSH hazards
3. Implement OSH programs

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Identify workplace hazards and risks	<ul style="list-style-type: none">• Identification of hazards in the workplace and/or the indicators of their presence• Evaluation and/or work environment measurements of OSH hazards/risk existing in the workplace• Gathering of OSH issues and/or concerns	<ul style="list-style-type: none">• Oral questions• Written tests• Portfolio of evidence• Third party report
2. Control OSH hazards	<ul style="list-style-type: none">• Prevention and control measures e.g. use of PPE• Risk assessment• Contingency measures	<ul style="list-style-type: none">• Oral questions• Written tests• Portfolio of evidence

		<ul style="list-style-type: none"> • Third party report
3. Implement OSH programs	<ul style="list-style-type: none"> • Company OSH program, evaluation and review • Implementation of OSH programs • Training of team members and advice on OSH standards and procedures • Implementation of procedures for maintaining OSH-related records 	<ul style="list-style-type: none"> • Oral questions • Written tests • Portfolio of evidence • Third party report

Suggested Methods of Instruction

- Assignments
- Discussion
- Q&A
- Role play
- Viewing of related videos

Recommended Resources

- Standard operating and/or other workplace procedures manuals
- Specific job procedures manuals
- Machine/equipment manufacturer's specifications and instructions
- Personal Protective Equipment (PPE) e.g.
 - Mask
 - Face mask/shield
 - Safety boots
 - Safety harness
 - Arm/Hand guard, gloves
 - Eye protection (goggles, shield)
 - Hearing protection (ear muffs, ear plugs)
 - Hair Net/cap/bonnet
 - Hard hat
 - Face protection (mask, shield)
 - Apron/Gown/coverall/jump suit
 - Anti-static suits
 - High-visibility reflective vest

COMMON UNITS OF LEARNING

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APPLIED MATHEMATICS

UNIT CODE: CON/CU/CET/CC/01/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply mathematical skills

Duration of Unit: 80 hours

Unit Description

This unit describes the competencies required by a technician in order to apply a wide range of mathematical skills in their work; apply ratios and proportions to solve problems; use algebraic and graphical techniques to analyse mathematical problems; apply concepts of probability; perform commercial calculations and collect, organise and analyse statistical data.

Summary of Learning Outcomes

1. Apply Algebra
2. Apply Trigonometry and hyperbolic functions
3. Apply complex numbers
4. Apply Coordinate Geometry
5. Carry out Binomial Expansion
6. Apply Calculus
7. Solve Ordinary differential equations
8. Carry out Mensuration
9. Apply Power Series
10. Apply Statistics
11. Apply Latitudes and Longitudes
12. Apply Vector theory
13. Apply Matrix
14. Apply Numerical methods

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply Algebra	<ul style="list-style-type: none">• Base and Index• Law of indices	<ul style="list-style-type: none">• Written tests• Oral questioning

	<ul style="list-style-type: none"> • Indicial equations • Laws of logarithm • Logarithmic equations • Conversion of bases • Use of calculator • Reduction of equations • Solution of equations reduced to quadratic form • Solutions of simultaneous linear equations in three unknowns • Solutions of problems involving AP and GP 	<ul style="list-style-type: none"> • Assignments • Supervised exercises •
2. Apply Trigonometry and hyperbolic functions	<ul style="list-style-type: none"> • Half -angle formula • Factor formula • Trigonometric functions • Parametric equations • Relative and absolute measures • Measures calculation • Definition of hyperbolic equations • Properties of hyperbolic functions • Evaluations of hyperbolic functions Hyperbolic identities • Osborne's Rule • $Ashx+bshx=C$ equation • One-to-one relationship in functions • Inverse functions for one-to-one relationship • Inverse functions for trigonometric functions • Graph of inverse functions • Inverse hyperbolic functions 	<ul style="list-style-type: none"> • Written tests • Oral questioning • Assignments • Supervised exercises • •
3. Apply complex numbers	<ul style="list-style-type: none"> • Definition of complex numbers 	<ul style="list-style-type: none"> • Assignments • Oral questioning

	<ul style="list-style-type: none"> • Stating complex numbers in terms of conjugate argument and • Modulus • Representation of complex numbers on the Argand diagram • Arithmetic operation of complex numbers Application of De Moivre's theorem • Application of complex numbers to engineering 	<ul style="list-style-type: none"> • Supervised exercises • Written tests
4. Apply Coordinate Geometry	<ul style="list-style-type: none"> • Polar equations • Cartesian equation • Graphs of polar equations • Normal and tangents • Definition of a point • Locus of a point in relation to a circle • Loci of points for given mechanism 	<ul style="list-style-type: none"> • Assignments • Oral questioning • Practical tests • Observation • Supervised exercises • Written tests
5. Carry out Binomial Expansion	<ul style="list-style-type: none"> • Binomial theorem Power series using binomial theorem Roots of numbers using binomial theorem. • Estimation of errors of small changes using binomial theorem 	<ul style="list-style-type: none"> • Assignments • Supervised exercises • Written tests
6. Apply calculus	<ul style="list-style-type: none"> • Definition of derivatives of a function • Differentiation from first principle • Tables of some common derivatives • Rules of differentiation • Rate of change and small change • Stationery points of functions of two variables • Definition of integration • Indefinite and definite integral 	<ul style="list-style-type: none"> • Assignments • Supervised exercises • Written tests •

	<ul style="list-style-type: none"> • Methods of integration application of integration. • Integrals of hyperbolic and inverse functions 	
7. Solve Ordinary differential equations	<ul style="list-style-type: none"> • Types of first order differential equations • Formation of first order differential equation • Solution of first order differential equations • Application of first order differential equations • Formation of second order differential equations for various systems • Solution of second order differential equations • Application of second order differential equations 	<ul style="list-style-type: none"> • Assignments • Oral questioning • Supervised exercises • Written tests •
8. Carry out Mensuration	<ul style="list-style-type: none"> • Units of measurements • Perimeter and areas of regular figures • Volume of regular solids • Surface area of regular solids • Area of irregular figures • Areas and volumes using Pappus theorem 	<ul style="list-style-type: none"> • Assignments • Supervised exercises • Written tests •
9. Apply Power Series	<ul style="list-style-type: none"> • Definition of the term power series • Taylor's theorem • Deduction of Maclaurin's theorem to obtain power series • Application of Taylor's theorem and Maclaurin's theorems in numerical work 	<ul style="list-style-type: none"> • Written tests • Assignments • Supervised exercises • •
10. Apply Statistics	<ul style="list-style-type: none"> • Classification of data • Grouped data 	<ul style="list-style-type: none"> • Oral questioning • Written tests

	<ul style="list-style-type: none"> • Ungrouped data • Data collection • Tabulation of data • Class intervals • Class boundaries • Frequency tables • Diagrammatic and graphical presentation of data e.g. • Histograms • Frequency polygons • Bar charts • Pie charts • Cumulative frequency curves • Measures of central tendency mean, mode and median • Measures of dispersion • Variance and standard deviation • Definition of probability • Laws of probability • Expectation variance and S.D. • Types of distributions • Mean, variance and SD of probability distributions • Application of probability distributions • Standard normal tables • Sampling distributions • Rank correlation coefficient 	<ul style="list-style-type: none"> • Assignments • Supervised exercises
11. Apply Latitudes and Longitudes	<ul style="list-style-type: none"> • Latitudes and longitudes • The equator and the Greenwich meridian • Distance between two points along small and great circle • Time between longitude • speed 	<ul style="list-style-type: none"> • Assignments • Oral questioning • Supervised exercises • Written tests

12. Apply Vector theory	<ul style="list-style-type: none"> • Vectors and scalar in two and three dimensions • Operations on vectors: Addition and Subtraction • Position vectors • Resolution of vectors 	<ul style="list-style-type: none"> • Assignments • Oral questioning • Supervised exercises • Written tests
13. Apply Matrix methods	<ul style="list-style-type: none"> • Matrix operation • Determinant of 3x3 matrix • Inverse of 3x3 matrix • Solution of linear simultaneous equations in 3 unknowns • Application of matrices 	<ul style="list-style-type: none"> • Assignments • Oral questioning • Supervised exercises • Written tests
14. Apply Numerical methods	<ul style="list-style-type: none"> • Definition of interpolation and extrapolation • Application of interpolation • Application of interactive methods to solve equations • Application of interactive methods to areas and volumes 	<ul style="list-style-type: none"> • Assignments • Oral questioning • Supervised exercises • Written tests

Suggested Methods of Instruction

- Group discussions
- Demonstration by trainer
- Exercises by trainee

Recommended Resources

- Scientific Calculators
- Rulers, pencils, erasers
- Charts with presentations of data
- Graph books
- Dice
- Computers with internet connection

TECHNICAL DRAWING

UNIT CODE: CON/CU/CET/CC/02/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Prepare and interpret technical drawings

Duration of Unit: 60 hours

Unit Description

This unit covers the competencies required to prepare and interpret technical drawings. It involves competencies to select, use and maintain drawing equipment and materials. It also involves producing plain geometry drawings, solid geometry drawings, pictorial and orthographic drawings of components and application of Computer Aided Design (CAD) packages.

Summary of Learning Outcomes

1. Use and maintain drawing equipment and materials
2. Produce plane geometry drawings
3. Produce solid geometry drawings
4. Produce pictorial and orthographic drawings of components
5. Apply CAD packages

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods
1. Use and maintain drawing equipment and materials	<ul style="list-style-type: none">• Identification and care of drawing equipment• Identification and care of drawing materials• Reference to manufacturer's instructions and work place procedures on use and maintenance of drawing equipment and materials• Reference to relevant environmental legislations	<ul style="list-style-type: none">• Observation• Oral questioning• Written tests•

	<ul style="list-style-type: none"> • Use of Personal Protective Equipment (PPEs) 	
2. Produce plane geometry drawings	<ul style="list-style-type: none"> • Types of lines in drawings • Construction of geometric forms e.g. squares, circles • Construction of different angles • Measurement of different angles • Bisection of different angles and lines • Standard drawing conventions 	<ul style="list-style-type: none"> • Oral questioning • Practical tests • Observation •
3. Produce solid geometry drawings	<ul style="list-style-type: none"> • Interpretation of sketches and drawings of patterns e.g. cylinders, prisms and pyramids • Sectioning of solids e.g. prisms, cones • Development and interpenetrations of solids e.g. cylinder to cylinder and cylinder to triangular, prism 	<ul style="list-style-type: none"> • Observation • Practical tests • Oral questioning • •
4. Produce orthographic drawings	<ul style="list-style-type: none"> • Meaning of pictorial and orthographic drawings • Meaning of sectioning • Meaning of symbols and abbreviations • Drawing and interpretation of orthographic elevations • Dimensioning of orthographic elevations • Sectioning of views 	<ul style="list-style-type: none"> • Observation • Practical tests • Oral questioning
5. Produce pictorial drawings	<ul style="list-style-type: none"> • Meaning of pictorial drawings • Drawing objects in isometric view • Drawing objects in oblique view 	<ul style="list-style-type: none"> • Observation • Oral questioning • Practical tests
6. Apply CAD packages	<ul style="list-style-type: none"> • Identification of CAD packages e.g. AutoCAD, circuit maker 	<ul style="list-style-type: none"> • Observation • Oral questioning

	<ul style="list-style-type: none"> • Use of CAD packages in drawing of: <ul style="list-style-type: none"> ○ Plane geometry ○ Solid ○ Orthographic ○ Pictorial 	<ul style="list-style-type: none"> • Practical tests
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Suggested Methods of Instruction

- Projects
- Demonstration by trainer
- Practice by the trainee
- Discussions

Recommended Resources

- Drawing room
- Drawing instruments e.g. T-squares, set squares, drawing sets
- Drawing tables
- Pencils, papers, erasers
- Masking tapes
- Computers installed with relevant CAD packages

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STRUCTURAL DESIGN AND ANALYSIS

UNIT CODE: CON/CU/CET/CC/03/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform Structural Design and Analysis

Duration of Unit: 70 Hours

Unit Description

This Unit describes the competencies required to Perform Structural Design and Analysis. It involves analysing structural designs, designing structural elements, preparing structural drawings interpreting structural drawings and applying structural drawings

Summary of Learning Outcomes

- 1 Analyse structural elements
- 2 Design structural elements
- 3 Prepare structural drawings
- 4 Interpret structural drawings
- 5 Apply and use structural drawings

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1 Analyse structural elements	<ul style="list-style-type: none">• Analyses of structural elements• Preparation of sketches• Determination of maximum moments• Structural designs	<ul style="list-style-type: none">• Written tests• Oral• Practical/Projects
2 Design structural elements	<ul style="list-style-type: none">• Structural designs• Methods of designs• Design codes• Design tools and equipment• Structural elements designs• Schedules for different elements	<ul style="list-style-type: none">• Written tests• Oral• Practical/Projects
3 Prepare structural drawings	<ul style="list-style-type: none">• Drawing tools and equipment	<ul style="list-style-type: none">• Written tests• Oral

	<ul style="list-style-type: none"> • Methods of drawing • Standard structural drawings • Preparation of material schedules 	<ul style="list-style-type: none"> • Practical/Projects
4 Interpret structural drawings	<ul style="list-style-type: none"> • Identification of project • Structural drawings • Steel and material schedules preparation • Standard construction procedures 	<ul style="list-style-type: none"> • Written tests • Oral • Practical/Projects
5 Apply and use structural drawings	<ul style="list-style-type: none"> • Interpretation of drawings • Statutory requirements • Foundation engineering • Preparation of structural elements • Development of working drawing, steel schedules and materials schedules 	<ul style="list-style-type: none"> • Written tests • Oral • Practical/Projects

Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Projects
- Group discussions
- Industrial attachment

Recommended Resources

- Computers
- Office equipment
- Calculators
- Scale rule
- Computer software
- Design codes (British standards)
- Stationery
- Standard design manuals

- Dust coat
- First aid kit

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MATERIAL SCIENCE

UNIT CODE: CON/CU/CET/CC/04/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply Construction Materials Science

Duration of Unit: 90 Hours

Unit Description

This unit describes the competence in applying building materials science. It involves identifying essential construction materials, selecting quality construction materials, testing construction materials and demonstrating knowledge in use of construction materials.

Summary of Learning Outcomes

1. Identify essential construction materials
2. Identify properties of construction materials
3. Manufacture construction materials
4. Select quality construction materials
5. Use construction materials appropriately
6. Test construction materials
7. Handle construction materials safely

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Identify essential construction materials	<ul style="list-style-type: none">• Engineering drawings interpretation• Bills of quantities• Construction materials	<ul style="list-style-type: none">• Written tests• Oral• Practical tests/Project
2. Identify properties of construction materials	<ul style="list-style-type: none">• Physical properties of construction materials• Chemical properties of construction materials• Mechanical properties of construction materials	<ul style="list-style-type: none">• Written tests• Oral• Practical tests/Project

3. Manufacture construction materials	<ul style="list-style-type: none"> • Raw materials used in manufacturing construction materials • Procedures of manufacturing construction materials • Plant and equipment used in manufacturing construction materials 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project
4. Select quality construction materials	<ul style="list-style-type: none"> • Properties of quality construction materials • Construction materials Cost and quality relationship • Selection of Construction materials 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project
5. Use construction materials appropriately	<ul style="list-style-type: none"> • Construction methods and processes • Appropriate use of construction materials 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project
6. Test construction materials	<ul style="list-style-type: none"> • Materials testing parameters • Destructive tests • Non-destructive tests • Materials testing procedures • Quality assurance and control 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project
7. Handle construction materials safely	<ul style="list-style-type: none"> • User safety in handling construction materials • Construction Materials handling and storage 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project

Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Projects
- Field trips

- Trainee group discussions

Recommended Resources

- Computer
- Laboratory testing equipment
- Laboratory apparatus
- Hand tools
- Machine tools
- Computer software
- Construction materials
- Computers
- Stationery
- Manufacturer's catalogues
- Safety boots
- Goggles
- Gas masks
- Helmets
- Gloves
- Dust coats
- First aid kit
- Ear muffs
- Dust masks
- Overalls

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WORKSHOP TECHNOLOGY PRACTICES

UNIT CODE: CON/CU/CET/CC/05/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Apply Workshop Technology Practices

Duration of Unit: 130 Hours

Unit Description

This unit describes the competence in applying workshop technology practices. It entails performing masonry, plumbing and carpentry tasks. It also involves performing electrical and mechanical operations.

Summary of Learning Outcomes

1. Perform masonry tasks
2. Perform plumbing tasks
3. Perform carpentry tasks
4. Perform electrical operations
5. Perform mechanical operations

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Perform masonry tasks	<ul style="list-style-type: none">• Masonry workshop safety requirements• Masonry hand tools• Masonry machine tools• Maintenance of masonry tools• Use of masonry tools	<ul style="list-style-type: none">• Written tests• Oral• Practical tests/Project
2. Perform plumbing tasks	<ul style="list-style-type: none">• Plumbing workshop safety requirements• Plumbing hand tools• Plumbing machine tools• Maintenance of Plumbing tools• Use of Plumbing tools	<ul style="list-style-type: none">• Written tests• Oral• Practical tests/Project

3. Perform carpentry tasks	<ul style="list-style-type: none"> • Carpentry workshop safety requirements • Carpentry hand tools • Carpentry machine tools • Maintenance of Carpentry tools • Use of Carpentry tools 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project
4. Perform electrical operations	<ul style="list-style-type: none"> • Electrical workshop safety requirements • Measurement of electrical quantities • IEE regulations • Electrical conventional tools • Installation of basic electrical circuits • Renewable energy • Power supply 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project
5. Perform mechanical operations	<ul style="list-style-type: none"> • Mechanical workshop safety requirements • Mechanical hand tools • Use of mechanical tools • Diesel and petrol engines • Water pumps • Maintenance of engines and water pumps 	<ul style="list-style-type: none"> • Written tests • Oral • Practical tests/Project

Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Field trips
- Trainee group discussions

Recommended Resources

- Masons trowel
- Wood float
- Cold chisels
- Masons square
- Spade
- Shovel
- Plumb bob
- Concrete mixer
- Block cutter
- Vibrator
- Pneumatic hammer
- Compactors
- Bench shears
- Anvil
- Pipe wrench
- Pliers
- Bending machine
- Welding
- Sheet metal holding machine
- Portable power drill
- Saws
- Planes
- Hammer
- Carpenter square
- Marking gauges
- Hand drill
- Screw drivers
- circular saw
- Thicknesser
- Portable sander
- Close cut saw
- Portable drill machine
- phase tester
- screw driver
- pliers

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- long nose
- side cutter
- draw in wire
- electrical knife
- electrical hammer
- Arc welding shields
- Leather gloves
- Chipping hammers
- Welding goggles
- Tongs
- Hand vices
- Mole punch
- Pliers
- Centrifugal
- Submersible
- Reciprocating pump
- Hand pumps
- Hand grinder
- Lumber
- PPR pipes
- PVC pipes
- GI pipes
- Pipe fittings
- Cement
- Sand
- Lime
- Sheet metal
- Steel plates
- Electrical materials
- Electrical appliances
- Plumbing appliances
- Fuel
- Grease
- Oil
- Filters

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- Helmets
- Gloves
- Safety goggles
- Safety boots
- Overalls
- Dust masks
- Gas masks
- Dust coats

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MEASUREMENT OF WORKS AND COST ESTIMATION

UNIT CODE: CON/CU/CET/CC/06/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Perform Measurement of Works and Cost Estimation

Duration of Unit: 80 Hours

Unit Description

This unit describes competencies required to perform measurement of works and cost estimation. It involves preparing tender documents, taking off quantities, working up dimensions and abstracting measured quantities

Summary of Learning Outcomes

1. Prepare tender documents
2. Take off quantities
3. Work up dimensions
4. Abstract measured quantities

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare tender documents	<ul style="list-style-type: none">• Preparation of working drawings• Work specifications• Bill of quantities• Preparation of schedule of rates• Preparation of conditions of contract• Forms of agreement• Forms of tender	<ul style="list-style-type: none">• Written tests• Oral• Practical/Projects
2. Take off quantities	<ul style="list-style-type: none">• Principles of measurement• Standard methods of measurement/CESMM• Preparation of dimension sheet/paper	<ul style="list-style-type: none">• Written tests• Oral• Practical/Projects

	<ul style="list-style-type: none"> • Preparation of quantities checklist • Computing building/civil works quantities • Booking of dimensions • Booked items description 	
3. Work up dimensions	<ul style="list-style-type: none"> • Timesing of dimensions • Squaring of booked dimensions 	<ul style="list-style-type: none"> • Written tests • Oral • Practical/Projects
4. Abstract measured quantities	<ul style="list-style-type: none"> • Abstracting sheet <ul style="list-style-type: none"> ○ Preparation of abstracting sheet ○ Transfer of booked quantities • Running through dimensions <ul style="list-style-type: none"> ○ Symbols used in running through dimensions 	<ul style="list-style-type: none"> • Written tests • Oral • Practical/Projects

Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Projects
- Group discussions

Recommended Resources

- Computers
- Office equipment
- Calculators
- Scale rule
- Computer software
- CESSM/SMM
- Stationery
- Dust coat
- First aid kit

WATER AND WASTEWATER TECHNOLOGY

UNIT CODE: CON/CU/CET/CC/07/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: apply water & wastewater technology

Duration of Unit: 120 Hours

Unit Description

This unit describes the competence required to apply water & wastewater technology practices. It involves applying basic water supply principles, principles of wastewater collection & treatment and basic irrigation & drainage principles.

Summary of Learning Outcomes

- 1) Apply basic water supply principles
- 2) Apply principles of wastewater collection and treatment
- 3) Apply basic irrigation and drainage principles

Learning Outcomes, Content and Suggested Assessment Methods:

Learning Outcome	Content	Suggested Assessment Methods
1. Apply basic water supply principles	<ul style="list-style-type: none">• Water demand• Sources of water• Water abstraction• Water treatment• Safe water storage and handling• Water pipes and appurtenances• Water supply symbols• Distribution system	<ul style="list-style-type: none">• Oral questioning• Written tests• Observation• Practical test
2. Apply principles of wastewater collection and treatment	<ul style="list-style-type: none">• Sources of waste water• Types of sewers• Sewerage systems• Characteristics of wastewater• Sewer appurtenances• Wastewater Treatment processes and disposal	<ul style="list-style-type: none">• Oral questioning• Written tests• Observation• Practical test

	<ul style="list-style-type: none"> • Wastewater symbols • Wastewater colour coding for pipes and exhauster trucks 	
3. Apply basic irrigation and drainage principles	<ul style="list-style-type: none"> • Soil, plant-water relationship • Land preparation • Sources of water for irrigation • Irrigation farm layout • Quality of irrigation water • Irrigation methods • Methods of drainage 	<ul style="list-style-type: none"> • Oral questioning • Written tests • Observation • Practical test

Suggested Methods of Instruction

- Demonstration by trainer
- Practice by the trainee
- Field trips
- On-job-training
- Discussions

Recommended Resources

- Scientific Calculators
- Relevant reference materials
- Stationery
- Relevant practical materials
- Laboratories (chemical, biological & soils)
- Internet
- Projector

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WATER RESOURCES, WATER SERVICES AND SANITATION MANAGEMENT PRINCIPLES

UNIT CODE: CON/CU/CET/CC/08/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: apply water resources, water services and sanitation management principles

Duration of Unit: 120 Hours

Unit Description

This unit describes the competencies required to apply water resource management principles. It involves determination of hydrological processes, quantification of surface water, mapping of rock types and aquifers, establishment of suitable site for wells. It also involves conservation of environment and development of water harvesting structures. It also involves application of water and environmental law in water resource management and application of integrated water resources management (IWRM) principles.

Summary of Learning Outcomes

- 1) Determine hydrological processes
- 2) Quantify surface water
- 3) Map rocks and aquifers
- 4) Establish well sites
- 5) Conserve the Environment
- 6) Develop water harvesting structures
- 7) Apply water and environmental law in water resource management
- 8) Apply Integrated Water Resources Management (IWRM) Principles

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Determine Hydrological Processes	<ul style="list-style-type: none"> • Concepts of hydrology • Hydrological cycle • Hydrological processes, principles and application in each case: <ul style="list-style-type: none"> ▪ Precipitation- types, forms, areal rainfall, causes 	<ul style="list-style-type: none"> • Written tests • Observation • Interviewing • Oral questioning

	<p>of errors of rainfall data, filling missing rainfall data</p> <ul style="list-style-type: none"> ▪ Evaporation ▪ Infiltration ▪ Percolation ▪ Condensation ▪ Surface run-off 	<ul style="list-style-type: none"> • Third party report
2. Quantify surface water	<ul style="list-style-type: none"> • Precipitation measurement-types of rain gauges • Evaporation measurement from US class A pan • Stream flow measurement-selection of a regular gauging station site, River gauging, Computation of stream discharge(mean section method, mid-section method; Stage discharge relationship) • Personal safety in hydrometry 	<ul style="list-style-type: none"> • Written tests • Interviewing • Observation • Oral questions • Third party report
3. Map rocks and aquifers	<ul style="list-style-type: none"> • Geologic time scale (Eons, Eras, Periods, Series) • Earth origin theories • • Internal structure of the earth (crust, mantle, core) • Earth processes (weathering, volcanism, isostasy, magmatism) • Rock types and their characteristics: (sedimentary, metamorphic, igneous,) • Rock structures 	<ul style="list-style-type: none"> • Written tests • Interviewing • Observation • Oral questions • Third party report

	<ul style="list-style-type: none"> • Minerology: Physical properties of minerals, rock forming minerals, mineral groups. • Aquifer types and characteristics : confined, non-confined, leaky, perched 	
4. Establish well sites	<ul style="list-style-type: none"> • Classifications of wells: dug, driven, drilled • Factors affecting well siting • Methods of well site establishment • Well site establishment report writing 	<ul style="list-style-type: none"> • Written tests • Interviewing • Observation • Oral questions • Third party report
5. Conserve the Environment	<ul style="list-style-type: none"> • Water conservation • Soil conservation • Types of land degradation • Causes of land degradation • Effects of land degradation • Control measures of land degradation 	<ul style="list-style-type: none"> • Written tests • Observation • Interviewing • Oral questioning • Third party report
6. Develop water harvesting structures	<ul style="list-style-type: none"> • Water harvesting techniques (roof catchment, rock catchment, surface water catchment) • Types of water harvesting reservoirs(water pans, water dams) • Site selection for water harvesting structures <ul style="list-style-type: none"> ✓ Hydraulic properties of rock units e.g. porosity, Permeability, compressibility 	<ul style="list-style-type: none"> • Written tests • Interviewing • Observation • Oral questions • Third party report

	<ul style="list-style-type: none"> ✓ Topography ✓ Proximity • Design of simple water harvesting structures • Operation and maintenance of water harvesting structures 	
<p>7. Apply water policy, water and environmental laws, legislation in water resource management, water and sanitation services</p>	<ul style="list-style-type: none"> • Water policy, water laws and legislation in Kenya • History of water reforms in Kenya (since 1999) • Implications of Constitution of Kenya on Water Resources Management and water services: National Government, County Governments • Legal and regulatory framework of Water Sector in Kenya: Laws, Policies, Water Act, EMCA, regulations (e.g. WRA, NEMA, WASREB) other sector Institutions e.g., WSTF, Water Harvesting Storage Authority(WHSA), WSBs WSPs,) • Water Law administration: mandates, roles of water sector regulators and institutions • Civil Laws: Law of tort, Law of contract, Law of evidence • Criminal Law basics and criminal procedure code 	<ul style="list-style-type: none"> • Written tests • Observation • Interviewing • Oral questioning • Third party report

<p>8. Apply Integrated Water Resources Management (IWRM) Principles</p>	<ul style="list-style-type: none"> ● Concepts of IWRM (the water challenge, need for integration, sustainable development goals- SDGs e.g. Goal 6,11,12,14) ● Principles of IWRM (Dublin principles) ● IWRM and its relation to sub-sectors (water for people, water for food, water for nature and other users) ● Pillars of IWRM: ● Enabling environment for IWRM(policies, legal framework, investment and financing) ● Institutional arrangement in IWRM (regulation and compliance, water supply and sanitation services, coordination and facilitation, capacity building) ● Management instruments for IWRM(understanding water endowments, assessment, modelling and decision making, planning for IWRM, communication, efficiency in water use, economic instruments, promoting social change) ● Gender mainstreaming in IWRM ● Applications/Implications of IWRM in Kenyan Context 	<ul style="list-style-type: none"> ● Written tests ● Observation ● Interviewing ● Oral questioning ● Third party report
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Suggested Methods of Instruction

- Direct instruction
- Project
- Case studies
- Field trips
- Discussions
- Demonstration by trainer
- Practice by the trainee

Recommended Resources:

- Computers
- Stationery
- Evaporation pan (Class A)
- Rain gauge
- Current meter
- Wading suit
- Tape measure
- Staff gauge
- Hand lens
- Clinometer
- GPS receiver
- Maps
- Steel file
- Steel knife
- Rock samples
- Minerals
- PPE

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CORE UNITS OF LEARNING

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MATERIAL TESTING

UNIT CODE: CON/CU/CET/CR/01/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Conduct material testing

Duration of Unit: 150 Hours

Unit Description

This unit specifies the competencies required to Conduct Material Testing. It involves preparing for material testing, sampling construction materials, performing tests on alignment soils, concrete, structural steel, bitumen materials and timber. It also includes documenting test results.

Summary of Learning Outcomes

- 1 Prepare for material testing
- 2 Sample road construction materials
- 3 Undertake tests on the alignment soils
- 4 Perform concrete tests
- 5 Carry out structural steel tests
- 6 Perform bitumen tests
- 7 Perform timber tests

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare for material testing	<ul style="list-style-type: none">• Preliminary site investigations• Construction material laboratory• Material testing manuals and contract documents• Material testing tools and equipment• Construction material laboratory personnel• Development of sampling procedures• Determination of various types of material tests	<ul style="list-style-type: none">• Written tests• Observation• Oral questioning• Third party report•

2. Sample road construction materials	<ul style="list-style-type: none"> • Sources of road construction materials • Sampling procedures and standard manuals • Sampling tools and equipment • Material sample analysis • Storage of samples • Handling of material samples 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
3. Undertake tests on the alignment soils	<ul style="list-style-type: none"> • Alignment soil tests i.e. <ul style="list-style-type: none"> ○ Shear test ○ Trial axial ○ CBR • Standard manuals and procedures • Material test laboratory • Soil testing tools and apparatus. • Obtaining soil samples • Conducting Soil tests <ul style="list-style-type: none"> ○ CBR ○ Atterberg limit <ul style="list-style-type: none"> ▪ Liquid limit ▪ Plastic limit ○ Proctor/compaction ○ Field density ○ Particle size distribution • Analysis of soil tests results • Preparation and presentation of test report 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report •
4. Perform concrete tests	<ul style="list-style-type: none"> • Concrete tests <ul style="list-style-type: none"> ○ Crushing test ○ Compressive strength ○ Slump ○ Cleanliness ○ Particle size distribution • Standard manuals and procedures 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report •

	<ul style="list-style-type: none"> • Concrete testing tools and apparatus • Obtaining test samples • Preparation of concrete samples <ul style="list-style-type: none"> ○ Casting cubes ○ Curing cubes • Test for concrete • Recording of tested cubes • Analysing and reporting of test result 	
5. Carry out structural steel tests	<ul style="list-style-type: none"> • Structural steel samples • Identification and calibration of tensile testing machines • Testing of samples for tensile strength • Recording and analysing of results • Preparation and presentation of test reports 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questioning • Third party report
6. Perform bitumen tests	<ul style="list-style-type: none"> • Identification of Bitumen tests • Standard manuals and test procedures • Identification and gathering of testing tools and apparatus • Obtaining of test samples • Preparation of Samples. • Conducting bitumen test <ul style="list-style-type: none"> ○ Penetration ○ Cleanliness ○ Viscosity ○ Ductility ○ Flash and Fire Point ○ Float Test ○ Loss on Heating ○ Specific Gravity 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questioning • Third party report

	<ul style="list-style-type: none"> ○ Softening Point ○ Spread Rate ● Recording and analysing of test results ● Preparation and presentation of report 	
7. Perform timber tests	<ul style="list-style-type: none"> ● Timber samples ● Identification and calibration of tensile testing machines ● Testing of samples for tensile strength ● Recording and analysing of results <ul style="list-style-type: none"> ○ Preparation and presentation of test reports 	<ul style="list-style-type: none"> ● Written tests ● Observation ● Oral questioning ● Third party report

Suggested Methods of Instruction:

- Direct instruction
- Project
- Case studies
- Field trips
- Discussions
- Demonstration by trainer
- Practice by the trainee

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Recommended Resources:

- Computers
- Software
- Cameras
- Construction manuals
- Projectors
- Flip charts
- Calculators
- Rulers, pencils, erasers
- Charts with presentations of data
- Drawing sheets
- Internet
- Relevant videos

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HIGHWAY SURVEY

UNIT CODE: CON/CU/CET/CR/02/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Perform Highway Engineering Survey

Duration of Unit: 190 Hours

Unit Description

This unit specifies the competencies required to Perform Highway Survey. It involves undertaking preliminary site survey, performing levelling activities, conducting tacheometry works and drafting road cross-sections. It also includes carrying out setting out activities, performing traversing works and performing traffic engineering survey.

Summary of Learning Outcomes

1. Undertake preliminary site survey
2. Carry out setting out activities
3. Conduct tacheometry works
4. Perform levelling activities
5. Draft road cross-sections
6. Perform traversing works
7. Perform traffic engineering survey

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1 Undertake preliminary site survey	<ul style="list-style-type: none">• Preliminary site survey plan• Mobilization of survey resources• Interpretation of survey drawings• Assessment of site survey conditions• Levelling activities	<ul style="list-style-type: none">• Written tests• Observation• Case study• Oral questions• Third party report

	<ul style="list-style-type: none"> • Establishment of Original ground level (OGL) • Establishment of reference points • Preparation of preliminary survey report 	
2 Perform levelling activities	<ul style="list-style-type: none"> • Description of levelling tools and equipment • Calibration of levelling tools and equipment • Setting out levelling machines and equipment. • Reading and booking surveying levels • Monitoring and control of road levels • Carrying out arithmetic checks 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report •
3 Conduct tacheometry works	<ul style="list-style-type: none"> • Tacheometry tools and equipment • Calibration of tools and equipment • Determination of horizontal distances • Determination of vertical distances • Collection of tacheometry data • Documentation of tacheometry data Collected • Carry out arithmetic checks 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questioning • Third party report •

<p>4 Draft road cross-sections</p>	<ul style="list-style-type: none"> • Recording and computing road levels. • Producing reduced levels • Road cross-sections • Drafting tools and equipment • Drafting road cross-sections • Interpretation of road cross-sections • Establishing road designs profiles 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report •
<p>5 Carry out setting out activities</p>	<ul style="list-style-type: none"> • Identification of Setting out tools and equipment • Calibrations of equipment • Determination of alignments • Setting out of alignments • Horizontal alignment • Vertical alignment • Computation of alignment data 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questioning • Third party report •
<p>6 Perform traversing works</p>	<ul style="list-style-type: none"> • Theodolite traversing • Compass traversing • Calibration of tools • Determination of horizontal and vertical angles • Calculation of coordinates • Data collection and analysis • Documentation of data 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report •

<p>7 Perform traffic engineering survey</p>	<ul style="list-style-type: none"> • Contract documents • Geographical information sources • Interpretation of geographical data • Location of traffic survey site • Topographical maps • Traffic survey • Identification of human resources • Traffic engineering survey tools, equipment and materials • Definition of duties and responsibilities • Methods of data collection and analysis • Establishment of data collection and monitoring methods • Legal and statutory requirements. • Allocation of resources • Allocation of duties and responsibilities • Provision for road safety requirements • Conducting traffic counts • Establishment of traffic volumes and axle loadings • Data analysis 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
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	<ul style="list-style-type: none"> • Preparation of traffic count report • Traffic data analysis • Categorization of traffic composition • Determination and estimation of traffic characteristics • Determination of road characteristics • Documentation of road and traffic characteristics • Preparation of road traffic survey reports 	
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Suggested Methods of Instruction

- Direct instruction
- Project
- Case studies
- Group discussions
- Field trips /site visits
- Demonstration by trainer
- Practice by the trainees
- Industrial attachment
- Viewing of related videos

Recommended Resources:

- Surveying tools and equipment
- Computers
- CAD & GIS Software
- Construction manuals and guidelines
- Projectors
- Flip charts
- Calculators
- Stationery

- Charts with presentations of data
- Drawing sheets
- Internet
- Relevant videos
- Printers
- Workstation
- Standard of specifications

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BASIC PAVEMENT STRUCTURE DESIGN

UNIT CODE: CON/CU/CET/CR/03/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Design pavement structure

Duration of Unit: 120 Hours

Unit Description

This unit specifies the competencies required to design basic pavement structures. It involves conducting site visit, designing highway drainage and hydraulic structures, designing road geometrics, designing pavement structure, designing pedestrian and cyclist path and designing for road furniture.

Summary of Learning Outcomes

- 1 Conduct site visit
- 2 Design highway, drainage and hydraulic structures
- 3 Design road geometrics
- 4 Design pavement structure
- 5 Design pedestrian and cyclist paths
- 6 Design road furniture

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Conduct site visit	<ul style="list-style-type: none">• Preliminary site visit• Determining of pavement location• Preparation for site visit• Data collection methods• Tools and equipment for data collection• Collection of on-site data	<ul style="list-style-type: none">• Observation• Case studies• Oral• Third party report
2. Design highway drainage and hydraulic structures	<ul style="list-style-type: none">• Contract documents• Survey resources• Statutory requirements	<ul style="list-style-type: none">• Observation• Case studies• Oral• Third party report

	<ul style="list-style-type: none"> • Data collection tools and equipment • Data analysis • Identification of pavement location • Natural characteristics of the drainage site • Hydrology engineering • Geological survey • Establishment of longitudinal section of the river • Determination of water levels and velocity at the river • Location of highway drainage sites • Determination of highway drainage and hydraulic structures for construction • Determination of drainage size • Estimation of rainfall intensity • Types and nature of ground cover • Estimation of surface run-off • Documentation of estimated surface run-off • Hydraulic and hydrology • Soil science • Location of drainage structures • Determination of drainage span • Development of material schedules • Designing highway drainage structures • Production of construction drawings • Documentation of drawings • Standard manuals and designs 	
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	<ul style="list-style-type: none"> • Geometry • Measuring tools and equipment • Types of highway drainages • Determination of Equivalent Standard Axle (ESA), life loads and bridge dead load • Selection of bridge construction resources • Determination of material properties for construction • Designing of bridge components • Geometrics • Foundation engineering • Design manuals • Material science • Basic quantity survey • Preparation of construction drawings • Reporting and documentation • Determination of Equivalent Standard Axle (ESA), life loads and drift dead load • Properties of construction materials • Geometrics • Design manuals • Soil science • Foundation engineering • Selection of drift and/or causeways construction materials • Design of drift and causeway • Preparation of drawings • Documentation of drawings • Preparations for designing 	
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	<ul style="list-style-type: none"> • Determination of retaining wall types for construction • Selection of materials for construction • Geometrics • Determination of nature of load • Soil science • Determination of soil lateral pressure and its line of action • Soil bearing capacity • Foundation engineering • Construction designs and standard manuals • Documentation of drawings • Interpretation of construction drawings • Interpretation of Material schedules • Determination of highway drainage structure for construction • Determination and selection of construction materials • Construction material science • Construction material estimates • Principles of quantity surveying 	
<p>3. Design road geometrics</p>	<ul style="list-style-type: none"> □ Acquisition of resources • Determination of Original Ground Levels (OGL) • Determination of: <ul style="list-style-type: none"> ○ Horizontal alignments ○ Vertical alignments • Determination of road intersections • Preparation of working drawings 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questioning • Third party report

	<ul style="list-style-type: none"> • Preparation and presentation of report. 	
2 Design pavement structure	<ul style="list-style-type: none"> • Introduction to pavements designs • Acquisition of design resources • Types of pavements • Designing of pavement structures • Preparation of pavement structural drawings • Development of materials schedules • Preparation and presentation of detailed report and material specifications 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
3 Design pedestrian and cyclist paths	<ul style="list-style-type: none"> • Identification and gathering of required resources • Estimation of pedestrian and cyclist traffic • Design manuals • Geometrics • Determination and locating of pedestrian and cyclist path • Designing of pedestrian and cyclist paths • Preparation of drawings • Preparation and presentation of detailed report and specifications 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
4 Design road furniture	<ul style="list-style-type: none"> • Introduction to road furniture • Gathering of required resources • Determination of road furniture • Location of road furniture • Design manuals • Geometrics • Designing of road furniture 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report

	<ul style="list-style-type: none"> • Production of drawings • Preparation and presentation of detailed report and specifications 	
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Suggested Methods of Instruction

- Direct instruction
- Project
- Case studies
- Field trips/site visits
- Discussions
- Demonstration by trainer
- Practice by the trainee

Recommended Resources:

- Computers
- CAD & GIS Software
- Cameras
- Construction manuals
- Projectors
- Flip charts
- Calculators
- Stationery
- Charts with presentations of data
- Drawing sheets
- Internet
- Relevant videos
- Workstation

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ROAD CONSTRUCTION WORKS

UNIT CODE: CON/CU/CET/CR/04/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: Perform Road Construction Works

Duration of Unit: 150 Hours

Unit Description

This unit specifies the competencies required to perform road construction works. It involves carrying out earthwork activities, constructing road/pavement structure layers and constructing parking, walk ways and cyclist lanes, foot bridges and bus bays. It also includes installing road furniture, construction of erosion prevention structures, constructing highway drainage and hydraulic structures and undertaking highway maintenance.

Summary of Learning Outcomes

- 1 Carry out earthwork activities
- 2 Construct road/pavement structure layers
- 3 Construct parking walk ways and cyclist lanes, foot bridges, bus bays
- 4 Install road furniture
- 5 Construct erosion prevention structures
- 6 Construct highway drainage and hydraulic structures
- 7 Undertake highway maintenance

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Carry out earthwork activities	<ul style="list-style-type: none">• Introduction to earthwork activities• Acquisition of relevant legal documents• Interpretation of drawings• Identification and mobilization of Earthwork resources• Setting out for earthworks• Site clearance and demolition activities	<ul style="list-style-type: none">• Observation• Case studies• Oral• Third party report

	<ul style="list-style-type: none"> • Statutory requirements for road construction • Establishment of road formation • Taking and documentation of ground levels • Determination of cut and fill materials volumes 	
2. Construct road/pavement structure layers	<ul style="list-style-type: none"> • Acquisition and mobilization of the required road construction resources • Interpretation of drawings • Standard construction manuals • Carrying out levelling activities • Types of road pavements • Rigid • Flexible • Construction of sub-grade pavement layer • Construction of sub-base pavement layer • Construction of base layer • Documentation of ground levels • Construction of road surface layer • Quality control operations 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questioning • Third party report
3. Construct parking walk ways and cyclist lanes, foot bridges, bus bays	<ul style="list-style-type: none"> • Contract documents • Acquisition and mobilization of required resources • Interpretation of drawings • Construction manuals • Construction of parking • Construction of walk ways, cyclist lanes and bus bays • Construction of foot bridges 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report

	<ul style="list-style-type: none"> • Levelling activities • Documentation of ground levels • Quality control operations 	
4. Install road furniture	<ul style="list-style-type: none"> • Acquisition and mobilization of road furniture resources • Interpretation of drawings • Standard installation manuals • Determination of location of road furniture • Identification of various types of road furniture • Installation of road furniture • Quality control procedures • Maintenance activities on road furniture • Legal and statutory requirements 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
5. Construct erosion prevention structures	<ul style="list-style-type: none"> • Mobilization of construction resources • Types of soil erosion • Determination of erosion control structures • Location of erosion prevention structures • Interpretation of drawings • Standard construction manuals • Construction of erosion prevention structures • Quality control procedures • Maintenance of erosion prevention structures • Legal and statutory requirements 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
6. Construct highway drainage and	<ul style="list-style-type: none"> • Mobilization of drainage construction resources 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions

<p>hydraulic structures</p>	<ul style="list-style-type: none"> • Determination of drainage positions • Legal documents for drainage structures construction • Definition of roles and responsibilities • Cost estimation and tendering for construction works • Interpretation of survey data • Interpretation of drawings • Setting out construction works • Construction of culvert • Quality control operations • Legal requirements • Contract documents • Licenses • Mobilization of construction resources • Location for construction • Interpretation of drawings • Setting out of construction works • Construction procedures for drains • Quality control operations • Legal and statutory requirements • Mobilization of construction resources • Identification of construction site location • Interpretation of survey data • Interpretation of drawings • Setting out operations • Construction of drains and gullies • Quality control operations 	<ul style="list-style-type: none"> • Third party report
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	<ul style="list-style-type: none"> • Legal requirements • Contract • Licenses • Mobilization of construction materials and resources • Location of bridge construction site sections • Interpretation of survey data • Interpretation of drawings • Setting out activities • Bridge construction • Quality control operation • Legal and statutory requirements • Mobilization of construction resources • Locate sections for construction site • Interpretation of drawings • Setting out activities • Construction of drifts and causeways • Quality control operations • Legal and statutory requirements • Mobilization of construction resources • Interpretation of drawings • Setting out activities • Retaining wall construction operations • Backfilling procedures • Quality control operations • Legal and statutory requirements 	
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<p>7. Undertake highway maintenance</p>	<ul style="list-style-type: none"> • Relevant road maintenance information • Road construction legal documents • Identification of road assessment tools and equipment • Definition of duties and roles • Road inspection • Data collection on the status of the road for maintenance • Data is analysis of road sections for maintenance • Identification of road sections for maintenance • Preparation and presentation of assessment report and material specifications • Cost estimation and tendering for maintenance works • Legal and statutory requirements for road maintenance • Identification of highway maintenance needs • Categorization of maintenance needs • Identification of sources of road maintenance construction materials • Development of road maintenance schedules • Determination of road maintenance resources • Identification of emergency site location 	<ul style="list-style-type: none"> • Written tests • Observation • Oral questions • Third party report
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	<ul style="list-style-type: none"> • Identification of the nature and magnitude of road emergency • Mobilization of emergency response resources • Allocation of duties and roles • Allocation of maintenance construction resources • Emergency maintenance procedures • Monitoring and quality operations • Legal documentation of emergency response maintenance • Mobilization of required resources • Interpretation of road designs • Categorization of routine maintenance activities • Carrying out routine maintenance activities • Maintenance of OSH requirements • Quality control activities • Legal documentation of routine maintenance activities • Identification and mobilization of resources • Interpretation of road designs • Categorization of periodic maintenance activities • Carrying out periodic maintenance activities • Maintenance of OSH requirements • Quality control activities 	
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	<ul style="list-style-type: none"> • Legal documentation of routine maintenance activities 	
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Suggested Methods of Instruction:

- Direct instruction
- Project
- Case studies
- Field trips/site visits
- Group discussions
- Demonstration by trainer
- Computer Aided Learning (CAL)
- Practice by the trainee
- Relevant video shows

Recommended Resources

- Computer
- Internet
- Workshop
- Construction materials
- Construction tools and equipment
- Construction designs and drawings
- Sample contract documents
- Computer software e.g. AutoCAD, ArchiCAD, Civil3D
- Stationery
- Road construction site
- Material testing laboratory
 - Moulds
 - Tamping rods
 - CBR Machines
 - Crushing machines
- Schedule of work
- Standard manuals
- Road under construction
- Contract documents

ENGINEERING STRUCTURES DESIGN

UNIT CODE: CON/CU/CET/CR/05/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Design engineering structures

Duration of Unit: 220 Hours

Unit Description

This unit specifies the competencies required to design engineering structures. This involves load estimation, designing structural elements, assessing of cost effectiveness of designs, analysing site test data and modifying structural designs.

Summary of Learning Outcomes

1. Calculate load estimates
2. Design structural elements
3. Assess cost effectiveness of the design
4. Modify structural designs

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Calculate load estimates	<ul style="list-style-type: none">• Architectural drawings• Codes of practice• Structural building use• Structural loading• Structural load analysis	<ul style="list-style-type: none">• Oral• Written• Project/Practical assignment
2. Design structural elements	<ul style="list-style-type: none">• Structural element types• Structural element design methods and calculations• CAD software• Design standards• Codes of practice	<ul style="list-style-type: none">• Oral• Written• Project/Practical assignment
3. Assess cost effectiveness of the design	<ul style="list-style-type: none">• Cost saving design methods• Building design analysis• Bill of quantities• Construction materials• Research	<ul style="list-style-type: none">• Oral• Written• Project/Practical assignment

4. Modify structural design	<ul style="list-style-type: none"> • Site survey data analysis • Construction hypotheses • Structural design modification 	<ul style="list-style-type: none"> • Oral • Written • Project/Practical assignment
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Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Projects
- Group discussions

Recommended Resources

- Computers
- Printers
- Measurement tools
- Survey instruments
- CAD software
- Stationery
- Workstations
- Civil Engineering laboratories
- Legal documents (Engineers Act)
- Civil Engineers Code of Practice
- Antiglare screen protection
- First aid kits

BUILDING DRAWINGS

UNIT CODE: CON/CU/CET/CR/06/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Produce building drawings

Duration of Unit: 200 hours

Unit Description

This unit describes the competencies required to produce building drawings. It involves interpreting architectural drawings, preparing structural and civil drawings, preparing plumbing layouts, interpreting electrical and mechanical drawings.

Summary of Learning Outcomes

1. Interpret architectural drawings
2. Prepare structural and civil drawings
3. Interpret electrical drawings
4. Design plumbing layout
5. Interpret mechanical drawings

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Interpret architectural drawings	<ul style="list-style-type: none">• Drawing tools and equipment• Site investigation/surveying• Construction dimensions• Project plan and design• Architectural drawings• Building codes	<ul style="list-style-type: none">• Practical assignment/project• Oral/written
2. Prepare structural and civil drawings	<ul style="list-style-type: none">• Structural elements• Codes of practice• Bar bending schedule• Structural drawings• Civil elements• Culverts• Retaining walls• Pavements• Storm water drain systems	<ul style="list-style-type: none">• Practical assignment/project• Oral• Written

	<ul style="list-style-type: none"> • Septic tanks • Codes of practice • Civil drawings 	
3. Interpret electrical drawings	<ul style="list-style-type: none"> • Electricity and electronics • Electrical codes of practice • Architectural layout • Electrical connection layout • Electrical drawings 	<ul style="list-style-type: none"> • Practical assignment/project • Oral • Written
4. Design plumbing layout	<ul style="list-style-type: none"> • Pipe sizes • Pipe types • Pipe fittings • Pipe installation • Consumption requirements • Plumbing layout 	<ul style="list-style-type: none"> • Written • Oral • Projects/practical assignment
5. Interpret mechanical drawings	<ul style="list-style-type: none"> • Dimensions (mechanical) • Mechanical systems • Mechanical components • Sketching mechanical components • Drafting mechanical components • Mechanical component dimensions 	<ul style="list-style-type: none"> • Oral • Projects/practical assignments • Written

Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Project
- Group discussions

Recommended Resources

- measuring and drawing tools
- computers/internet
- printers/plotting device
- Codes of practice
- mechanical conventions,

- workstation
- CAD & GIS Software
- Dust coat
- First aid kits

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BUILDING WORKS

UNIT CODE: CON/CU/CET/CR/07/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Carry out building works

Duration of Unit: 200 hours

Unit Description

This unit describes competencies required to carry out building works. It involves executing site preliminary works, building temporary works, substructure works, superstructure works, building finishes and external works.

Summary of Learning Outcomes

- 1 Execute site preliminary works
- 2 Execute building temporary works
- 3 Execute substructure works
- 4 Execute superstructure works
- 5 Execute building finishes
- 6 Execute building external works

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Execute site preliminary works	<ul style="list-style-type: none">• Site investigation/• Land surveying• Building Drawings and interpretation• Surveying tools and equipment• Building codes• Building site conditions• Plant and equipment• Building safety regulations• Hoarding/screening materials• Site hoarding/fencing• Hoarding tools• Surveying tools and equipment• Survey maps	<ul style="list-style-type: none">• Practical assignment/project• Oral/written

	<ul style="list-style-type: none"> ● Surveying methods ● Soil sampling ● Building site services ● Site facilities, infrastructure and traffic ● Building codes ● Levelling ● Site layout ● Construction site zones ● Site installation ● Methods of demolishing ● Safety consideration during demolition ● Masonry ● Concrete 	
2. Execute building temporary works	<ul style="list-style-type: none"> ● Trench timbering materials and tools ● Soil mechanics ● Site investigation ● Trench timbering methods ● Trench layout design ● Trench timbering dismantling ● Types of scaffolds ● Scaffold drawing ● Assembling and dismantling of scaffolds ● Personal protective equipment ● Site safety requirements ● Site clearance ● Structural elements ● Types of formwork ● Formwork materials ● Formwork measurements and dimensions ● Timber properties ● Formwork construction/installation ● Formwork dismantling 	<ul style="list-style-type: none"> ● Practical assignment/project ● Oral ● Written

	<ul style="list-style-type: none"> • Types of foundations • Types of shores • Shoring materials • Shores connection methods • Construction laws • Local authority guidelines • Shoring construction and erection • Shoring dismantling 	
3. Execute substructure works	<ul style="list-style-type: none"> • Site investigation/surveying • Building Drawings and interpretation • Construction dimensions • Setting out tools and equipment • Setting out procedure • Building codes • Building foundations • Soil analysis • Timbering • Dewatering methods • Excavation plant and equipment • Types of foundations • Working drawings • Foundation reinforcement • Architectural layout • Masonry • Building codes • Working drawing • Levelling • Mortar/ concrete technology • Damp proof membrane • Construction materials • Termite control • Damp proof membrane • Concrete technology • Floor reinforcement 	<ul style="list-style-type: none"> • Practical assignment/project • Oral • Written

<p>4. Execute superstructure works</p>	<ul style="list-style-type: none"> ● Structural elements ● Codes of practice ● Design dimensions ● Column design ● Structural design drawings ● Reinforcement steel ● Formwork ● Concrete materials ● Concrete mix design ● Concrete testing methods ● Concrete compaction methods ● Wall dimensions ● Structure openings ● Building and design plans ● Mortar materials and mixing ● Mortar joints ● Codes of practice ● Wall construction ● Occupational safety and health standards ● Environment Act and by laws ● Beam design ● Stair design ● Slab design ● Formwork props ● Compaction methods ● Floor finishing methods ● Types of roofs ● Roof materials ● Timber properties ● Steel properties ● Truss design ● Truss installation ● Roof material installation method ● Fireplace design layout ● Fireplace elements 	<ul style="list-style-type: none"> ● Practical assignment/project ● Oral ● Written
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	<ul style="list-style-type: none"> ● Fireplace construction ● Fireplace finishing ● Types of fixtures ● Types of fittings ● Installation methods ● Installation tools and equipment 	
5. Execute building finishes	<ul style="list-style-type: none"> ● Types of floor finishes ● Floor finishing tools & Equipment ● Background preparation. ● Floor finishing ● Painting materials ● Painting tools & Equipment ● Preparation of painting surface ● Paint mixing ● Application of paint ● Protection of painted surfaces ● Facing materials, tools and equipment ● Preparation of facing materials ● Preparation of facing background ● Fixing of facings ● Wall mastering materials, tools and equipment ● Preparation of wall surfaces ● Application of wall master ● Protection of wall mastered surface ● Lining materials, tools and equipment ● Background preparation. ● Fixing of Linings ● Cladding materials, tools and equipment ● Background preparation ● Application of claddings ● Plastering tools and equipment. 	<ul style="list-style-type: none"> ● Written ● Oral ● Projects/practical assignment

	<ul style="list-style-type: none"> ● Plastering materials ● Background preparation ● Mixing ratios/Mortar making ● Application of plaster ● Tools, materials and equipment ● Types of ceiling finishes ● Application of ceiling finishes ● Background preparation ● Pointing and jointing materials, tools and equipment ● Preparation of materials ● Background preparation ● Pointing and jointing ● Rough casting materials tools and equipment ● Preparation of materials ● Background preparation ● Application of rough cast 	
<p>6. Execute building external works</p>	<ul style="list-style-type: none"> ● Types of external paving ● Survey ● Design interpretation ● Levelling ● Bonding paving joints ● Plan interpretation ● Ground preparation ● Beautification ● Ground irrigation methods ● Building codes ● Excavation ● Laying drainage pipes ● Drainage collection chambers ● Types of fences ● Gate shutter materials and preparation ● Taking measurements ● Gate dimensions ● Gate shutter fixing 	<ul style="list-style-type: none"> ● Oral ● Projects/practical assignments ● Written

Suggested Methods of Instruction

- Demonstration by trainer
- Practical work by trainee
- Demonstration videos
- Project
- Group discussions

Recommended Resources

- measuring and drawing tools
- computers/internet
- printers/plotting device
- calculator
- Codes of practice
- mechanical conventions,
- site office
- standard manuals and guidelines
- Dust coat
- First aid kits

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WATER RESOURCES QUALITY MANAGEMENT

UNIT CODE: CON/CU/CET/CR/08/6/A

Relationship to Occupational Standards

This unit addresses the Unit of Competency: manage water resources quality

Duration of Unit: 60 hours

Unit Description

This unit covers the competencies required to manage water resources quality. It involves monitoring, managing water resources quality, managing groundwater quality, managing wastewater quality and treating and disposing wastewater.

This standard applies in water sector.

Summary of Learning Outcomes

- 1 Monitor water resources quality
- 2 Surface Water quality management
- 3 Ground Water quality management
- 4 Manage wastewater quality

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Monitor water resources quality	<ul style="list-style-type: none">• Objectives of water quality monitoring• Reconnaissance survey and reporting• Water quality monitoring protocol• WQM schedules• Water resources quality monitoring site selection• Indicators of environmental water quality• Tools and equipment for environmental water quality	<ul style="list-style-type: none">• Observation• Interviewing• Oral questioning• Field study reports• Third party report• Project reports• Written tests

	<p>monitoring (field, laboratory and remote sensing)</p> <ul style="list-style-type: none"> • Operation and maintenance of tools and equipment • Water quality monitoring (theory and practice) • Water quality monitoring reports • Occupational safety and health in water quality monitoring 	
2. Manage surface water quality	<ul style="list-style-type: none"> • Surface Water quality challenges and issues • Surface water quality management plans • Implementation of surface water quality management plans 	<ul style="list-style-type: none"> • Observation • Interviewing • Oral questioning • Field study reports • Third party report • Written tests • Project report
3. Manage ground water quality	<ul style="list-style-type: none"> • Groundwater quality challenges and issues • Groundwater quality management plans • Implementation of ground water quality management plans 	<ul style="list-style-type: none"> • Observation • Interviewing • Oral questioning • Field study reports • Third party report • Written tests
4. Manage Storm and wastewater quality	<ul style="list-style-type: none"> • Storm water quality management • Domestic wastewater quality management • Agricultural wastewater quality management • Industrial wastewater quality management 	<ul style="list-style-type: none"> • Observation • Interviewing • Oral questioning • Field study reports • Third party report • Written tests

Suggested Methods of Instruction:

- Direct instruction

- Project
- Case studies
- Field trips
- Discussions
- Demonstration by trainer
- Practice by the trainee
- Laboratory exercises

Recommended Resources:

- Computers
- Stationery
- water sampling kit (manual, automated)
- sampling equipment (sampling bottles, boats)
- Standard operating procedures
- Portable water quality test kits (with Thermometers, pH, EC, turbidity,DO meters, microbial test kits for resent/absent etc)
- GIS Software
- Digital cameras
- GPS

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DESIGN OF WASTEWATER COLLECTION AND TREATMENT INFRASTRUCTURE

UNIT CODE: CON/CU/CET/CR/09/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Design Wastewater Collection and Treatment Infrastructure

Duration of Unit: **200 hours**

Unit Description

This unit covers the competencies required to design waste water collection and treatment infrastructure. It involves collection of wastewater infrastructure design data, analysis of wastewater infrastructure design data, and calculation of wastewater infrastructure design parameters, drawing wastewater infrastructure units and compiling wastewater infrastructure design report.

Summary of Learning Outcomes

1. Apply hydraulic engineering principles
2. Analyse structural elements
3. Design structural elements
4. Collect wastewater infrastructure design data
5. Analyse wastewater infrastructure design data
6. Calculate wastewater infrastructure design parameters
7. Draw wastewater infrastructure units
8. Compile wastewater infrastructure design report

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Apply hydraulic engineering principles	<ul style="list-style-type: none">• Fluid properties<ul style="list-style-type: none">○ Viscosity○ Density○ Mass○ Volume○ Compressibility○ Pressure	<ul style="list-style-type: none">• Written test• Interview• Oral question• Assignments• Supervised exercises• Practical tests

	<ul style="list-style-type: none"> ○ Surface tension ○ Specific gravity ○ Specific weight ● Fluid pressure measurement <ul style="list-style-type: none"> ○ Manometers ○ piezometer, ○ mechanical gauges, ○ Hydraulic bench ○ Statement of Pascal's law ○ Application of Pascal's Law Total pressure and centre of pressure;horizontally immersed plane surface, vertically immersed plane surface, inclined immersed plane surface) ○ Basic definitions; area of flow, mean velocity, rate of flow. ○ Types of flow; steady and unsteady ○ uniform and non-uniform, ○ laminar and turbulent (Reynold's experiment) ○ Compressible and incompressible flow. ○ Flow equations; discharge equation, continuity equation, Bernoulli's equation) 	
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	<ul style="list-style-type: none"> • Discharge and velocity measurement <ul style="list-style-type: none"> ○ Venturimeters ○ Pitot and pitot static tubes ○ Orificemeter ○ Orifices and mouthpieces ○ Weirs and notches ○ Flow in pipes • Head losses in pipes; major losses (Darcy's formula, Chezy's formula, Manning's formula, Hazen Williams formula) <ul style="list-style-type: none"> ○ Minor losses (due to fittings, enlargement, contractions), ○ Hydraulic grade line, total head loss. ○ Total energy line ○ Flow in open channels • Simple channel sections; rectangular, triangular, trapezoidal, circular. <ul style="list-style-type: none"> ○ Parameters of open channel; wetted perimeter, hydraulic mean depth/radius, hydraulic gradient. ○ Application of Chezy's and Manning's equations to open channel flow problems; simple sections and compound sections 	
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	<ul style="list-style-type: none"> ○ Design of most economical channel sections ; rectangular, trapezoidal 	
2. Analyse structural elements	<ul style="list-style-type: none"> ○ Properties material ○ Stress, strain, ductility, malleability, ○ Types of Stresses, Working Stress: Types of Strain, ○ Stress-strain relationship: Stress-strain diagram, ○ Hooke's law, Young's modulus, Definition ● Moments in beams <ul style="list-style-type: none"> ○ Types of beams: Simple, Cantilever, Overhanging, ○ Type of beam supports, Hinged or pinned supports, Fixed or encastre supports, Rollers and simple supports, ○ Types of loads/Forces and loading systems: Point loads, Uniformity distributed loads, uniformly varying loads, combination of point loads and uniformly distributed loads, ○ Support reactions: Calculation of support reactions, signs and taking moments at a given reaction point, ○ Calculation of Shear forces and bending moments: Definitions, 	<ul style="list-style-type: none"> ● Written test ● Interview ● Oral question ● Assignments ● Supervised exercises ● Practical Tests

	<p>Sign conventions, Calculations of shear force and bending moments at critical points.</p> <ul style="list-style-type: none"> ○ Determination of maximum Shear forces and Bending moments: Graphical representations: Shear force and bending moment diagrams. ● Section properties <ul style="list-style-type: none"> ○ Centre of gravity and Centroid: Definition of centre of gravity and centroid, Determination of centre of gravity and centroid by (Calculation, Graphical) Solve simple problems involving centre of gravity or centroid ○ Second moment of area (I): Definition, Derivation of second moment of area formula. ○ Section modulus (Z): Definition, Calculation of section modulus ○ Radius of gyration ● Theory of simple bending <ul style="list-style-type: none"> ○ Basic assumptions: General principles: Bending tendency, Neutral axis, Variation of stress/strain in a beam 	
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	<p>section, General theory of bending equation:, Moment of resistance (rectangular beam) :</p> <ul style="list-style-type: none"> • Forces in frames <ul style="list-style-type: none"> ○ Types of Frames: Perfect frame, imperfect frame, redundant frame, Nature of forces in frames: Tension and compression forces, ○ Analysis of forces in frames: Methods of analysis: method of sections, method of joint resolution • Deflection In Beams <ul style="list-style-type: none"> ○ General Principles: Effects of deflection, General differential equation for deflection, Derivation of the general slope and deflection formula, double integration. 	
<p>3. Design structural elements</p>	<ul style="list-style-type: none"> ○ Design of Reinforced Concrete Structures ○ Beams: simply supported beams ○ Columns: short columns, centrally axially loaded and eccentrically loaded- uniaxial and biaxial bending ○ Floors/slabs: one way spanning and two way spanning suspended slabs 	<ul style="list-style-type: none"> • Written test • Interview • Oral question • Assignments • Supervised exercises • Practical tests

	<ul style="list-style-type: none"> ○ Foundations: isolated footing/pad footing and strip footing ● Design of Timber Structures <ul style="list-style-type: none"> ○ Timber grading: Visual / machine grading, Stress grading, Stresses: Grade, Basic, Dry, Wet, Permissible, Strength class ● Design of Steel <ul style="list-style-type: none"> ○ Struts ○ Ties ○ Purlins ○ Joists 	
4. Collect wastewater infrastructure design data	<ul style="list-style-type: none"> ● Mapping the area ● Tools preparation ● Data collection/ Quantity of Wastewater ● Quantity of wastewater (Design periods, wastewater generation rates (urban, periurban, rural)) ● Storm water infiltration and exfiltration. 	<ul style="list-style-type: none"> ● Written test ● Interview ● Oral question ● Assignments ● Supervised exercises ● Practical tests ●
5. Analyze wastewater infrastructure design data	<ul style="list-style-type: none"> ● Categorize population into various classes ● Analyse and clean climatic and hydrological data ● Produce topographical maps and ground profiles from survey data 	<ul style="list-style-type: none"> ● Written test ● Interview ● Oral question ● Assignments ● Supervised exercises ● Practical tests

<p>6. Calculate wastewater infrastructure design parameters</p>	<ul style="list-style-type: none"> • Population projection • Population equivalent • Discharge /volume • Velocities • Load estimation (BOD, TSS,FC) • Computations of profile data • Sizing of the pipes • Hydraulic flow in pipes • Depth of flow • Gradient • Sizing of treatment units 	<ul style="list-style-type: none"> • Written test • Interview • Oral question • Assignments • Supervised exercises • Practical tests
<p>7. Draw wastewater infrastructure units</p>	<ul style="list-style-type: none"> • Draw profiles • Draw: <ul style="list-style-type: none"> ○ Sewer Line ○ Sewer Appurtenances ○ Screens ○ Grit Chamber ○ Sedimentation Tanks ○ Trickling Filters ○ Activated Sludge Unit ○ Stabilization Ponds ○ Oxidation Ditch ○ Aerated Lagoons ○ Storm Water Drains ○ Sludge Treatment Units • Legal requirements for approvals 	<ul style="list-style-type: none"> • Written test • Interview • Oral question • Assignments • Supervised exercises • Practical tests
<p>8. Compile wastewater infrastructure design report</p>	<ul style="list-style-type: none"> • Technical report writing • Legal requirements 	<ul style="list-style-type: none"> • Written test • Interview • Oral question • Assignments • Supervised exercises • Practical tests

Suggested Methods of Instruction

- Group discussions
- Demonstration by trainer
- Online videos

- Power point presentation
- Exercises by trainee

Recommended Resources

- Scientific calculators
- Relevant reference materials
- Stationeries
- GPS
- CAD and GIS Software
- Computer lab
- Relevant practical materials
- Laboratories (chemical, biological & soils)
- Internet
- Concrete workshop
- Hydraulics laboratory
- Design codes
- Printers
- Workstation
- Plumbing and pipe fitting workshop

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CONSTRUCTION OF WASTEWATER INFRASTRUCTURE

UNIT CODE: CON/CU/CET/CR/10/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Construct Wastewater Infrastructure

Duration of Unit: **180 hours**

Unit Description

This unit covers the competencies required to construct wastewater infrastructure. It involves analysis of soil properties, construction of the wastewater infrastructure units, organization of the construction site, and preparation of construction schedule

Summary of Learning Outcomes

- 1 Analyse soil properties
- 2 Prepare construction schedule
- 3 Organize the construction site
- 4 construct the wastewater infrastructure

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Analyse soil properties	<ul style="list-style-type: none">• Physical properties of soils<ul style="list-style-type: none">○ phase diagram,○ Definitions of various properties of soils; Unit weight; Specific gravity, Moisture content, void ratio, porosity, degree of saturation & density index.• Index properties of soils<ul style="list-style-type: none">○ Consistency limits; definition, types,, methods of determination; liquid limit: cone penetrometer method, Cassagrande apparatus, plastic limit, shrinkage limit,	<ul style="list-style-type: none">• Written test• Interview• Oral question• Assignments• Supervised exercises• Practical tests

	<ul style="list-style-type: none"> ○ Determination of water content (oven drying method, pycnometer method), ○ determination of specific gravity(density bottle method), ○ Determination of field density ; ○ Density index ○ Particle size distribution: sieve analysis, particle size and grading curves. ● Soil classification and identification <ul style="list-style-type: none"> ○ Soil description ○ Purpose of soil classification ○ Soil classification systems ○ Shortcomings of classification systems ● Compaction of soils <ul style="list-style-type: none"> ○ Proctor test ● Field compaction tools and equipment ● Seepage & permeability ● Darcy' Law of Permeability ● Factors affecting permeability of soils ● Laboratory methods determination soil permeability <ul style="list-style-type: none"> ○ Constant head permeability ○ Falling head permeability test Field methods for determination of soil permeability <ul style="list-style-type: none"> ○ Pumping out from unconfined aquifer 	
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	<ul style="list-style-type: none"> ○ Pumping out from confined aquifer ● Shear strength <ul style="list-style-type: none"> ○ Definitions of term shear strength, components of shear strength, coulombs theory. Methods for determination of shear strength: direct shear box method, Triaxial compression test, unconfined compression test & vane shear test. ● Vertical Stress Distribution: <ul style="list-style-type: none"> ○ principles of stress distribution in soils, ○ Boussinesq's analysis for point load, ○ Analysis for distributed loads; Fadum's influence chart analysis, Newmark's influence chart. ● Lateral earth pressure <ul style="list-style-type: none"> ○ Principles of earth pressure, ○ Rankine's theory of earth pressure; theory of active and passive earth pressures, ○ earth pressure for cohesionless soils and cohesive soils (dry backfill, submerged backfill, backfill with surcharge load), ● Consolidation and settlement <ul style="list-style-type: none"> ○ Theory of soil compressibility and settlement 	
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	<ul style="list-style-type: none"> ○ Determination of consolidation (Oedometer test), ○ Theory of one dimensional consolidation ● Stability of slopes <ul style="list-style-type: none"> ○ Causes of slope instability, ○ Remedial measures to slope instability, ○ Analysis of slope instability ● Bearing capacity <ul style="list-style-type: none"> ○ definition of terms used in bearing capacity, ○ modes of failures of foundation (general shear failure, local shear failure, punching shear failure), ○ bearing capacity analysis (Terzaghi's analysis for foundations, ○ Skempton's analysis). <p>Site Investigation:</p> <ul style="list-style-type: none"> ○ procedure for site investigation (desk study, reconnaissance study, detailed study), ○ methods of site investigation (Trial pits, Shafts and headings, Borings, Augering, Drilling, Geophysical methods), ○ sampling (disturbed samples, undisturbed samples, samplers; 54mm samplers, Split barrel 	
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	samplers, U4 samplers, Core cutters).	
2. Prepare construction schedule	<ul style="list-style-type: none"> • Interpretation of working drawings • Construction activities • Project planning <ul style="list-style-type: none"> ○ Work study: Aims of Work study, Pioneers in work study, Methods of work study: Method study and work measurement. ○ Productivity: Measurement of productivity: Timing, rating, normalizing and allocation of allowances. ○ Programming: Methods of programming: Use of Bar charts (Gantt charts), Critical Path method (CPM), Program Evaluation and Review Techniques (PERT) 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests
3. Organize the construction Site	<ul style="list-style-type: none"> • Site layout and organisation <ul style="list-style-type: none"> ○ Temporary features on site: hoardings, site huts, sanitary conveniences, emergency services, accommodation, storage, Plant area, offices and access roads, ○ Materials: Procurement of materials, documentation in purchase of materials, materials control and reduction of waste. ○ Site Safety: Causes of accidents on site, cost of accidents and prevention of accidents, Recruitment 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

	<p>procedures and communication on site</p> <ul style="list-style-type: none"> • Resource mobilization • Contract documents • Legal requirements (construction industry) 	
4. Construct the wastewater infrastructure units	<ul style="list-style-type: none"> • Site clearance • Setting out for construction works • Tools and equipment for setting out. • Procedure for setting out. • Interpretation of bill of quantities • Constructional details of onsite sanitation facilities • Construction plant and equipment • Construct: • Septic Tanks • Bio-Digesters • Anaerobic Baffled Reactors • Latrines- pit, VIP, Aqua privy • Soak Pits • Imhoff tank • Progress Report • As-built drawings • Payment certificate • Substantial completion certificate • Completion certificate 	<ul style="list-style-type: none"> • Interview • Oral Question • Supervised Exercises • Practical Tests • Assignments •

Suggested Methods of Instruction

- Group discussions
- Demonstration by trainer
- Online videos
- Power point presentation

- Exercises by trainee

Recommended Resources

- Scientific Calculators
- Relevant reference materials
- Stationeries
- GPS
- Design Software
- Computer lab
- Relevant practical materials
- Laboratories (chemical, biological & soils)
- Internet
- Construction equipment
- Surveying equipment store
- Timber workshop
- Plumbing and pipe fitting workshop
- Electromechanical workshop

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DESIGNING ONSITE SANITATION FACILITIES

UNIT CODE: CON/CU/CET/CR/11/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Design Onsite Sanitation Facilities

Duration of Unit: **80 hours**

Unit Description

This unit covers the competencies required to design onsite sanitation facilities. It involves Collection and analysis of onsite sanitation design data, calculation of onsite sanitation design parameters, drawing onsite sanitation units, designing shit flow diagram and compilation of onsite sanitation design report

Summary of Learning Outcomes

1. Collect onsite sanitation design data
2. Analyse onsite sanitation design data
3. Calculate onsite sanitation design parameters
4. Draw onsite sanitation units
5. Design shit flow diagram
6. Compile onsite sanitation design report

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Collect onsite sanitation design data	<ul style="list-style-type: none">• Area Mapping• Data collection tools• Data collection process• Need for wastewater disposal• Population• Legal framework	<ul style="list-style-type: none">• Written Test• Interview• Oral Question• Assignments• Supervised Exercises• Practical Tests
2. Analyze onsite sanitation design data	<ul style="list-style-type: none">• Arrangement of data and information• Design software (excel)• Presentation of design data	<ul style="list-style-type: none">• Written Test• Interview• Oral Question• Assignments

		<ul style="list-style-type: none"> • Supervised Exercises • Practical Tests
3. Calculate onsite sanitation design parameters	<ul style="list-style-type: none"> • Wastewater estimation • Population projection • Design parameters • Design tools • Design of Onsite facilities: <ul style="list-style-type: none"> ○ Design of septic tank ○ Design of bio-digester ○ Design of anaerobic baffled reactors ○ Design of latrines ○ Design of soak pits ○ Eco-san toilets ○ Imhoff tank 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests
4. Draw onsite sanitation units	<ul style="list-style-type: none"> • Drawing tools, supplies and materials • Drawing of Onsite facilities: <ul style="list-style-type: none"> • Septic Tank • Bio-Digester • Anaerobic Baffled Reactors • Latrines • Soak Pits • Eco-san Toilets • Imhoff Tank 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests
5. Design shit flow diagram	<ul style="list-style-type: none"> • Shit flow diagram design • Fecal waste flow matrix • Sanitation service chain • Risks along the Sanitation Service Chain • Sanitation intervention measures • Faecal sludge management 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical projects
6. Compile onsite sanitation design report	<ul style="list-style-type: none"> • Design report format • Design report preparation • Design report submission 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments

		<ul style="list-style-type: none"> • Supervised Exercises • Practical Tests
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Suggested Methods of Instruction

- Group discussions
- Demonstration by trainer
- Online videos
- Power point presentation
- Exercises by trainee

Recommended Resources

- Scientific Calculators
- Relevant reference materials
- Stationeries
- GPS
- Design Software
- Computer lab
- Relevant practical materials
- Laboratories (chemical, biological & soils)
- Internet
- Surveying equipment
- Drawing room/workstation

CONSTRUCTION OF ONSITE SANITATION FACILITIES

UNIT CODE: CON/CU/CET/CR/12/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Construct Onsite Sanitation Facilities

Duration of Unit: 80 hours

Unit Description

This unit covers the competencies required to construct onsite sanitation facilities. It involves Preparing construction schedule, organizing the construction site and construction of the various onsite sanitation facilities

Summary of Learning Outcomes

1. Prepare construction schedule
2. Organize the construction Site
3. Construct the various onsite sanitation facilities

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Prepare construction schedule	<ul style="list-style-type: none">• Design of onsite sanitation facilities• Interpretation of Engineering Drawings• Construction activities• Project planning and management	<ul style="list-style-type: none">• Written Test• Interview• Oral Question• Assignments• Supervised Exercises• Practical Tests
2. Organize the construction Site	<ul style="list-style-type: none">• Site clearance• Site layout• Resource mobilization• Contract documents• Legal requirements•	<ul style="list-style-type: none">• Written Test• Interview• Oral Question• Assignments• Supervised Exercises

		<ul style="list-style-type: none"> • Practical Tests
3. Construct the various onsite sanitation facilities	<ul style="list-style-type: none"> • Interpretation of bill of quantities • Constructional details of onsite sanitation facilities • Construction plant and equipment • Construct: • Septic Tanks • Bio-Digesters • Anaerobic Baffled Reactors • Latrines- pit, VIP, Aqua privy • Soak Pits • Imhoff tank • Progress Report • As-built drawings • Payment certificate • Substantial completion certificate • Completion certificate 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

Suggested Methods of Instruction

- Group discussions
- Demonstration by trainer
- Online videos
- Power point presentation
- Exercises by trainee

Recommended Resources

- Scientific Calculators
- Relevant reference materials
- Stationeries
- GPS
- Design Software
- Computer lab
- Relevant practical materials
- Laboratories (chemical, biological & soils)
- Internet

- Concrete laboratory
- Soil laboratory
- Surveying equipment
- Construction plant
- Timber workshop
- Plumbing and pipe fitting workshop
- Electromechanical workshop

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CIVIL ENGINEERING PROJECT MANAGEMENT

UNIT CODE: CON/CU/CET/CR/13/6/A

Relationship to Occupational Standards

This unit addresses the unit of competency: Manage civil engineering projects

Duration of Unit: 120 hours

Unit Description

This unit describes the competencies required to manage civil engineering projects. It involves managing project time, managing construction project quality, managing project site safety, health and security, managing construction project cost, managing project labour, managing project contracts and managing construction materials, plant, tools and equipment.

Summary of Learning Outcomes

- 1 Manage project time
- 2 Manage construction project quality
- 3 Manage project site, safety, health and security
- 4 Manage construction project cost
- 5 Manage project labour
- 6 Manage project contracts
- 7 Manage construction materials, plant, tools and equipment

Learning Outcomes, Content and Suggested Assessment Methods

Learning Outcome	Content	Suggested Assessment Methods
1. Manage project time	<ul style="list-style-type: none">• Project definition• Meaning of statutory bodies• Types of statutory bodies and their legal requirements• Types of project approvals• Project approvals procedures• Functions of statutory approval documents• Statutory approvals	<ul style="list-style-type: none">• Written Test• Interview• Oral Question• Assignments• Supervised Exercises• Practical Tests

	<ul style="list-style-type: none"> • Definition of project work schedule • Benefits of a work schedule in a project • Documents necessary in the preparation of a work schedule • Classification of project activities • Inter-relationship of project activities • Definition of a time project time programme • Project work programming tools • Process of allocating activity timelines • Importance of reviewing previous similar jobs • Primary sources of information • Secondary sources of information • Characteristics of the best practices • Project plans definition • Types of project plans • Definition of Bills of Quantity (BQs) • Roles of plans and BQs in a project • Procedure of developing project plans and BQs • Definition and importance of monitoring • Monitoring tools • Analysis and evaluation methodologies • Identification and implementation of control 	
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	<p>measures Identification of project time risk</p> <ul style="list-style-type: none"> • analysis of project time risk (categories and ranking) • Mitigation of time risk (transfer, avoidance, delegation) • Monitoring project time risk • Definition of client's team • Definition of time variation • Time variation approval process • Identification and implementation of control measures • Time variation documentation • Time variation report writing • Identification of project stakeholders • Identification of project expectations • Importance of communicating with project stakeholders • Process of communicating with project stakeholders' feedback 	
2. Manage construction project quality	<ul style="list-style-type: none"> • Definition of quality • Code of professional conduct and ethics • Importance of quality in a project • Contract documents • Project activities • Site dynamics • Development of quality checklists • Elements of a project quality plan • Characteristics of an effective project quality plan 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

	<ul style="list-style-type: none"> • Implementation methodologies of a project quality plan • Evaluation of project quality plan • Definition of methodology in a project • Identification of project activities • Identification of relationships among the activities • Types of project methodologies • Factors determining the choice of a methodology • Development of a project works methodology plan • Processes of implementing project methodologies • Evaluation of a project methodology • Definition of project resource schedule • Types of project resources • Identification of project activities • Identification of the activities' resources requirements • Project resource sources • Development of a procurement plan • Implementation and review of a procurement plan • Warehousing and storage of the project resources • Definition and importance of a project quality control plan • Importance and methods of project material testing • Project plant and equipment maintenance 	
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	<ul style="list-style-type: none"> • Project quality inspection tools and methodology • Work quality inspection • Principles of work quality control • Contract documents analysis • Site information documentation methods • Features of a project quality report • Report writing 	
3. Manage project site, safety, health and security	<ul style="list-style-type: none"> • Code of professional conduct and ethics • Definition of Occupational Safety and Health • Legal frameworks (OSHA, County authority regulations, NEMA, WARMA, NCA) • Environmental Management Policies • Identification of other sources of health and safety policy • Project risk analysis and documentation • Characteristics of a good health and safety policy • Formulation of occupational safety and health guidelines • Communication of health and safety policy • Regular review of the policy • Definition of site safety and health audits • Importance of conducting site health and safety inspections • Site health and safety inspection tools and methodologies 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

	<ul style="list-style-type: none"> • Site health and safety inspection stakeholders • Evaluation of site safety and health audits • Report writing • Sources and characteristics of site security threats • Process of project site security risk analysis • Elements of security provision • External and internal sources of security services • Security coordination meetings • Project site security reports 	
4. Manage construction project cost	<ul style="list-style-type: none"> • Code of professional conduct and ethics • Definition of a budget • Importance of a project budget • Analysis of contract documents • Identification of budget elements • Cost risk analysis • Identification of project activities • Preparation of resource schedules • Estimating and pricing project resources • Budget preparation • Project budget evaluation and reporting • Procurement laws and regulation • Law of contract and tort • Procurement methods (electronic or manual) • Material handling and wastage management • Warehousing and storage • Material sampling and testing 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

	<ul style="list-style-type: none"> • Material utilization plan development and implementation • Resource utilization monitoring tools • Project resource utilization report • definition of cost variation • sources of cost variations • cost variation approval procedures • project cost variation documentation • cost variation control methods • project cost variation report writing • Project budget and cash flow analysis • Resource utilization analysis • Variation and price fluctuations analysis • Features of a project financial report • Preparation of a project financial report 	
5. Manage project labour	<ul style="list-style-type: none"> • Code of professional conduct and ethics • Definition of project human resources • Identification of legislations affecting the management of human resources (labour laws) • Types of human resource policies • Sources of human resource policies • Characteristics of good human resource policies 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

	<ul style="list-style-type: none"> • Factors to consider when formulating human resource policies • Development and documentation of human resource policies • Communication of human resource policies • Implementation and regular review of human resource policies • Identification of Project activities human resource requirements • Human resource planning process • Regular review of the human resource plan • Principles of management and the associated theories • Process of job analysis • Implementation of the human resource plan • Placement and induction of human resources • Maintenance of human resources • Motivation of human resources (theories of motivation) • Meaning of staff welfare • Types of welfare facilities • Factors to consider when determining the welfare to offer employees • Group and individual welfare facilities • Implementation and review of staff welfare • Importance of keeping human resource records 	
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	<ul style="list-style-type: none"> • Uses of human resource records • Filing systems and methods • Characteristics of a good filing system • Features of a human resource management system (manual or electronic) • Security of records • Confidentiality of information • Retention policy 	
6. Manage project contracts	<ul style="list-style-type: none"> • Code of professional ethics and conduct • Identification of contract documents and their functions • Laws and regulations governing construction industry (NEMA, building codes, County Statutes, NCA Act, WARMA Act, Labour laws, land laws, property laws, insurance laws) • Approving bodies and information centres • Process of approval • Development of a project documentation register • Updating project register • Confidentiality of the information in the register • Security of the register • Definition of project stakeholders • Identification and classification of stakeholders • Roles of each stakeholder during the life of the project • Types of stakeholders' contracts • Stakeholders engagement plan development and review 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

	<ul style="list-style-type: none"> • Definition of a construction work plan • Development and implementation of a construction work plan • Definition of project works inspection plan • Development and implementation of a project works plan • Development and implementation of project works inspection tools and methodologies • Documentation and projects work inspection report writing • Project works control measures • Identification of project contract elements • Importance of managing project information • Sources of information • Development of a project contract information management system • Confidentiality of information • Security of documents • Professional ethics in handling project information • Analysis and uses of project information • Project information review processes • Methods of communicating the information • Definition and importance of a project implementation report 	
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	<ul style="list-style-type: none"> • Elements in a project implementation report • Types of information included in a project implementation report • Methodologies of gathering information and findings • Report writing and review 	
7. Manage construction materials, plant, tools and equipment	<ul style="list-style-type: none"> • Building materials, tools and equipment • clearing • Levelling • Erection of the facility • Types of building materials • Standard material schedule • Standard material rates • Types of equipment • Standard equipment schedule • Verification of documents • Catalogues • Price lists • Ordering • Verification of materials • Receiving • Recording • Issuing of materials • Recording of issued materials • Construction materials • Testing methods • Concrete technology 	<ul style="list-style-type: none"> • Written Test • Interview • Oral Question • Assignments • Supervised Exercises • Practical Tests

Suggested Methods of Instruction

- Group discussions
- Demonstration by trainer
- Online videos
- Power point presentation
- Exercises by trainee

Recommended Resources

- Scientific Calculators
- Relevant reference materials
- Stationeries
- GPS
- Design Software
- Computer lab
- Relevant practical materials
- Laboratories (chemical, biological & soils)
- Internet
- Manuals and guidelines
- Project management software
- Measuring and drawing tool
- Printer/plotting device
- Codes of practice
- Mechanical conventions

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