BENCHMARK MINIMUM ACADEMIC AND PROFESSIONAL STANDARD

FOR

HIGHER NATIONAL DIPLOMA (HND)

IN

CHEMICAL ENGINEERING TECHNOLOGY, MECHANICAL ENGINEERING TECHNOLOGY, CIVIL ENGINEERING TECHNOLOGY, AND ELECTRICAL/ELECTRONIC ENGINEERING TECHNOLOGY

GENERAL INFORMATION FOR HIGHER NATIONAL DIPLOMA PROGRAMME IN CHEMICAL ENGINEERING TECHNOLOGY

1.0 PHILOSOPHY OF THE CHEMICAL ENGINEERING TECHNOLOGY PROGRAMME

The Chemical Engineering programme is designed to reflect a functional philosophy of education. While seeking to achieve academic excellence and promote the furtherance of knowledge, the Chemical Engineering programme also seeks to aid… the acquisition of appropriate skills, abilities and competence, both mental and physical as equipment for the individual to live in and contribute to the development of his/her society…"

This programme is designed to produce Chemical Engineering Technologists capable of applying Chemical Engineering Principles in various chemical processes; laboratory analysis and industrial productions.

2. Programme Aim

The programme aims to produce graduates who can effectively support engineering operations in manufacturing, automotive, power, oil and gas, construction, utilities, and allied industries, and who can adapt to technological changes through continuous professional development.

3. Programme Educational Objectives

(HND Mechanical Engineering Technology)

The PEOs of the HND Mechanical Engineering Technology programme are:

PEO 1 – Engineering Technology Practice

Apply engineering technology principles, standards, and modern tools to install, operate, test, maintain, and improve engineering systems in industrial and service environments.

PEO 2 – Technical Problem Solving

Identify and solve broadly-defined engineering problems using practical skills, standard methods, manuals, codes, and established engineering practices.

PEO 3 – Professionalism, Safety, and Ethics

Demonstrate professional ethics, workplace safety consciousness, quality assurance, and compliance with industry regulations and standards.

PEO 4 – Teamwork, Communication, and Supervision

Work effectively as technologists, supervisors, or team leaders, and communicate technical information clearly through reports, drawings, and oral presentations.

PEO 5 – Career Development and Lifelong Learning *(optional but recommended)*

i. Engage in continuous professional development, certification, entrepreneurship, or further education to adapt to technological changes and career progression.

4. Programme Outcomes (POs)

Graduates of the programme should be able to:

SA1: Apply knowledge of mathematics, natural science, computing and engineering fundamentals and an engineering specialization as specified in SK1 to SK4 respectively to defined and applied engineering procedures, processes, systems or methodologies.
SA2: Identify, formulate, research literature and analyze *broadly-defined* engineering problem searching substantiated conclusions using analytical tools appropriate to the discipline or area of specialization. (SK1 to SK4)
SA3: Design solutions for *broadly-defined* engineering technology problems and *contribute to* the design of systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (SK5)
SA4: Conduct investigations of *broadly-defined* engineering problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions (SK8)
SA5: Select and apply, and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *broadly-defined* engineering problems (SK2 and SK6)
SA6: When solving broadly-defined engineering problems, analyze and evaluate sustainable development impacts* to: society, the economy, sustainability, health and safety, legal frameworks, and the environment (SK1, SK5, and SK7)
SA7: Understand and commit to professional ethics and norms of engineering technology practice including compliance with national and international laws. Demonstrate an understanding of the need for diversity and inclusion (SK9)
SA8: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (SK9)
SA9: Communicate effectively and inclusively on *broadly-defined* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, taking into account cultural, language, and learning differences.
SA10: Apply knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.
SA11: Recognize the need for, and have the ability for i) independent and life-long learning and ii) critical thinking in the face of new specialist technologies (SK8)

2.0 ENTRY REQUIREMENTS

The general entry requirements for the HND programme include:-

a. All the entry requirements for admission into the ND programme in Chemical Engineering.
b. A minimum of lower credit pass (CGPA of 2.50) and above in the ND examinations in Chemical Engineering Technology; and
c. A minimum of one year cognate work experience.

In exceptional cases, the ND diPOmates with a pass grade (CGPA of 2.0-2.49) in the ND examinations that had two or more years of cognate work experience may be considered for admission into the HND programme. However, such candidates should not be more than 10% of the total student intake in each class.

3.0 DURATION

The programme is designed to run for a minimum of two academic sessions (four Semesters) and a maximum of four academic sessions (eight semesters). Each semester is to last for eighteen weeks.

4.0 CURRICULUM

4.1 The curriculum of HND programme consists of four main components. These are: -

a. General studies/Education
b. Foundation courses
c. Professional courses
d. Project.

4.2 The General Studies/Education component shall include courses in:-

English Language, Communication, Industrial Management and Engineer in Society, The General Education component shall account for not more than 15% of the total contact hours for the programme.

4.3 Foundation courses include courses in Mathematics. The number of hours for the programme may account for about 10-15% of the total contact hours.

4.4 Professional courses are core courses of the programme, which give the student the theory, and professional skills he needs to practice in his field of calling at the technologist level. These may account for 60-70% of the contact hours.

5.0 CURRICULUM STRUCTURE

The structure of the Higher National DIPLOMA programme consists of a minimum four semesters of classroom, laboratory and workshop activities in the Polytechnic/Monotechnic. Each semester shall be of 18 weeks duration made up as follows:-

a. 15 weeks of teaching, i.e. recitation, practical exercise, quizzes, test, e.t.c.; and
b. 3 weeks of examinations and registration.

6.0 ACCREDITATION

The DIPLOMA Programme shall be accredited by the National Board for Technical Education before the diPOmates can be awarded the Higher National DIPLOMA Certificates. Details about the process of accrediting a programme for the award of the Higher National DIPLOMA are available from the Executive Secretary, National Board for Technical Education, POt B, Bida Road, P.M.B. 2239, Kaduna, Nigeria.

7.0 AWARD OF HIGHER NATIONAL DIPOMA

Conditions for the award of Higher National DIPLOMA include the following:-

a. Satisfactory performance in all prescribed course work, which may include class work, tests, quizzes. Workshop practice and laboratory work.
b. Supervised industrial work experience scheme for four months.
c. Satisfactory performance at all semester examinations.
d. Satisfactory completion of final year project work. Normally, continuous assessment contributes 30%, project work 10% while semester examinations are weighted 60% to make a total of 100%.

Higher National DIPLOMA shall be awarded in four classes:-

(i)	Distinction	-	CGPA of 3.50 and above
(ii)	Upper credit	-	CGPA of 3.00 – 3.49
(iii)	Lower credit	-	CGPA of 2.50 – 2.99
(iv)	Pass	-	CGPA of 2.00 – 2.49

8.0 GUIDANCE NOTES FOR TEACHERS

8.1 The new curriculum is drawn in unit courses. This is in line with the provisions of the National Policy on Education which stress the need to introduce the semester credit units which will enable a student who so wishes to transfer the units already completed in an institution of similar standard from which he/she is transferring.

8.2 In designing the units, the Principle of the modular system by-product has been adopted, thus making each of the professional modules, which when completed provides the student with technologist operative skills, which can be used for emPOyment purposes, self-reliance or otherwise.

8.3 As the success of the credit unit system depends on the articulation of programmes between the institutions and industry, the curriculum content has been written in behavioural objectives, so that it is clear to all the expected performance of the student who successfully completed some of the courses or the diPOmates of the programme. This is a slight departure from the presentation of the Performance-based curriculum which required the conditions under which the performances of the students are expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme to write their own curriculum stating the conditions existing in their institutions under which performance can take place and to follow that with the criteria for determining an acceptance level of performance.

The Academic Board of the institution may vet departmental submission on the final curriculum.
Our aim is to continue to see to it that a solid internal evaluation system exists in each institution for ensuring minimum standard and quality of education in the programmes offered throughout the Polytechnic system.

8.4 The teaching of the theory and practical work should, as much as possible, be integrated. Practical exercises, especially those in professional courses and laboratory work should not be taught in isolation from the theory. For each course, there should be a balance of theory to practical in the ratio of 50:50 or 60:40.

9.0 FINAL YEAR PROJECT

Final year students in this programme are expected to carry out

a project work. This could be on individual basis or group work. The project should, as much as possible incorporate basic element of design, drawing and complete fabrication of a marketable item or something that can be put to use. Project reports should be well presented and be properly supervised.

The departments should make their own arrangement of schedules for project work.

HND CHEMICAL ENGINEERING TECHNOLOGY CURRICULUM

HND I SEMESTER ONE

CODE	COURSE TITLE	L	T	P	CH	CU
MTH 311	Advanced Algebra	2	1	-	3	2.0
MTH 312	Advanced Calculus	2	1	-	3	2.0
CHE 301	Engineer in Society	2	-	-	2	2.0
CHE 303	Unit Operations 111	2	-	-	2	2.0
CHE 305	Chemical Engineering Laboratory 111	-	-	6	6	3.0
CHE 307	Heat Transfer 11	2	1	-	3	2.0
CHE 309	Chemical Engineering Thermodynamics 11	2	1	-	3	2.0
CHE 311	Mass Transfer 11	2	1	-	3	2.0
MTH 313	Engineering Statistics	2	1	-	3	2.0
GNS 301	Use of English 11	2	-	-	2	2.0
		18	**6**	**6**	**30**	**21.0**

HND I SEMESTER TWO

CODE	COURSE TITLE	L	T	P	CH	CU
MTH 321	Advanced Numerical Methods	2	1	-	3	2.0
COM 321	Computer Programming	2	1	1	4	3.0
GLT 301	Instrumentation	2		-	3	2.0
CHE 302	Unit Operations IV	2	-	-	2	2.0
CHE 304	Fluid Mechanics 11	2	1	-	3	2.0
CHE 306	Chemical Reaction Engineering 11	2	1	-	3	2.0
CHE 308	Chemical Engineering Laboratory IV	-	-	6	6	3.0
CHE 310	Polymer Science and Technology	2	-	-	2	2.0
CHE 312	Strength of Materials	2	1	-	3	2.0
GNS 302	Communication in English	2	-	-	2	2.0
		18	**5**	**7**	**31**	**22.0**

HND II SEMESTER ONE

CODE	COURSE TITLE	L	T	P	CH	CU
CHE 401	Process Design	2	1	-	3	3.0
CHE 403	Chemical Plant Economics	2	1	-	3	2.0
CHE 405	Unit Operations V	2	-	-	2	2.0
CHE 407	Food Science & Technology	2	-	-	2	2.0
CHE 409	Chemical Engineering Laboratory V	-	-	6	6	3.0
CHE 411	Chemical Engineering Analysis	2	1	-	3	2.0
CHE 413	Project	2	-	-	2	2.0
CHE 415	Engineering Management	2	-	-	2	2.0
	Elective 1					
CHE 417	Pulp and Paper Technology					
CHE 419	Process Metallurgy					
		18	**3**	**6**	**27**	**22.0**

HND II SEMESTER TWO

CODE	COURSE TITLE	L	T	P	CH	CU
CHE 402	Unit Operations VI	**2**	**1**	**-**	**3**	**2.0**
CHE 404	Equipment Design	**2**	**1**	**-**	**3**	**2.0**
CHE 406	Chemical Process Dynamics & Control	**2**	**-**	**-**	**2**	**2.0**
CHE 408	Health, Safety & Environment II	**2**	**-**	**-**	**2**	**2.0**
CHE 410	Chemical Engineering Entrepreneurship	**2**	**-**	**-**	**2**	**2.0**
CHE 412	Plant Services and Maintenance	**2**	**-**	**-**	**2**	**2.0**
CHE 414	Petroleum Refining and Petrochemical Technology	**2**	**-**	**-**	**2**	**2.0**
CHE 416	Project	**2**	**2**	**4**	**6**	**2.0**
	Elective II					
CHE 418	(i) Biochemical Engineering					
CHE 420	(ii) Gas Processing Technology					
CHE 422	(iii) Reservoir Engineering.					
		16	**4**	**4**	**24**	**20.0**

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LIST OF COURSE, COURSE CONTENTS AND COURSE LEARNING OUTCOMES

HND I – SEMESTER ONE

MTH 311: Advanced Algebra

Course Contents

- Matrices and determinants
- Systems of linear equations
- Eigenvalues and eigenvectors
- Complex numbers and functions
- Vector spaces and linear transformations

Course Learning Outcomes

1. Solve systems of linear equations using matrix methods.
2. Apply eigenvalue concepts to engineering problems.
3. Manipulate complex numbers in engineering analysis.
4. Use vector algebra in modelling chemical engineering systems.

MTH 312: Advanced Calculus

Course Contents

- Functions of several variables
- Partial differentiation
- Multiple integrals
- Vector calculus
- Applications to engineering problems

Course Learning Outcomes

1. Apply partial derivatives to multivariable engineering problems.
2. Evaluate multiple integrals relevant to mass and energy balances.
3. Use vector calculus in transport phenomena analysis.
4. Solve applied calculus problems in chemical engineering contexts.

CHE 301: Engineer in Society

Course Contents

- Role of engineers in society
- Engineering ethics and professionalism

- Sustainable development
- Environmental and social impact of engineering
- Safety and regulatory frameworks

Course Learning Outcomes

1. Explain the professional and ethical responsibilities of engineers.
2. Assess the societal and environmental impact of engineering projects.
3. Apply safety and regulatory principles in engineering practice.
4. Demonstrate responsible professional conduct in engineering environments.

CHE 303: Unit Operations III

Course Contents

- Size reduction equipment
- Mechanical separation processes
- Sedimentation and filtration
- Screening and classification

Course Learning Outcomes

1. Describe principles of mechanical separation processes.
2. Analyze the performance of size reduction equipment.
3. Apply separation theories to industrial operations.
4. Select appropriate unit operations for process requirements.

CHE 305: Chemical Engineering Laboratory III

Course Contents

- Laboratory safety procedures
- Experiments on unit operations
- Heat and mass transfer experiments
- Data collection and analysis
- Technical report writing

Course Learning Outcomes

1. Conduct laboratory experiments safely and accurately.
2. Apply theoretical principles to practical experiments.
3. Analyze experimental data and interpret results.
4. Prepare standard laboratory and technical reports.

CHE 307: Heat Transfer II

Course Contents

- Conduction in solids
- Convective heat transfer
- Radiation heat transfer
- Heat exchangers
- Heat transfer coefficients

Course Learning Outcomes

1. Analyze conduction, convection, and radiation processes.
2. Compute heat transfer rates in engineering systems.
3. Evaluate performance of heat exchangers.
4. Apply heat transfer principles in process design.

CHE 309: Chemical Engineering Thermodynamics II

Course Contents

- First and second laws of thermodynamics
- Phase equilibria
- Properties of pure substances
- Thermodynamic cycles
- Applications to chemical processes

Course Learning Outcomes

1. Apply thermodynamic laws to chemical processes.
2. Analyze phase equilibrium behaviour of systems.
3. Evaluate thermodynamic properties of substances.
4. Solve energy balance problems in process systems.

CHE 311: Mass Transfer II

Course Contents

- Molecular diffusion
- Convective mass transfer
- Mass transfer coefficients
- Interphase mass transfer
- Industrial mass transfer operations

Course Learning Outcomes

1. Explain mass transfer mechanisms in engineering systems.
2. Calculate mass transfer rates and coefficients.
3. Analyze industrial mass transfer operations.
4. Apply mass transfer principles in process analysis.

MTH 313: Engineering Statistics

Course Contents

- Probability theory
- Random variables
- Statistical distributions
- Regression and correlation
- Quality control methods

Course Learning Outcomes

1. Apply probability concepts to engineering data.
2. Analyze data using statistical distributions.
3. Perform regression and correlation analysis.
4. Use statistical tools for quality control applications.

GNS 301: Use of English II

Course Contents

- Advanced grammar
- Technical writing
- Reading and comprehension
- Oral communication skills
- Report writing

Course Learning Outcomes

1. Communicate effectively in written and oral forms.
2. Apply correct grammar in technical documentation.
3. Prepare structured engineering reports.
4. Demonstrate effective professional communication skills.

MTH 321: Advanced Numerical Methods

Course Contents

- Numerical solutions of equations
- Interpolation and extrapolation
- Numerical differentiation and integration

- Solutions of differential equations
- Engineering applications

Course Learning Outcomes

1. Apply numerical techniques to solve engineering problems.
2. Use numerical methods for differential equations.
3. Analyze accuracy and stability of numerical solutions.
4. Implement numerical solutions in chemical engineering applications.

COM 321: Computer Programming

Course Contents

- Programming fundamentals
- Algorithms and flowcharts
- High-level programming languages
- Engineering problem solving
- Introduction to simulation tools

Course Learning Outcomes

1. Develop simple programs for engineering calculations.
2. Apply algorithms to solve numerical problems.
3. Use programming tools for data analysis.
4. Demonstrate basic computational modelling skills.

GLT 301: Instrumentation

Course Contents

- Measurement principles
- Sensors and transducers
- Temperature, pressure, and flow measurement
- Control instrumentation
- Calibration and maintenance

Course Learning Outcomes

1. Explain principles of industrial measurement.
2. Identify and use common process instruments.
3. Interpret instrumentation diagrams.
4. Apply calibration procedures in process plants.

CHE 302: Unit Operations IV

Course Contents

- Distillation processes
- Absorption and stripping
- Liquid–liquid extraction
- Industrial separation equipment

Course Learning Outcomes

1. Describe principles of stagewise separation processes.
2. Analyze distillation and absorption operations.
3. Select appropriate separation equipment.
4. Apply unit operation concepts to process design.

CHE 304: Fluid Mechanics II

Course Contents

- Fluid flow in pipes
- Pumps and compressors
- Flow measurement
- Boundary layer theory
- Applications in chemical plants

Course Learning Outcomes

1. Analyze fluid flow in pipelines and channels.
2. Calculate pressure losses in fluid systems.
3. Evaluate pump and compressor performance.
4. Apply fluid mechanics principles to plant operations.

CHE 306: Chemical Reaction Engineering II

Course Contents

- Reaction kinetics
- Reactor design equations
- Ideal reactors
- Non-ideal reactor behaviour
- Industrial reactor applications

Course Learning Outcomes

1. Analyze reaction kinetics and rate laws.
2. Design basic chemical reactors.
3. Evaluate reactor performance.
4. Apply reaction engineering principles to industrial processes.

CHE 308: Chemical Engineering Laboratory IV

Course Contents

- Advanced laboratory experiments
- Process equipment testing
- Data acquisition and analysis
- Safety and risk assessment
- Technical reporting

Course Learning Outcomes

1. Perform advanced chemical engineering experiments.
2. Apply safety procedures during laboratory work.
3. Analyze experimental results critically.
4. Produce comprehensive laboratory reports.

CHE 310: Polymer Science and Technology

Course Contents

- Polymer chemistry basics
- Polymerization processes
- Properties of polymers
- Polymer processing techniques
- Industrial applications

Course Learning Outcomes

1. Explain polymer structures and properties.
2. Describe polymerization methods.
3. Analyze polymer processing techniques.
4. Identify industrial applications of polymers.

CHE 312: Strength of Materials

Course Contents

- Stress and strain analysis

- Elastic and plastic behaviour
- Bending and torsion
- Failure theories
- Applications in equipment design

Course Learning Outcomes

1. Analyze stresses and strains in materials.
2. Evaluate mechanical behaviour of engineering materials.
3. Apply failure theories to engineering components.
4. Use strength of materials concepts in equipment design.

GNS 302: Communication in English

Course Contents

- Advanced communication skills
- Technical presentations
- Business correspondence
- Professional ethics in communication

Course Learning Outcomes

1. Deliver effective technical presentations.
2. Communicate professionally in business contexts.
3. Prepare clear technical and formal documents.
4. Demonstrate effective interpersonal communication skills.

HND II – SEMESTER ONE

CHE 401: Process Design

Course Contents

- Process design concepts and methodology
- Material and energy balances in process design
- Process flow diagrams (PFDs) and piping & instrumentation diagrams (P&IDs)
- Equipment selection and sizing
- Safety, environmental, and economic considerations

Course Learning Outcomes

1. Apply process design principles to chemical engineering systems.
2. Develop process flow diagrams for industrial processes.

3. Perform basic material and energy balance calculations for design purposes.
4. Incorporate safety and environmental considerations into process designs.

CHE 403: Chemical Plant Economics

Course Contents

- Cost estimation techniques
- Capital and operating costs
- Depreciation and taxation
- Profitability analysis
- Economic decision-making in process plants

Course Learning Outcomes

1. Estimate capital and operating costs of chemical plants.
2. Analyze economic feasibility of engineering projects.
3. Apply profitability evaluation methods to process investments.
4. Make informed economic decisions for chemical engineering projects.

CHE 405: Unit Operations V

Course Contents

- Drying operations
- Evaporation processes
- Crystallization
- Industrial dryers and evaporators
- Design considerations for solid–fluid systems

Course Learning Outcomes

1. Explain principles of drying, evaporation, and crystallization.
2. Analyze performance of solid–fluid unit operations.
3. Select appropriate equipment for industrial applications.
4. Apply unit operation concepts to process problem-solving.

CHE 407: Food Science and Technology

Course Contents

- Composition and properties of food materials

- Food processing operations
- Food preservation techniques
- Food safety and quality control
- Food processing equipment

Course Learning Outcomes

1. Explain the chemical and physical properties of food materials.
2. Describe food processing and preservation methods.
3. Apply food safety and quality control principles.
4. Identify food processing equipment and applications.

CHE 409: Chemical Engineering Laboratory V

Course Contents

- Advanced laboratory safety practices
- Pilot-scale unit operations experiments
- Process performance evaluation
- Data acquisition and interpretation
- Technical reporting and documentation

Course Learning Outcomes

1. Conduct pilot-scale experiments following safety standards.
2. Analyze process performance using experimental data.
3. Interpret laboratory results for engineering decisions.
4. Prepare comprehensive technical laboratory reports.

CHE 411: Chemical Engineering Analysis

Course Contents

- Mathematical modelling of chemical processes
- Solution of engineering equations
- Optimization techniques
- Steady-state and unsteady-state analysis
- Engineering problem-solving strategies

Course Learning Outcomes

1. Develop mathematical models of chemical engineering systems.
2. Solve complex engineering equations analytically and numerically.
3. Apply optimization methods to process problems.

4. Analyze steady and unsteady process behaviour.

CHE 413: Project

Course Contents

- Project topic selection
- Literature review techniques
- Research methodology
- Data collection and analysis
- Project report writing

Course Learning Outcomes

1. Identify and define a chemical engineering project problem.
2. Conduct a structured literature review.
3. Apply appropriate research methods to engineering problems.
4. Produce a well-documented project report.

CHE 415: Engineering Management

Course Contents

- Principles of management
- Project planning and scheduling
- Human resource management
- Engineering leadership
- Legal and ethical issues in engineering management

Course Learning Outcomes

1. Apply management principles in engineering organizations.
2. Plan and manage engineering projects effectively.
3. Demonstrate leadership and teamwork skills.
4. Apply ethical and legal principles in engineering management.

Electives (One Only)

CHE 417: Pulp and Paper Technology

Course Contents

- Raw materials for pulp and paper production
- Pulping processes
- Paper manufacturing operations
- Environmental issues in pulp and paper industry

Course Learning Outcomes

1. Explain pulping and paper manufacturing processes.
2. Analyze equipment used in pulp and paper production.
3. Identify environmental challenges in the industry.
4. Apply process principles to pulp and paper technology.

CHE 419: Process Metallurgy

Course Contents

- Mineral processing principles
- Pyrometallurgy and hydrometallurgy
- Extractive metallurgy processes
- Metallurgical equipment

Course Learning Outcomes

1. Explain principles of extractive metallurgy.
2. Analyze metallurgical processing techniques.
3. Identify metallurgical equipment and operations.
4. Apply process metallurgy concepts to industrial practice.

HND II – SEMESTER TWO

CHE 402: Unit Operations VI

Course Contents

- Adsorption processes
- Ion exchange operations
- Membrane separation techniques
- Industrial applications of advanced separations

Course Learning Outcomes

1. Explain principles of adsorption and membrane separations.

2. Analyze performance of advanced separation processes.
3. Select appropriate separation techniques for industrial use.
4. Apply advanced unit operation concepts to process design.

CHE 404: Equipment Design

Course Contents

- Mechanical design principles
- Pressure vessel design
- Heat exchanger design
- Design codes and standards
- Materials selection

Course Learning Outcomes

1. Apply mechanical design principles to process equipment.
2. Design basic pressure vessels and heat exchangers.
3. Use engineering codes and standards in equipment design.
4. Select suitable materials for chemical engineering equipment.

CHE 406: Chemical Process Dynamics and Control

Course Contents

- Dynamic behaviour of processes
- Process modelling
- Control strategies and controllers
- Stability analysis
- Industrial control applications

Course Learning Outcomes

1. Analyze dynamic behaviour of chemical processes.
2. Develop basic dynamic models for process systems.
3. Apply control strategies to process operations.
4. Evaluate process stability and control performance.

CHE 408: Health, Safety and Environment II

Course Contents

- Industrial hazard identification
- Risk assessment techniques
- Process safety management
- Environmental impact assessment
- Occupational health and safety regulations

Course Learning Outcomes

1. Identify hazards in chemical process industries.
2. Conduct basic risk assessments.
3. Apply safety and environmental regulations in process plants.
4. Promote safe and sustainable engineering practices.

CHE 410: Chemical Engineering Entrepreneurship

Course Contents

- Entrepreneurship concepts
- Innovation and technology commercialization
- Small and medium-scale chemical industries
- Business plan development
- Financing and venture management

Course Learning Outcomes

1. Explain principles of entrepreneurship in engineering.
2. Identify business opportunities in chemical engineering.
3. Develop basic business plans for engineering ventures.
4. Apply entrepreneurial skills to technology-based enterprises.

CHE 412: Plant Services and Maintenance

Course Contents

- Utilities in chemical plants
- Maintenance strategies
- Reliability and availability analysis
- Plant troubleshooting
- Maintenance safety practices

Course Learning Outcomes

1. Explain the role of utilities and services in process plants.
2. Apply maintenance strategies for plant equipment.

3. Analyze plant reliability and performance issues.
4. Implement safe maintenance practices.

CHE 414: Petroleum Refining and Petrochemical Technology

Course Contents

- Crude oil properties and characterization
- Refining processes
- Petrochemical production routes
- Refinery equipment and operations
- Environmental issues in refining

Course Learning Outcomes

1. Explain crude oil refining and petrochemical processes.
2. Analyze refinery operations and equipment.
3. Identify major petrochemical production routes.
4. Apply environmental considerations in petroleum processing.

CHE 416: Project

Course Contents

- Advanced project execution
- Experimental or design-based project work
- Data analysis and interpretation
- Project presentation and defense

Course Learning Outcomes

1. Execute an independent chemical engineering project.
2. Analyze and interpret project data critically.
3. Apply engineering principles to solve real-world problems.
4. Present and defend project findings effectively.

Electives (One Only)

CHE 418: Biochemical Engineering

Course Contents

- Biochemical process principles
- Enzyme kinetics
- Fermentation technology
- Bioreactor design
- Industrial biotechnology applications

Course Learning Outcomes

1. Explain principles of biochemical engineering processes.
2. Analyze enzyme and fermentation systems.
3. Apply bioreactor concepts to biochemical production.
4. Identify industrial applications of biotechnology.

CHE 420: Gas Processing Technology

Course Contents

- Natural gas properties
- Gas separation and purification
- Gas processing equipment
- LNG and gas utilization
- Environmental issues in gas processing

Course Learning Outcomes

1. Explain natural gas processing operations.
2. Analyze gas separation and treatment methods.
3. Identify gas processing equipment and applications.
4. Apply environmental considerations in gas processing plants.

CHE 422: Reservoir Engineering

Course Contents

- Reservoir rock and fluid properties
- Fluid flow in porous media
- Reservoir performance analysis
- Enhanced oil recovery methods

Course Learning Outcomes

1. Explain fundamental reservoir properties and behaviour.
2. Analyze fluid flow in porous media.
3. Evaluate reservoir performance using engineering methods.
4. Apply reservoir engineering concepts in oil and gas production.

PROGRAMME OUTCOMES (POs) – HND Chemical Engineering Technology

For clarity and consistency, the following **standard POs** are adopted:

PO Code	Programme Learning Outcome
PO 1	Apply mathematics, science, and engineering fundamentals to solve chemical engineering problems.
PO 2	Analyze and solve broadly defined chemical engineering problems using appropriate principles and tools.
PO 3	Conduct experiments, analyze data, and interpret results relevant to chemical engineering practice.
PO 4	Design and operate chemical engineering systems, processes, and equipment safely.
PO 5	Apply modern engineering tools, ICT, and computational techniques.
PO 6	Demonstrate professionalism, ethics, communication skills, and societal responsibility.
PO 7	Apply safety, environmental, and sustainability principles in engineering practice.

HND I – SEMESTER ONE

CLO–PO Mapping with Bloom's Taxonomy

MTH 311: Advanced Algebra

CLO	Bloom's Level	Mapped PO(s)
Solve systems of linear equations using matrix methods	Apply	PO 1
Apply eigenvalue concepts to engineering problems	Apply	PO 1, PO 2
Manipulate complex numbers in engineering analysis	Apply	PO 1
Use vector algebra in modelling engineering systems	Analyze	PO 1, PO 2

MTH 312: Advanced Calculus

CLO	Bloom's Level	Mapped PO(s)
Apply partial derivatives to multivariable problems	Apply	PO 1
Evaluate multiple integrals for mass and energy balances	Apply	PO 1
Use vector calculus in transport phenomena	Analyze	PO 1, PO 2
Solve applied calculus problems in engineering	Analyze	PO 2

CHE 301: Engineer in Society

CLO	Bloom's Level	Mapped PO(s)
Explain professional and ethical responsibilities	Understand	PO 6
Assess societal and environmental impacts	Evaluate	PO 6, PO 7
Apply safety and regulatory principles	Apply	PO 7
Demonstrate responsible professional conduct	Apply	PO 6

CHE 303: Unit Operations III

CLO	Bloom's Level	Mapped PO(s)
Describe mechanical separation principles	Understand	PO 1
Analyze performance of size reduction equipment	Analyze	PO 2
Apply separation theories to operations	Apply	PO 4
Select appropriate unit operations	Evaluate	PO 2, PO 4

CHE 305: Chemical Engineering Laboratory III

CLO	Bloom's Level	Mapped PO(s)
Conduct laboratory experiments safely	Apply	PO 3, PO 7
Apply theory to practical experiments	Apply	PO 3
Analyze experimental data	Analyze	PO 3
Prepare laboratory reports	Create	PO 6

CHE 307: Heat Transfer II

CLO	Bloom's Level	Mapped PO(s)
Analyze conduction, convection, radiation	Analyze	PO 1, PO 2
Compute heat transfer rates	Apply	PO 1
Evaluate heat exchanger performance	Evaluate	PO 2, PO 4
Apply heat transfer in process design	Apply	PO 4

CHE 309: Chemical Engineering Thermodynamics II

CLO	Bloom's Level	Mapped PO(s)
Apply thermodynamic laws	Apply	PO 1
Analyze phase equilibrium behavior	Analyze	PO 2
Evaluate thermodynamic properties	Apply	PO 1
Solve energy balance problems	Analyze	PO 2

CHE 311: Mass Transfer II

CLO	Bloom's Level	Mapped PO(s)
Explain mass transfer mechanisms	Understand	PO 1
Calculate mass transfer rates	Apply	PO 1
Analyze industrial mass transfer operations	Analyze	PO 2

CLO	Bloom's Level	Mapped PO(s)
Apply mass transfer principles	Apply	PO 4

MTH 313: Engineering Statistics

CLO	Bloom's Level	Mapped PO(s)
Apply probability concepts	Apply	PO 1
Analyze statistical distributions	Analyze	PO 2
Perform regression analysis	Analyze	PO 2
Use statistical tools for quality control	Apply	PO 5

GNS 301: Use of English II

CLO	Bloom's Level	Mapped PO(s)
Communicate effectively	Apply	PO 6
Apply correct grammar in documentation	Apply	PO 6
Prepare structured reports	Create	PO 6
Demonstrate professional communication	Apply	PO 6

HND I – SEMESTER TWO

MTH 321: Advanced Numerical Methods

CLO	Bloom's Level	Mapped PO(s)
Apply numerical techniques	Apply	PO 1
Solve differential equations numerically	Apply	PO 1
Analyze solution accuracy	Analyze	PO 2
Implement numerical solutions in engineering	Apply	PO 5

COM 321: Computer Programming

CLO	Bloom's Level	Mapped PO(s)
Develop simple engineering programs	Create	PO 5
Apply algorithms to numerical problems	Apply	PO 1, PO 5
Use programming tools for data analysis	Apply	PO 5
Demonstrate computational modelling	Apply	PO 5

GLT 301: Instrumentation

CLO	Bloom's Level	Mapped PO(s)
Explain measurement principles	Understand	PO 1
Identify and use instruments	Apply	PO 4
Interpret instrumentation diagrams	Analyze	PO 2
Apply calibration procedures	Apply	PO 4

CHE 302: Unit Operations IV

CLO	Bloom's Level	Mapped PO(s)
Describe separation principles	Understand	PO 1
Analyze distillation operations	Analyze	PO 2
Select separation equipment	Evaluate	PO 4
Apply unit operation concepts	Apply	PO 4

CHE 304: Fluid Mechanics II

CLO	Bloom's Level	Mapped PO(s)
Analyze fluid flow systems	Analyze	PO 1, PO 2
Calculate pressure losses	Apply	PO 1
Evaluate pump performance	Evaluate	PO 4
Apply fluid mechanics to plant operations	Apply	PO 4

CHE 306: Chemical Reaction Engineering II

CLO	Bloom's Level	Mapped PO(s)
Analyze reaction kinetics	Analyze	PO 2
Design basic reactors	Create	PO 4
Evaluate reactor performance	Evaluate	PO 2
Apply reaction engineering principles	Apply	PO 4

CHE 308: Chemical Engineering Laboratory IV

CLO	Bloom's Level	Mapped PO(s)
Perform advanced experiments	Apply	PO 3
Apply laboratory safety	Apply	PO 7
Analyze experimental results	Analyze	PO 3
Produce comprehensive reports	Create	PO 6

CHE 310: Polymer Science and Technology

CLO	Bloom's Level	Mapped PO(s)
Explain polymer structures	Understand	PO 1
Describe polymerization methods	Understand	PO 1
Analyze polymer processing	Analyze	PO 2
Identify industrial applications	Apply	PO 4

CHE 312: Strength of Materials

CLO	Bloom's Level	Mapped PO(s)
Analyze stresses and strains	Analyze	PO 1
Evaluate mechanical behaviour	Evaluate	PO 2
Apply failure theories	Apply	PO 4

CLO	Bloom's Level	Mapped PO(s)
Use concepts in equipment design	Apply	PO 4

GNS 302: Communication in English

CLO	Bloom's Level	Mapped PO(s)
Deliver technical presentations	Apply	PO 6
Communicate professionally	Apply	PO 6
Prepare technical documents	Create	PO 6
Demonstrate interpersonal skills	Apply	PO 6

HND II – SEMESTER ONE

CHE 401: Process Design

CLO	Bloom's Level	Mapped PO(s)
Apply process design principles	Apply	PO 1, PO 4
Develop process flow diagrams	Create	PO 4
Perform material & energy balances	Apply	PO 1
Incorporate safety & environmental aspects	Evaluate	PO 7

CHE 403: Chemical Plant Economics

CLO	Bloom's Level	Mapped PO(s)
Estimate capital & operating costs	Apply	PO 2
Analyze economic feasibility	Analyze	PO 2
Apply profitability methods	Apply	PO 2
Make economic decisions	Evaluate	PO 6

CHE 405: Unit Operations V

CLO	Bloom's Level	Mapped PO(s)
Explain drying/evaporation/crystallization	Understand	PO 1
Analyze unit operation performance	Analyze	PO 2
Select appropriate equipment	Evaluate	PO 4
Apply unit operation concepts	Apply	PO 4

CHE 407: Food Science & Technology

CLO	Bloom's Level	Mapped PO(s)
Explain properties of food materials	Understand	PO 1
Describe processing & preservation	Understand	PO 2
Apply food safety & quality control	Apply	PO 7
Identify food processing equipment	Apply	PO 4

CHE 409: Chemical Engineering Laboratory V

CLO	Bloom's Level	Mapped PO(s)
Conduct pilot-scale experiments	Apply	PO 3
Analyze process performance data	Analyze	PO 3
Interpret results for decisions	Evaluate	PO 2
Prepare technical reports	Create	PO 6

CHE 411: Chemical Engineering Analysis

CLO	Bloom's Level	Mapped PO(s)
Develop mathematical models	Create	PO 1, PO 2
Solve complex equations	Apply	PO 1
Apply optimization methods	Apply	PO 2
Analyze steady/unsteady behavior	Analyze	PO 2

CHE 413: Project

CLO	Bloom's Level	Mapped PO(s)
Define an engineering problem	Analyze	PO 2
Conduct literature review	Analyze	PO 6
Apply research methodology	Apply	PO 3
Produce project report	Create	PO 6

CHE 415: Engineering Management

CLO	Bloom's Level	Mapped PO(s)
Apply management principles	Apply	PO 6
Plan & manage projects	Apply	PO 6
Demonstrate leadership & teamwork	Apply	PO 6
Apply ethical & legal principles	Evaluate	PO 6

Electives (Semester One)

CHE 417: Pulp and Paper Technology

CLO	Bloom's Level	Mapped PO(s)
Explain pulping & paper processes	Understand	PO 1
Analyze production equipment	Analyze	PO 2
Identify environmental challenges	Analyze	PO 7
Apply process principles	Apply	PO 4

CHE 419: Process Metallurgy

CLO	Bloom's Level	Mapped PO(s)
Explain extractive metallurgy	Understand	PO 1
Analyze metallurgical techniques	Analyze	PO 2
Identify metallurgical equipment	Apply	PO 4
Apply metallurgy concepts	Apply	PO 4

HND II – SEMESTER TWO

CHE 402: Unit Operations VI

CLO	Bloom's Level	Mapped PO(s)
Explain advanced separations	Understand	PO 1
Analyze separation performance	Analyze	PO 2
Select appropriate techniques	Evaluate	PO 4
Apply concepts to design	Apply	PO 4

CHE 404: Equipment Design

CLO	Bloom's Level	Mapped PO(s)
Apply mechanical design principles	Apply	PO 1
Design pressure vessels/heat exchangers	Create	PO 4
Use codes & standards	Apply	PO 4
Select suitable materials	Evaluate	PO 4

CHE 406: Chemical Process Dynamics & Control

CLO	Bloom's Level	Mapped PO(s)
Analyze dynamic behavior	Analyze	PO 2
Develop dynamic models	Create	PO 2
Apply control strategies	Apply	PO 4

CLO	Bloom's Level	Mapped PO(s)
Evaluate control performance	Evaluate	PO 2

CHE 408: Health, Safety & Environment II

CLO	Bloom's Level	Mapped PO(s)
Identify industrial hazards	Analyze	PO 7
Conduct risk assessments	Apply	PO 7
Apply HSE regulations	Apply	PO 7
Promote sustainable practices	Apply	PO 7

CHE 410: Chemical Engineering Entrepreneurship

CLO	Bloom's Level	Mapped PO(s)
Explain entrepreneurship principles	Understand	PO 6
Identify business opportunities	Analyze	PO 6
Develop a business plan	Create	PO 6
Apply entrepreneurial skills	Apply	PO 6

CHE 412: Plant Services & Maintenance

CLO	Bloom's Level	Mapped PO(s)
Explain plant utilities & services	Understand	PO 4
Apply maintenance strategies	Apply	PO 4
Analyze reliability issues	Analyze	PO 2
Implement safe maintenance practices	Apply	PO 7

CHE 414: Petroleum Refining & Petrochemical Technology

CLO	Bloom's Level	Mapped PO(s)
Explain refining & petrochemical processes	Understand	PO 1
Analyze refinery operations	Analyze	PO 2
Identify petrochemical routes	Apply	PO 4
Apply environmental considerations	Apply	PO 7

CHE 416: Project

CLO	Bloom's Level	Mapped PO(s)
Execute an independent project	Apply	PO 3

CLO	Bloom's Level	Mapped PO(s)
Analyze and interpret data	Analyze	PO 3
Apply engineering solutions	Apply	PO 4
Present and defend findings	Create	PO 6

Electives (Semester Two)

CHE 418: Biochemical Engineering

CLO	Bloom's Level	Mapped PO(s)
Explain biochemical processes	Understand	PO 1
Analyze enzyme/fermentation systems	Analyze	PO 2
Apply bioreactor concepts	Apply	PO 4
Identify industrial applications	Apply	PO 4

CHE 420: Gas Processing Technology

CLO	Bloom's Level	Mapped PO(s)
Explain gas processing operations	Understand	PO 1
Analyze separation & treatment	Analyze	PO 2
Identify processing equipment	Apply	PO 4
Apply environmental considerations	Apply	PO 7

CHE 422: Reservoir Engineering

CLO	Bloom's Level	Mapped PO(s)
Explain reservoir properties	Understand	PO 1
Analyze flow in porous media	Analyze	PO 2
Evaluate reservoir performance	Evaluate	PO 2
Apply reservoir concepts	Apply	PO 4

KEY

- **T** = Test / Quiz
- **A** = Assignment / Coursework
- **L** = Laboratory / Practical
- **P** = Project / Design / Seminar
- **E** = End-of-Semester Examination

HND I – SEMESTER ONE
CLO–Assessment–PO Matrix

Course	CLO	Assessment Tool(s)	Mapped PO(s)
Advanced Algebra	Solve & apply linear algebra concepts	T, A, E	PO 1, PO 2
Advanced Calculus	Apply multivariable calculus	T, A, E	PO 1
Engineer in Society	Ethics, safety & societal impact	A, T, E	PO 6, PO 7
Unit Operations III	Analyze mechanical separations	T, A, E	PO 2, PO 4
Chem. Eng. Lab III	Conduct & analyze experiments	L, A, E	PO 3, PO 7
Heat Transfer II	Analyze & compute heat transfer	T, A, E	PO 1, PO 2
Thermodynamics II	Energy & phase equilibrium analysis	T, A, E	PO 1, PO 2
Mass Transfer II	Mass transfer analysis	T, A, E	PO 1, PO 4
Engineering Statistics	Statistical data analysis	T, A, E	PO 1, PO 5
Use of English II	Technical communication	A, E	PO 6

HND I – SEMESTER TWO
CLO–Assessment–PO Matrix

Course	CLO	Assessment Tool(s)	Mapped PO(s)
Numerical Methods	Apply numerical techniques	T, A, E	PO 1, PO 5
Computer Programming	Develop engineering programs	T, A, P, E	PO 5
Instrumentation	Apply measurement & calibration	T, L, E	PO 4
Unit Operations IV	Analyze separation processes	T, A, E	PO 2, PO 4
Fluid Mechanics II	Fluid flow & equipment analysis	T, A, E	PO 1, PO 4
Reaction Eng. II	Reactor analysis & design	T, A, E	PO 2, PO 4
Chem. Eng. Lab IV	Advanced experimentation	L, A, E	PO 3
Polymer Science	Polymer processing analysis	T, A, E	PO 2, PO 4
Strength of Materials	Stress & failure analysis	T, A, E	PO 1, PO 4
Communication in English	Professional communication	A, E	PO 6

HND II – SEMESTER ONE
CLO–Assessment–PO Matrix

Course	CLO	Assessment Tool(s)	Mapped PO(s)
Process Design	Process design & safety	T, A, P, E	PO 4, PO 7
Plant Economics	Economic feasibility analysis	T, A, E	PO 2, PO 6
Unit Operations V	Drying & crystallization	T, A, E	PO 2, PO 4
Food Sci. & Tech.	Food processing principles	T, A, E	PO 1, PO 7
Chem. Eng. Lab V	Pilot-scale experimentation	L, A, E	PO 3
Eng. Analysis	Mathematical modelling	T, A, E	PO 1, PO 2
Project (I)	Problem definition & methods	P	PO 3, PO 6
Engineering Management	Leadership & project planning	A, T, E	PO 6
Elective I	Specialized process analysis	T, A, E	PO 2, PO 4

HND II – SEMESTER TWO
CLO–Assessment–PO Matrix

Course	CLO	Assessment Tool(s)	Mapped PO(s)
Unit Operations VI	Advanced separations	T, A, E	PO 2, PO 4
Equipment Design	Equipment sizing & standards	T, A, P, E	PO 4
Process Dynamics & Control	Control system analysis	T, A, E	PO 2
HSE II	Risk & safety management	A, T, E	PO 7
Entrepreneurship	Business plan development	A, P, E	PO 6
Plant Services & Maintenance	Utilities & maintenance strategy	T, A, E	PO 4, PO 7
Petroleum & Petrochemical Tech	Refining process analysis	T, A, E	PO 2, PO 7
Project (II)	Project execution & defense	P	PO 3, PO 4, PO 6
Elective II	Advanced specialization	T, A, E	PO 2, PO 4

PART A: PO ATTAINMENT & PERFORMANCE INDICATORS

1. PO Attainment Measurement Framework

Assessment Weighting (Standard NBTE Practice)

Assessment Tool	Typical Weight (%)
Tests / Quizzes	10–20
Assignments	10–20
Laboratory / Practical	20–30
Project / Design	20–30
End-of-Semester Exam	40–60

Each **CLO contributes to one or more POs**.
PO attainment is computed as a **weighted average of CLO scores** mapped to that PO.

2. Performance Rating Scale

Score (%)	Attainment Level	Interpretation
≥ 70	**High**	PO strongly attained
60 – 69	**Satisfactory**	PO adequately attained
50 – 59	**Marginal**	Improvement required
< 50	**Unsatisfactory**	Immediate corrective action

Benchmark:
✓ Minimum acceptable PO attainment = **60%**

3. PO Attainment Indicators & KPIs

PO 1: Engineering Knowledge

Apply mathematics, science, and engineering fundamentals

Indicator	Measurement Tool
Correct application of equations and principles	Tests, Exams
Accuracy of calculations	Assignments
Integration of theory in labs	Laboratory reports

KPI: ≥ 60% average score in math- and theory-based CLOs

PO 2: Problem Analysis

Analyze broadly defined engineering problems

Indicator	Measurement Tool
Problem interpretation and assumptions	Tests, Assignments
Analytical depth and logic	Exams
Correct selection of solution methods	Projects

KPI: ≥ 60% in analytical CLOs

PO 3: Experimentation & Data Analysis

Conduct experiments and interpret data

Indicator	Measurement Tool
Experimental procedure adherence	Laboratory
Data accuracy and analysis	Lab reports
Interpretation of results	Projects

KPI: ≥ 65% average laboratory score

PO 4: Design & Engineering Practice

Design, operate, and maintain engineering systems

Indicator	Measurement Tool
Equipment/process selection	Assignments
Design calculations	Projects
Compliance with codes & safety	Exams

KPI: ≥ 60% in design-oriented CLOs

PO 5: Modern Tool Usage

Use ICT and engineering software/tools

Indicator	Measurement Tool
Use of computational tools	Programming tasks
Data processing & simulations	Assignments
Software-based problem solving	Projects

KPI: ≥ 60% in tool-based assessments

PO 6: Professionalism & Communication

Ethics, teamwork, communication, management

Indicator	Measurement Tool
Technical report quality	Projects
Oral presentation effectiveness	Project defense
Ethical reasoning	Tests, Assignments

KPI: ≥ 70% in reports and presentations

PO 7: Safety, Environment & Sustainability

Apply HSE and sustainability principles

Indicator	Measurement Tool
Hazard identification	Tests
Risk assessment application	Assignments
Environmental consideration in design	Projects

KPI: ≥ 65% in HSE-related CLOs

4. Continuous Quality Improvement (CQI) Trigger

Attainment Status	Action
≥ 70%	Maintain current strategy
60–69%	Minor curriculum/assessment improvement
< 60%	Review CLOs, teaching method, assessment design

PART B: SYDNEY ACCORD–STYLE GRADUATE ATTRIBUTE ALIGNMENT

Sydney Accord Graduate Attributes (Engineering Technologist)

GA Code	Graduate Attribute
GA1	Engineering Knowledge
GA2	Problem Analysis
GA3	Design / Development of Solutions
GA4	Investigation & Experimentation
GA5	Modern Tool Usage
GA6	Engineer and Society
GA7	Environment & Sustainability
GA8	Ethics
GA9	Individual & Teamwork
GA10	Communication
GA11	Project Management & Finance
GA12	Lifelong Learning

PO–Graduate Attribute Alignment Matrix

PO	Mapped Sydney Accord Graduate Attributes
PO 1	GA1
PO 2	GA2
PO 3	GA4
PO 4	GA3, GA5
PO 5	GA5
PO 6	GA6, GA8, GA9, GA10, GA11
PO 7	GA7

Curriculum Evidence for Sydney Accord Compliance

Graduate Attribute	Evidence in Curriculum
GA1–GA2	Engineering mathematics, thermodynamics, transport phenomena
GA3	Process design, equipment design, unit operations
GA4	Chemical engineering laboratories (III–V), final projects
GA5	Programming, numerical methods, instrumentation
GA6–GA8	Engineer in Society, HSE II, Engineering Management
GA9–GA10	Group labs, project teamwork, presentations
GA11	Plant economics, entrepreneurship
GA12	Final year project, research-based assignments

LIST OF EQUIPMENT FOR CHEMICAL ENGINEERING TECHNOLOGY HIGHER NATIONAL DIPOMA

In addition to the equipment listed for the National DIPLOMA Programme, the following are required for the Higher National DIPLOMA Programme in Chemical Engineering Technology:

S/NO	ITEM	QUANTITY
1.	Fluid circuit system	2
2.	Multi pump test rig (Universal)	2
3.	Centrifugal pump test rig	2
4.	Free and Forced convection heat apparatus	2
5.	Fixed and Fluidised bed system	2
6.	Pre cessinulation unit	1
7.	Packed distillation equipment	2
8.	Double effect evaporator	1
9.	Vapour-liquid equilibria apparatus	1
10	Batch chemical reactors	3
11.	Basic climbing film evaporator	2
12.	Multi-function plate distillation column	2
13.	Old refrigerator	21
14.	Process control training plant (Thermo-tutor multi-function)	1
15.	Centrifugal filter	4
16.	Enzyme catalytic reactor	4
17.	Glass blowing kit	4
18.	Gas chromatograph	1
19.	Mass spectrometer	1
20.	Computer simulation softwares in: i). Fluid and Particle Mechanics ii). Unit Operations iii). Heat and Mass Transfer Process Control	

HIGHER NATIONAL DIPOMA

In addition to the equipment listed for the National DIPLOMA Programme, the following are required for the Higher National DIPLOMA Programme in Chemical Engineering Technology.

S/NO	ITEM	QUANTITY

1.	Fluid circuit system	2
2.	Multi Pump	2
3.	test rig	2
4.	(Universal)	2
5.	Centrifugal	2
6.	Pump test rig	2
7.	Free and	1
8.	forced	1
9.	convection	3
10.	heat	2
11.	apparatus	2
12.	Fixed and	2
13.	fluidized bed	1
14.	system	4
15.	Packed	4
16.	distillatio	4
17.	n	1
18.	equipme	1
19.	nt Double effect evaporat or Vapour-liquid equilibria apparatus Batch Chemical reactors Basic climbing film evaporator Multi-functional plate distillation column Old refrigerator Process control training plant(Thermo-tutor Multi-function) Centrifugal filter Enzyme catalytic reactor Glass blowing unit Gas Chromatograph Mass spectrometer Computer Simulation soft wares: i) Fluid and Particle Mechanics ii) Unit Operations iii) Heat and Mass transfer iv) Process control	

1. Core Chemical Engineering Textbooks

These are foundational texts covering unit operations, transport phenomena, and core chemical engineering principles:

1. **Unit Operations of Chemical Engineering** – McCabe, W.L., Smith, J.C., & Harriott, P. — classic reference on fluid flow, heat transfer, mass transfer, and particulate operations.
2. **Transport Phenomena** – Bird, R.B., Stewart, W.E., & Lightfoot, E.N. — comprehensive treatment of momentum, heat, and mass transfer.
3. **Elementary Principles of Chemical Processes** – Richard M. Felder & Ronald W. Rousseau — excellent introduction to material & energy balances.
4. **Basic Principles and Calculations in Chemical Engineering** – David M. Himmelblau & James B. Riggs — strong grounding in calculations and fundamentals.

2. Thermodynamics and Physical Chemistry

5. **Chemical Engineering Thermodynamics** – J.M. Smith, H.C. Van Ness & M.M. Abbott — a standard for thermodynamics applications in chemical engineering. Funai
6. **Introduction to Chemical Engineering Thermodynamics** – J.M. Smith, H.C. Van Ness & M.M. Abbott — clear explanations with engineering examples.

3. Heat and Mass Transfer

7. **Heat Transfer** – J.P. Holman or Frank P. Incropera & David P. DeWitt — comprehensive coverage for chemical engineers.
8. **Mass Transfer Operations** – Robert E. Treybal — widely used for designing and understanding mass transfer equipment.

4. Chemical Reaction Engineering

9. **Chemical Reaction Engineering** – Octave Levenspiel — essential for reactor design and kinetics.
10. **Elements of Chemical Reaction Engineering** – H. Scott Fogler — industry standard for reactor analysis and design.

5. Process Design, Equipment and Economics

11. **Plant Design and Economics for Chemical Engineers** – Max S. Peters, Klaus D. Timmerhaus & Ronald E. West — strong focus on economic evaluation and design.
12. **Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design** – Gavin Towler & Ray Sinnott — widely used in plant design courses.

6. Handbook and Reference Works

13. **Perry's Chemical Engineers' Handbook** – Don W. Green & Marylee Z. Southard — comprehensive reference covering virtually all chemical engineering topics. Wikipedia
14. **CRC Handbook of Chemistry and Physics** — essential tables and physical data. Wikipedia
15. **Ullmann's Encyclopedia of Industrial Chemistry** — detailed industrial chemical process reference. Wikipedia

7. Specialized and Supporting Texts

16. **Polymer Science and Technology** – Joel R. Fried or Chanda & Roy — useful for polymer processing modules. Auburn Engineering
17. **Chemical Engineering Process Simulation** — for process modeling (e.g., Aspen HYSYS, CHEMCAD).
18. **Rules of Thumb for Chemical Engineers** – also known as "chemical engineering shortcuts and heuristics." U of T Library Guides

8. Supplementary Texts for Specific Courses

- **Fluid Mechanics for Chemical Engineers** — for advanced fluid flows.
- **Process Control: Designing Processes and Control Systems for Dynamic Performance** — essential for instrumentation and control topics.
- **Engineering Statistics** — for data analysis and design of experiments.
- **Health, Safety & Environment Textbooks** — covering regulations, risk assessment, and safety engineering.

BENCHMARK MINIMUM ACADEMIC AND PROFESSIONAL STANDARD (BMAS)

HIGHER NATIONAL DIPLOMA (HND)

IN

MECHANICAL ENGINEERING TECHNOLOGY

1. Programme Philosophy

The HND Mechanical Engineering Technology programme is designed to produce practice-oriented engineering technologists with the competence to apply established mechanical engineering principles, standards, and tools to broadly defined engineering problems. The programme emphasizes hands-on skills, safety, sustainability, professionalism, teamwork, and lifelong learning, consistent with the Sydney Accord expectations for Engineering Technologists.

2. Programme Aim

The programme aims to produce graduates who can effectively support engineering operations in manufacturing, automotive, power, oil and gas, construction, utilities, and allied industries, and who can adapt to technological changes through continuous professional development.

3. Programme Educational Objectives

(HND Mechanical Engineering Technology)

The PEOs of the HND Mechanical Engineering Technology programme are:

PEO 1 – Engineering Technology Practice

Apply engineering technology principles, standards, and modern tools to install, operate, test, maintain, and improve engineering systems in industrial and service environments.

PEO 2 – Technical Problem Solving

Identify and solve broadly-defined engineering problems using practical skills, standard methods, manuals, codes, and established engineering practices.

PEO 3 – Professionalism, Safety, and Ethics

Demonstrate professional ethics, workplace safety consciousness, quality assurance, and compliance with industry regulations and standards.

PEO 4 – Teamwork, Communication, and Supervision

Work effectively as technologists, supervisors, or team leaders, and communicate technical information clearly through reports, drawings, and oral presentations.

PEO 5 – Career Development and Lifelong Learning

Engage in continuous professional development, certification, entrepreneurship, or further education to adapt to technological changes and career progression.

4. Programme Outcomes (POs)

Graduates of the programme should be able to:

SA1: Apply knowledge of mathematics, natural science, computing and engineering fundamentals and an engineering specialization as specified in SK1 to SK4 respectively to defined and applied engineering procedures, processes, systems or methodologies.
SA2: Identify, formulate, research literature and analyze *broadly-defined* engineering problem searching substantiated conclusions using analytical tools appropriate to the discipline or area of specialization. (SK1 to SK4)
SA3: Design solutions for *broadly-defined* engineering technology problems and *contribute to* the design of systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (SK5)
SA4: Conduct investigations of *broadly-defined* engineering problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions (SK8)
SA5: Select and apply, and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *broadly-defined* engineering problems (SK2 and SK6)
SA6: When solving broadly-defined engineering problems, analyze and evaluate sustainable development impacts* to: society, the economy, sustainability, health and safety, legal frameworks, and the environment (SK1, SK5, and SK7)
SA7: Understand and commit to professional ethics and norms of engineering technology practice including compliance with national and international laws. Demonstrate an understanding of the need for diversity and inclusion (SK9)
SA8: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (SK9)
SA9: Communicate effectively and inclusively on *broadly-defined* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, taking into account cultural, language, and learning differences.
SA10: Apply knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.
SA11: Recognize the need for, and have the ability for i) independent and life-long learning and ii) critical thinking in the face of new specialist technologies (SK8)

5. Admission Requirements

- National Diploma (ND) in Mechanical Engineering Technology or related discipline
- Minimum of Lower Credit pass
- Evidence of completion of SIWES at ND level

6. Programme Duration

- Four (4) semesters over two (2) academic years
- 4 Months mandatory supervised industrial training

7. Curriculum Structure

The programme consists of:

- Foundation and supporting courses
- Core mechanical engineering technology courses
- Automotive and manufacturing technology courses
- Professional, management, safety, and environmental courses
- Final year project

Higher National DIPLOMA (HND) in Mechanical Engineering Technology Options in: (a) Automotive (b) Manufacturing and (c) Plant

HND I Semester One

Course Code	Course Title	L	T	P	CU	CH
GNS 301	Use of English III - Comprehension & Essay	2	0	0	2	2
MTH 311	Advanced Algebra	1	0	1	2	2
EEd 413	Entrepreneurship Development	1	0	2	2	3
COM 311	Computer Programming	1	0	1	2	2
MEC 311	Engineer in Society	2	0	0	2	2
MEC 312	Engineering Design	2	0	2	3	4
MEC 313	Stress Analysis	2	0	1	3	3
MEC 314	Instrumentation and Control	2	0	1	3	3
MEC 315	Mechanics of Machines	2	0	2	3	4
MEC 316	Machine Element Design I	2	0	2	3	4
TOTAL		**17**	**1**	**12**	**25**	

HND I Semester Two

Course Code	Course Title	L	T	P	CU	CH
GNS 302	Technical Report Writing II	1	0	0	1	1
MTH 312	Advanced Calculus	2	0	0	2	2
MEC 321	Project Management	2	0	0	2	2
MEC 322	Mechanical Structural Analysis	2	0	1	3	3
MEC 323	Advanced Fluid Mechanics	2	0	2	3	4
MEC 324	Safety and Environmental Engineering	2	0	0	2	2
Automotive Engineering Technology Option						
MEA 321	Applied Thermodynamics	2	0	2	3	4
MEA 322	Automotive Engines, Performance and Test	1	0	2	2	3
MEA 323	Transmission Technology and Practice	1	0	2	2	3
MEA 324	Autotronics	1	0	2	2	3
MEA 325	Mechanics of Motor Vehicles	2	0	1	2	3
	Total	**18**	**0**	**12**	**24**	**30**

Manufacturing Engineering Technology Option						
MEM 321	Metal Forming and Heat Treatment	2	0	2	3	4

MEM 322	Joining and Fabrication Processes	2	0	2	3	4
MEM 323	Foundry Technology and Practice	2	0	2	3	4
	Total	**16**	**0**	**10**	**22**	**26**
Plant Engineering Technology Option						
MEA 321	Applied Thermodynamics	2	0	2	3	4
MEP 322	Internal Combustion Engines	2	0	2	3	4
MEP 323	Energy Conversion and Heat Transfer	2	0	1	2	3
MEP 324	Renewable Energy Systems	2	0	2	3	4
	Total	**18**	**0**	**11**	**24**	**29**

HND II Semester One

Course Code	**Course Title**	**L**	**T**	**P**	**CU**	**CH**
MTH 412	Numerical Methods	2	0	0	2	2
MEC 411	CAD/CAM	1	0	2	2	3
MEC 412	Fluid Power Machines	2	0	2	3	4
MEC 413	Operations Management	2	0	0	2	2
MEC 414	Engineering Materials and Applications	1	0	2	3	3
MEC 400	Final Year Project	0	0	3	3	3
Automotive Engineering Technology Option						
MEA 411	Vehicle Chassis and Body Technology	2	0	2	3	4
MEA 413	Automotive Air Conditioning Systems	1	0	2	2	3
MEA 414	Workshop Management	2	0	0	2	2
	Total	**13**	**0**	**13**	**22**	**26**
Manufacturing Engineering Technology Option						
MEM 411	Metrology	2	0	1	2	3
MEM 412	Testing and Failure of Materials	2	0	1	2	3
MEM 413	Machine Elements Design II	2	0	1	2	3
MEM 415	CNC Programming and Robotics	1	0	2	2	3
Total		**15**	**0**	**14**	**23**	**29**
Plant Engineering Technology Option						
EEE 442	Electrical Power and Machines	2	0	2	3	4
MEP 411	Refrigeration and Air-conditioning	2	0	2	3	4
MEP 412	Mechanical Equipment in Building	2	0	2	3	4

otal	**14**	**0**	**15**	**24**	**29**

HND II Semester Two

Course Code	**Course Title**	**L**	**T**	**P**	**CU**	**CH**
MTH 422	Statistical Methods in Engineering	1	0	1	2	2
MEC 421	Quality Assurance	2	0	0	2	2
MEC 422	Industrial Engineering	2	0	0	2	2
MEC 423	Materials Handling	2	0	0	2	2
MEC 424	Piping Design	2	0	1	2	3
MEC 400	Final Year Project	0	0	3	3	3
Automotive Engineering Technology Option						
MEA 421	Engine and Transmission Design	2	0	2	3	4
MEA 422	Automotive Tribology	2	0	2	3	4

MEA 423	Vehicle Diagnosis and Maintenance	1	0	2	2	3
MEA 424	Transport Management	2	0	0	2	2
	Total	**16**	**0**	**11**	**23**	**27**
Manufacturing Engineering Technology Option						
MEM 421	Machine Tools System	1	0	2	2	3
MEM 422	Machine Tools Processes	2	0	2	3	4
MEM 423	Press and Cutting Tools Design	1	0	2	2	3
MEM 424	Machine Assembly, Installation and Commissioning	2	0	1	2	3
MEM 425	Jigs and Fixtures Design	1	0	2	2	3
Total		**16**	**0**	**14**	**24**	**30**
Plant Engineering Technology Option						
MEP 421	Process, Construction and Mining Equipment	2	0	2	3	3
MEP 422	Maintenance Management	1	0	0	1	1
MEP 423	Power Plant Engineering	2	0	2	3	4
MEP 424	Electro-Mechanical Controls	2	0	1	2	3
MEM 424	Machine Assembly, Installation and Commissioning	2	0	1	2	3
Total		**18**	**0**	**11**	**24**	**29**

8. List of Courses, Course Contents, and CLOs

HND I – SEMESTER ONE

GNS 301: Use of English III (Comprehension & Essay)

Course Contents

- Advanced reading comprehension techniques
- Critical analysis of technical and non-technical texts
- Essay types: argumentative, expository, technical essays
- Vocabulary development and usage
- Oral presentation skills

Course Learning Outcomes

1. Analyze complex texts for meaning, structure, and intent.
2. Write coherent and well-structured essays on technical subjects.
3. Apply appropriate vocabulary and grammar in formal communication.
4. Deliver clear and effective oral presentations.

MTH 311: Advanced Algebra

Course Contents

- Complex numbers and applications
- Matrices and determinants
- Eigenvalues and eigenvectors
- Systems of linear equations
- Polynomial equations

Course Learning Outcomes

1. Solve engineering problems using complex numbers and matrices.
2. Apply eigenvalue techniques in mechanical system analysis.
3. Analyze systems of linear equations relevant to engineering models.
4. Use algebraic methods to support engineering computations.

EED 413: Entrepreneurship Development

Course Contents

- Entrepreneurship concepts and theories
- Opportunity identification and feasibility studies
- Business plan development
- Small-scale manufacturing enterprises
- Legal and ethical issues in entrepreneurship

Course Learning Outcomes

1. Explain the principles and roles of entrepreneurship in engineering practice.
2. Identify viable engineering-based business opportunities.
3. Prepare a basic business plan for a mechanical enterprise.
4. Apply entrepreneurial skills to self-emPOyment and innovation.

COM 311: Computer Programming

Course Contents

- Introduction to programming concepts
- Algorithms and flowcharts
- High-level programming languages (e.g. C, Python – fundamentals)
- Program debugging and testing
- Engineering applications of programming

Course Learning Outcomes

1. Develop simple computer programs for engineering calculations.
2. Apply algorithms to solve mechanical engineering problems.
3. Debug and test basic engineering programs.
4. Use programming tools to support technical problem-solving.

MEC 311: Engineer in Society

Course Contents

- Role and responsibilities of engineers
- Engineering ethics and professionalism
- Sustainable development and society
- Safety, health, and environmental responsibilities
- Regulatory bodies and standards

Course Learning Outcomes

1. Explain the social responsibilities of engineers.
2. Apply ethical principles to engineering decision-making.
3. Assess the societal and environmental impacts of engineering projects.
4. Identify regulatory and professional standards governing practice.

MEC 312: Engineering Design

Course Contents

- Engineering design process and methodology
- Problem definition and conceptual design
- Engineering drawings and specifications
- Materials selection
- Design documentation and reporting

Course Learning Outcomes

1. Apply systematic design procedures to mechanical problems.
2. Develop conceptual and detailed engineering designs.
3. Select appropriate materials based on design requirements.
4. Prepare technical design drawings and reports.

MEC 313: Stress Analysis

Course Contents

- Stress and strain relationships
- Axial, bending, and torsional stresses
- Combined stresses
- Mohr's circle
- Failure theories

Course Learning Outcomes

1. Analyze stresses and strains in mechanical components.

2. Evaluate combined loading conditions in structures.
3. Apply failure theories in mechanical design.
4. Use analytical tools to predict component failure.

MEC 314: Instrumentation and Control

Course Contents

- Measurement systems and standards
- Sensors and transducers
- Control system fundamentals
- Feedback and stability
- Industrial instrumentation applications

Course Learning Outcomes

1. Explain principles of measurement and instrumentation.
2. Identify and apply common sensors and transducers.
3. Analyze basic control system behavior.
4. Apply instrumentation techniques in industrial settings.

MEC 315: Mechanics of Machines

Course Contents

- Kinematics of machines
- Velocity and acceleration analysis
- Cams, gears, and linkages
- Dynamic forces in machines
- Balancing of rotating masses

Course Learning Outcomes

1. Analyze motion in mechanical systems.
2. Evaluate forces acting on machine components.
3. Apply kinematic principles to machine design.
4. Assess balancing requirements of rotating systems.

MEC 316: Machine Element Design I

Course Contents

- Design philosophy and standards
- Design of shafts, keys, and couplings
- Springs and fasteners
- Bearings and seals
- Factor of safety and reliability

Course Learning Outcomes

1. Design basic machine elements under static loading.
2. Apply standards and codes in mechanical design.
3. Select suitable machine elements for given applications.
4. Evaluate safety and reliability in design decisions.

HND I – SEMESTER TWO

GNS 302: Technical Report Writing II

Course Contents

- Structure of technical reports
- Data presentation and interpretation
- Referencing and citation
- Technical proposals and documentation
- Editing and proofreading

Course Learning Outcomes

1. Prepare well-structured technical reports.
2. Present engineering data clearly and accurately.
3. Apply proper referencing and citation techniques.
4. Edit and proofread technical documents professionally.

MTH 312: Advanced Calculus

Course Contents

- Partial differentiation
- Multiple integrals
- Differential equations
- Series expansions
- Engineering applications of calculus

Course Learning Outcomes

1. Solve differential equations relevant to mechanical systems.
2. Apply calculus to analyze engineering phenomena.
3. Use multiple integrals in physical system modeling.
4. Interpret mathematical solutions in engineering contexts.

MEC 321: Project Management

Course Contents

- Project planning and scheduling
- Cost estimation and budgeting
- Resource management
- Risk analysis
- Project monitoring and control

Course Learning Outcomes

1. Apply project management principles to engineering projects.
2. Develop project schedules and cost estimates.
3. Manage resources effectively within project constraints.
4. Monitor and control project performance.

MEC 322: Mechanical Structural Analysis

Course Contents

- Structural systems and loading
- Determinate and indeterminate structures
- Bending moment and shear force analysis
- Deflection of beams
- Stability of structures

Course Learning Outcomes

1. Analyze structural members under various loads.
2. Determine internal forces and deflections.
3. Assess stability and safety of mechanical structures.
4. Apply analytical methods to structural design problems.

MEC 323: Advanced Fluid Mechanics

Course Contents

- Fluid properties and statics
- Fluid kinematics and dynamics
- Flow through pipes and channels
- Boundary layer theory
- Turbomachinery fundamentals

Course Learning Outcomes

1. Analyze fluid flow behavior in engineering systems.
2. Apply fluid dynamics equations to practical problems.
3. Evaluate losses in pipe and channel flows.
4. Relate fluid mechanics principles to turbomachinery.

MEC 324: Safety and Environmental Engineering

Course Contents

- Industrial safety principles
- Hazard identification and risk assessment
- Accident prevention and control
- Environmental pollution and control
- Safety regulations and standards

Course Learning Outcomes

1. Identify hazards in mechanical engineering environments.
2. Apply safety management principles in industry.
3. Assess environmental impacts of engineering activities.
4. Comply with safety and environmental regulations.

MEA 321: Applied Thermodynamics *(Common to Options)*

Course Contents

- Laws of thermodynamics
- Properties of pure substances
- Thermodynamic cycles
- Energy analysis of engineering systems
- Applications to engines and power plants

Course Learning Outcomes

1. Apply thermodynamic laws to engineering systems.
2. Analyze energy conversion processes.

3. Evaluate performance of thermodynamic cycles.
4. Solve practical thermodynamic problems.

AUTOMOTIVE ENGINEERING TECHNOLOGY OPTION

MEA 322: Automotive Engines, Performance and Test

Course Contents

- Classification of automotive engines (SI, CI, hybrid concepts)
- Engine components and operating principles
- Combustion processes and performance parameters
- Engine testing methods and instrumentation
- Emission characteristics and efficiency improvement techniques

Course Learning Outcomes

1. Explain the construction and operating principles of automotive engines.
2. Analyze engine performance parameters using test data.
3. Conduct basic engine performance tests using standard procedures.
4. Evaluate factors affecting engine efficiency and emissions.

MEA 323: Transmission Technology and Practice

Course Contents

- Functions and types of automotive transmission systems
- Manual, automatic, and continuously variable transmissions
- Clutches, torque converters, and gearboxes
- Differential and final drive systems
- Transmission faults, diagnostics, and maintenance

Course Learning Outcomes

1. Describe the operating principles of vehicle transmission systems.
2. Analyze torque and power flow through transmission components.
3. Perform basic diagnostics and maintenance on transmission systems.
4. Differentiate between manual, automatic, and modern transmission technologies.

MEA 324: Autotronics

Course Contents

- Introduction to automotive electronics

- Sensors, actuators, and electronic control units (ECUs)
- Engine management systems
- Vehicle communication networks (CAN, LIN)
- Fault diagnosis using electronic tools

Course Learning Outcomes

1. Explain the role of electronics in modern automotive systems.
2. Identify and apply sensors and actuators used in vehicles.
3. Analyze basic ECU-controlled automotive functions.
4. Perform electronic fault diagnosis using diagnostic tools.

MEA 325: Mechanics of Motor Vehicles

Course Contents

- Vehicle structure and layout
- Vehicle dynamics: traction, braking, and stability
- Suspension and steering systems
- Tyres, wheels, and road interaction
- Ride comfort and handling characteristics

Course Learning Outcomes

1. Explain the mechanical layout of motor vehicles.
2. Analyze forces acting on vehicles during motion.
3. Evaluate suspension and steering system performance.
4. Relate vehicle dynamics principles to ride and handling behavior.

MANUFACTURING ENGINEERING TECHNOLOGY OPTION

MEM 321: Metal Forming and Heat Treatment

Course Contents

- Plastic deformation of metals
- Hot and cold working processes
- Rolling, forging, extrusion, and drawing
- Heat treatment processes and equipment
- Mechanical property modification through heat treatment

Course Learning Outcomes

1. Explain principles of metal forming processes.

2. Analyze effects of hot and cold working on material properties.
3. Apply heat treatment techniques to improve mechanical properties.
4. Select appropriate forming and heat treatment processes for applications.

MEM 322: Joining and Fabrication Processes

Course Contents

- Welding principles and classifications
- Arc, gas, and resistance welding processes
- Brazing and soldering
- Fabrication techniques and workshop practices
- Weld defects, inspection, and quality control

Course Learning Outcomes

1. Describe major joining and fabrication processes.
2. Select suitable welding techniques for given applications.
3. Identify common weld defects and inspection methods.
4. Apply safe fabrication practices in workshop environments.

MEM 323: Foundry Technology and Practice

Course Contents

- Foundry layout and equipment
- Pattern making and moulding materials
- Casting processes (sand, die, investment casting)
- Melting furnaces and metal handling
- Casting defects and quality control

Course Learning Outcomes

1. Explain foundry processes and equipment operation.
2. Prepare basic moulds and patterns for casting.
3. Identify common casting defects and remedies.
4. Apply foundry safety and quality control practices.

PLANT ENGINEERING TECHNOLOGY OPTION

MEP 322: Internal Combustion Engines

Course Contents

- Classification of internal combustion engines
- Engine cycles and thermodynamic analysis
- Fuel supply and ignition systems
- Cooling and lubrication systems
- Engine performance testing and maintenance

Course Learning Outcomes

1. Explain operating principles of internal combustion engines.
2. Analyze engine cycles and performance characteristics.
3. Evaluate cooling and lubrication system effectiveness.
4. Perform basic engine testing and maintenance procedures.

MEP 323: Energy Conversion and Heat Transfer

Course Contents

- Energy conversion principles
- Modes of heat transfer: conduction, convection, radiation
- Heat exchangers and applications
- Energy efficiency in industrial systems
- Waste heat recovery methods

Course Learning Outcomes

1. Explain principles of energy conversion and heat transfer.
2. Analyze heat transfer mechanisms in engineering systems.
3. Evaluate performance of heat exchangers.
4. Apply heat transfer concepts to improve energy efficiency.

MEP 324: Renewable Energy Systems

Course Contents

- Overview of renewable energy sources
- Solar thermal and photovoltaic systems
- Wind energy conversion systems
- Biomass and small hydro systems
- Integration of renewables into power systems

Course Learning Outcomes

1. Describe major renewable energy technologies and applications.
2. Analyze energy conversion principles in renewable systems.
3. Evaluate performance and limitations of renewable energy systems.
4. Apply renewable energy concepts to sustainable engineering solutions.

HND II – SEMESTER ONE

MTH 412: Numerical Methods

Course Contents

- Errors and numerical accuracy
- Solutions of algebraic and transcendental equations
- Numerical differentiation and integration
- Solutions of ordinary differential equations
- Engineering applications of numerical techniques

Course Learning Outcomes

1. Apply numerical techniques to solve engineering equations.
2. Analyze numerical errors and solution accuracy.
3. Use numerical methods to solve differential equations.
4. Interpret numerical solutions in mechanical engineering contexts.

MEC 411: CAD/CAM

Course Contents

- Computer-aided design fundamentals
- Solid and surface modeling
- Computer-aided manufacturing concepts
- CNC integration and tool path generation
- CAD/CAM applications in manufacturing

Course Learning Outcomes

1. Develop mechanical component models using CAD tools.
2. Apply CAM principles for manufacturing processes.
3. Generate CNC tool paths from CAD models.
4. Integrate CAD/CAM systems in production environments.

MEC 412: Fluid Power Machines

Course Contents

- Hydraulic and pneumatic systems
- Pumps, compressors, and turbines
- Fluid power transmission
- Control valves and actuators
- Industrial applications and maintenance

Course Learning Outcomes

1. Explain operating principles of fluid power machines.
2. Analyze performance of pumps and compressors.
3. Apply fluid power systems to industrial operations.
4. Perform basic troubleshooting and maintenance of fluid power systems.

MEC 413: Operations Management

Course Contents

- Production planning and control
- Inventory management
- Facility layout and capacity planning
- Quality and productivity improvement
- Operations strategy

Course Learning Outcomes

1. Apply operations management principles to manufacturing systems.
2. Analyze production planning and inventory decisions.
3. Improve productivity through effective operations strategies.
4. Evaluate facility layout and capacity requirements.

MEC 414: Engineering Materials and Applications

Course Contents

- Metallic, polymeric, ceramic, and composite materials
- Material properties and testing
- Material selection for engineering applications
- Failure mechanisms and degradation
- Industrial material applications

Course Learning Outcomes

1. Classify engineering materials and their properties.
2. Select appropriate materials for mechanical applications.

3. Analyze material failure and degradation mechanisms.
4. Apply material testing data to engineering decisions.

MEC 400: Final Year Project

Course Contents

- Project topic selection and proposal development
- Literature review and research methodology
- Design, analysis, fabrication, or experimentation
- Technical reporting and presentation

Course Learning Outcomes

1. Identify and define an engineering problem for investigation.
2. Apply engineering principles to solve practical problems.
3. Demonstrate independent technical analysis and design skills.
4. Communicate project outcomes effectively in written and oral form.

AUTOMOTIVE ENGINEERING TECHNOLOGY OPTION (HND II – SEMESTER ONE)

MEA 411: Vehicle Chassis and Body Technology

Course Contents

- Vehicle chassis design and construction
- Body structures and materials
- Suspension mounting and load paths
- Crashworthiness and safety standards
- Manufacturing and assembly processes

Course Learning Outcomes

1. Explain chassis and body construction principles.
2. Analyze load distribution and structural behavior of vehicles.
3. Evaluate vehicle safety and crashworthiness features.
4. Apply materials selection to chassis and body design.

MEA 413: Automotive Air Conditioning Systems

Course Contents

- Refrigeration principles
- Automotive air-conditioning components
- Control systems and refrigerants
- Performance testing and servicing
- Environmental regulations

Course Learning Outcomes

1. Explain principles of automotive air-conditioning systems.
2. Analyze system performance and cooling capacity.
3. Diagnose and service automotive air-conditioning faults.
4. Apply environmental and safety standards in servicing.

MEA 414: Workshop Management

Course Contents

- Workshop organization and layout
- Maintenance planning and scheduling
- Cost control and inventory management
- Safety and personnel supervision
- Quality assurance in workshops

Course Learning Outcomes

1. Manage workshop operations efficiently.
2. Apply maintenance planning and cost control techniques.
3. Enforce safety and quality standards in workshops.
4. Supervise technical personnel effectively.

MANUFACTURING ENGINEERING TECHNOLOGY OPTION (HND II – SEMESTER ONE)

MEM 411: Metrology

Course Contents

- Measurement standards and systems
- Linear and angular measurement instruments
- Limits, fits, and tolerances
- Surface roughness measurement
- Quality inspection techniques

Course Learning Outcomes

1. Apply precision measurement techniques in manufacturing.
2. Use metrological instruments accurately.
3. Interpret limits, fits, and tolerances.
4. Perform quality inspection of manufactured components.

MEM 412: Testing and Failure of Materials

Course Contents

- Mechanical testing methods
- Fatigue, creep, and fracture
- Failure analysis techniques
- Non-destructive testing
- Case studies of material failure

Course Learning Outcomes

1. Conduct mechanical testing of engineering materials.
2. Analyze material failure modes.
3. Apply non-destructive testing techniques.
4. Interpret test results for design improvement.

MEM 413: Machine Elements Design II

Course Contents

- Design for fatigue and dynamic loading
- Gears and gear trains
- Brakes and clutches
- Reliability and life estimation
- Design standards and codes

Course Learning Outcomes

1. Design machine elements under dynamic loading.
2. Analyze fatigue and reliability in mechanical design.
3. Apply design standards to complex components.
4. Evaluate life expectancy of machine elements.

MEM 415: CNC Programming and Robotics

Course Contents

- CNC machine tools and controllers
- CNC programming (G- and M-codes)
- Industrial robotics fundamentals
- Robot programming and applications
- Automation in manufacturing

Course Learning Outcomes

1. Develop CNC programs for machining operations.
2. Operate and troubleshoot CNC machines.
3. Explain fundamentals of industrial robotics.
4. Apply automation concepts to manufacturing systems.

PLANT ENGINEERING TECHNOLOGY OPTION (HND II – SEMESTER ONE)

EEE 442: Electrical Power and Machines

Course Contents

- Electrical power generation and distribution
- Transformers and electric machines
- Motors and motor control
- Industrial electrical installations
- Safety in electrical systems

Course Learning Outcomes

1. Explain principles of electrical power generation and machines.
2. Analyze operation of motors and transformers.
3. Apply motor control techniques in industry.
4. Observe safety standards in electrical installations.

MEP 411: Refrigeration and Air-Conditioning

Course Contents

- Refrigeration cycles and refrigerants
- System components and controls
- Cooling load estimation
- Installation and maintenance practices
- Energy efficiency considerations

Course Learning Outcomes

1. Analyze refrigeration and air-conditioning cycles.
2. Design basic refrigeration and AC systems.
3. Perform installation and maintenance operations.
4. Evaluate system efficiency and performance.

MEP 412: Mechanical Equipment in Buildings

Course Contents

- Building services systems
- Lifts, escalators, and HVAC systems
- Fire protection and plumbing systems
- Installation standards and codes
- Maintenance management

Course Learning Outcomes

1. Identify mechanical equipment used in buildings.
2. Analyze operation of building service systems.
3. Apply installation standards and codes.
4. Plan maintenance of building mechanical systems.

HND II – SEMESTER TWO

MTH 422: Statistical Methods in Engineering

Course Contents

- Probability concepts
- Statistical distributions
- Regression and correlation
- Quality control charts
- Engineering data analysis

Course Learning Outcomes

1. Apply statistical methods to engineering data.
2. Analyze variability and uncertainty in processes.
3. Use quality control tools effectively.
4. Interpret statistical results for engineering decisions.

MEC 421: Quality Assurance

Course Contents

- Quality concepts and standards
- Quality management systems
- Inspection and testing procedures
- Continuous improvement tools
- Auditing and documentation

Course Learning Outcomes

1. Explain quality assurance principles.
2. Apply quality management systems in industry.
3. Conduct inspection and quality control activities.
4. Implement continuous improvement strategies.

MEC 422: Industrial Engineering

Course Contents

- Work study and method engineering
- Time and motion study
- Ergonomics and human factors
- Production optimization
- Systems analysis

Course Learning Outcomes

1. Apply industrial engineering tools to improve productivity.
2. Analyze work methods and time standards.
3. Incorporate ergonomics into system design.
4. Optimize industrial operations.

MEC 423: Materials Handling

Course Contents

- Materials handling systems
- Conveyors, cranes, and hoists
- Storage systems and layout
- Automation in materials handling

- Safety and cost considerations

Course Learning Outcomes

1. Explain principles of materials handling.
2. Select appropriate handling equipment.
3. Design basic materials handling layouts.
4. Apply safety and cost optimization principles.

MEC 424: Piping Design

Course Contents

- Piping materials and standards
- Pipe sizing and pressure losses
- Layout and stress analysis
- Valves, fittings, and supports
- Codes and safety considerations

Course Learning Outcomes

1. Apply piping standards and codes.
2. Design piping systems for industrial applications.
3. Analyze pressure losses and stresses in pipes.
4. Select appropriate piping materials and components.

AUTOMOTIVE ENGINEERING TECHNOLOGY OPTION

MEA 421: Engine and Transmission Design

Course Contents

- Design requirements for automotive engines and transmissions
- Stress, thermal, and fatigue considerations in engine components
- Gear trains, clutches, and transmission shafts design
- Material selection and lubrication considerations
- Design standards, safety factors, and reliability

Course Learning Outcomes

1. Design basic automotive engine components for strength and performance.
2. Analyze transmission elements under static and dynamic loading.
3. Select suitable materials and lubrication systems for engines and transmissions.
4. Apply design standards and reliability principles in automotive systems.

MEA 422: Automotive Tribology

Course Contents

- Fundamentals of friction, wear, and lubrication
- Tribological behavior of automotive components
- Lubricants and lubrication systems
- Wear mechanisms and surface engineering
- Failure analysis and tribology testing

Course Learning Outcomes

1. Explain tribological principles in automotive systems.
2. Analyze friction and wear in engine and drivetrain components.
3. Select appropriate lubricants for automotive applications.
4. Evaluate tribology-related failures in vehicle systems.

MEA 423: Vehicle Diagnosis and Maintenance

Course Contents

- Vehicle inspection and condition monitoring
- Diagnostic tools and fault codes
- Mechanical, electrical, and electronic fault diagnosis
- Preventive and corrective maintenance strategies
- Maintenance documentation and safety practices

Course Learning Outcomes

1. Diagnose faults in automotive mechanical and electronic systems.
2. Apply preventive and corrective maintenance techniques.
3. Use diagnostic tools and service manuals effectively.
4. Implement safe and systematic vehicle maintenance procedures.

MEA 424: Transport Management

Course Contents

- Transport systems and logistics
- Fleet management principles
- Vehicle scheduling and routing
- Cost analysis and budgeting
- Transport safety, regulations, and sustainability

Course Learning Outcomes

1. Explain principles of transport and fleet management.
2. Analyze vehicle operating and maintenance costs.
3. Apply scheduling and routing techniques in transport operations.
4. Comply with transport regulations and safety requirements.

MANUFACTURING ENGINEERING TECHNOLOGY OPTION

MEM 421: Machine Tools System

Course Contents

- Classification of machine tools
- Machine tool components and kinematics
- Drives, controls, and automation
- Machine tool accuracy and rigidity
- Maintenance and safety of machine tools

Course Learning Outcomes

1. Explain the structure and functions of machine tool systems.
2. Analyze kinematic and drive systems of machine tools.
3. Evaluate machine tool accuracy and rigidity requirements.
4. Apply maintenance and safety practices in machine tool operations.

MEM 422: Machine Tools Processes

Course Contents

- Machining processes: turning, milling, drilling, grinding
- Cutting tool materials and geometry
- Machining parameters and economics
- Surface finish and dimensional accuracy
- Process planning and optimization

Course Learning Outcomes

1. Analyze machining processes and cutting mechanics.
2. Select appropriate tools and parameters for machining operations.
3. Evaluate surface finish and dimensional accuracy.
4. Optimize machining processes for productivity and quality.

MEM 423: Press and Cutting Tools Design

Course Contents

- Press working fundamentals
- Design of punches, dies, and press tools
- Cutting, bending, and drawing operations
- Tool materials and heat treatment
- Safety and tool life considerations

Course Learning Outcomes

1. Design basic press and cutting tools for manufacturing.
2. Analyze forces involved in press operations.
3. Select suitable materials and heat treatment for tools.
4. Apply safety and durability considerations in tool design.

MEM 424: Machine Assembly, Installation and Commissioning

Course Contents

- Assembly methods and tolerances
- Alignment and leveling of machinery
- Installation planning and procedures
- Commissioning tests and documentation
- Troubleshooting and handover procedures

Course Learning Outcomes

1. Assemble mechanical systems according to specifications.
2. Apply installation and alignment techniques for machinery.
3. Conduct commissioning tests and performance checks.
4. Troubleshoot installation-related mechanical problems.

MEM 425: Jigs and Fixtures Design

Course Contents

- Principles of jig and fixture design
- Locating, clamping, and supporting systems
- Design for accuracy and productivity
- Materials and manufacturing of jigs and fixtures
- Cost and safety considerations

Course Learning Outcomes

1. Design jigs and fixtures for machining operations.
2. Analyze locating and clamping requirements.
3. Improve productivity and accuracy through proper fixture design.
4. Apply safety and cost considerations in design.

PLANT ENGINEERING TECHNOLOGY OPTION

MEP 421: Process, Construction and Mining Equipment

Course Contents

- Classification of process and mining equipment
- Crushers, conveyors, pumps, and compressors
- Construction machinery and earth-moving equipment
- Selection criteria and performance evaluation
- Operation, maintenance, and safety

Course Learning Outcomes

1. Identify major process, construction, and mining equipment.
2. Analyze operating principles and performance characteristics.
3. Select appropriate equipment for industrial applications.
4. Apply safe operation and maintenance practices.

MEP 422: Maintenance Management

Course Contents

- Maintenance concepts and strategies
- Preventive, predictive, and corrective maintenance
- Maintenance planning and scheduling
- Spare parts and inventory management
- Maintenance performance indicators

Course Learning Outcomes

1. Explain maintenance management principles.
2. Develop maintenance plans and schedules.
3. Manage maintenance resources and spare parts.
4. Evaluate maintenance performance and reliability.

MEP 423: Power Plant Engineering

Course Contents

- Thermal, hydro, gas turbine, and diesel power plants
- Power plant components and layouts
- Energy conversion and efficiency
- Operation and maintenance practices
- Environmental and safety considerations

Course Learning Outcomes

1. Explain operating principles of power plants.
2. Analyze energy conversion processes in power generation.
3. Evaluate performance and efficiency of power plant systems.
4. Apply operational, safety, and environmental standards.

MEP 424: Electro-Mechanical Controls

Course Contents

- Control system fundamentals
- Sensors, actuators, and controllers
- PLCs and industrial control circuits
- Electro-mechanical system integration
- Fault detection and troubleshooting

Course Learning Outcomes

1. Explain principles of electro-mechanical control systems.
2. Analyze control circuits and system behavior.
3. Apply PLCs and control devices in industrial systems.
4. Diagnose and troubleshoot control system faults.

MEC 400: Final Year Project

(Continues from Semester One)
Course Contents

- Project execution and data analysis
- Design optimization or experimental validation
- Final report writing
- Oral defense and presentation

Course Learning Outcomes

1. Implement and complete an engineering project.
2. Analyze results and validate design or experimental outcomes.
3. Demonstrate professional documentation skills.
4. Defend technical work effectively.

1. PROGRAMME OUTCOMES (POs) – HND MECHANICAL ENGINEERING TECHNOLOGY

PO Code	Programme Learning Outcome
PO1	Apply mathematics, science, and engineering fundamentals to solve mechanical engineering problems.
PO2	Analyze and solve well-defined mechanical engineering problems using appropriate tools and techniques.
PO3	Design mechanical components, systems, or processes to meet specified requirements.
PO4	Conduct experiments, tests, and measurements; analyze and interpret data.
PO5	Use modern engineering tools, software, and equipment effectively.
PO6	Apply safety, environmental, and sustainability principles in engineering practice.
PO7	Communicate effectively through technical reports and oral presentations.
PO8	Demonstrate professionalism, ethics, teamwork, and entrepreneurship skills.

2. HND I – SEMESTER ONE

CLO–PO Mapping with Bloom's Taxonomy Levels

GNS 301: Use of English III

CLO	Bloom's Level	Mapped POs
Analyze complex texts	Analyze (C4)	PO7
Write structured essays	Create (C6)	PO7
Apply grammar and vocabulary	Apply (C3)	PO7
Deliver oral presentations	Apply (C3)	PO7

MTH 311: Advanced Algebra

CLO	Bloom's Level	Mapped POs
Solve algebraic engineering problems	Apply (C3)	PO1
Apply eigenvalue techniques	Analyze (C4)	PO1, PO2
Analyze linear systems	Analyze (C4)	PO2
Support engineering computations	Apply (C3)	PO1

EED 413: Entrepreneurship Development

CLO	Bloom's Level	Mapped POs
Explain entrepreneurship concepts	Understand (C2)	PO8

Identify business opportunities	Analyze (C4)	PO8
Prepare a business plan	Create (C6)	PO8
Apply entrepreneurial skills	Apply (C3)	PO8

COM 311: Computer Programming

CLO	Bloom's Level	Mapped POs
Develop simple programs	Apply (C3)	PO5
Apply algorithms to problems	Analyze (C4)	PO2, PO5
Debug engineering programs	Analyze (C4)	PO5
Use programming for problem-solving	Apply (C3)	PO5

MEC 311: Engineer in Society

CLO	Bloom's Level	Mapped POs
Explain societal role of engineers	Understand (C2)	PO8
Apply ethical principles	Apply (C3)	PO8
Assess societal impacts	Evaluate (C5)	PO6
Identify regulatory standards	Understand (C2)	PO6, PO8

MEC 312: Engineering Design

CLO	Bloom's Level	Mapped POs
Apply design procedures	Apply (C3)	PO3
Develop engineering designs	Create (C6)	PO3
Select materials	Analyze (C4)	PO3
Prepare design drawings	Create (C6)	PO3, PO7

MEC 313: Stress Analysis

CLO	Bloom's Level	Mapped POs
Analyze stresses and strains	Analyze (C4)	PO1, PO2
Evaluate combined loading	Analyze (C4)	PO2
Apply failure theories	Apply (C3)	PO2
Predict component failure	Evaluate (C5)	PO2

MEC 314: Instrumentation and Control

CLO	Bloom's Level	Mapped POs
Explain measurement principles	Understand (C2)	PO4
Apply sensors and transducers	Apply (C3)	PO4, PO5
Analyze control systems	Analyze (C4)	PO2
Apply industrial instrumentation	Apply (C3)	PO5

MEC 315: Mechanics of Machines

CLO	Bloom's Level	Mapped POs
Analyze motion	Analyze (C4)	PO1, PO2
Evaluate forces	Analyze (C4)	PO2
Apply kinematic principles	Apply (C3)	PO1

Assess balancing	Evaluate (C5)	PO2

MEC 316: Machine Element Design I

CLO	Bloom's Level	Mapped POs
Design machine elements	Create (C6)	PO3
Apply design standards	Apply (C3)	PO3
Select machine elements	Analyze (C4)	PO3
Evaluate safety and reliability	Evaluate (C5)	PO3, PO6

3. HND I – SEMESTER TWO

CLO–PO Mapping with Bloom's Taxonomy Levels

GNS 302: Technical Report Writing II

CLO	Bloom's Level	Mapped PO(s)
Prepare structured technical reports	Create (C6)	PO7
Present engineering data clearly	Apply (C3)	PO7
Apply referencing and citation standards	Apply (C3)	PO7
Edit and proofread technical documents	Evaluate (C5)	PO7

MTH 312: Advanced Calculus

CLO	Bloom's Level	Mapped PO(s)
Solve differential equations for engineering systems	Apply (C3)	PO1
Apply calculus to mechanical engineering problems	Apply (C3)	PO1
Analyze engineering phenomena using calculus	Analyze (C4)	PO2
Interpret mathematical solutions in engineering context	Analyze (C4)	PO2

MEC 321: Project Management

CLO	Bloom's Level	Mapped PO(s)
Apply project management principles	Apply (C3)	PO8
Develop project schedules and budgets	Create (C6)	PO8
Manage project resources effectively	Apply (C3)	PO8
Monitor and control project performance	Evaluate (C5)	PO8

MEC 322: Mechanical Structural Analysis

CLO	Bloom's Level	Mapped PO(s)
Analyze structural members under load	Analyze (C4)	PO1, PO2
Determine internal forces and deflections	Analyze (C4)	PO2
Assess stability and safety of structures	Evaluate (C5)	PO2, PO6
Apply analytical methods to structural problems	Apply (C3)	PO1

MEC 323: Advanced Fluid Mechanics

CLO	Bloom's Level	Mapped PO(s)
Analyze fluid flow behavior	Analyze (C4)	PO1, PO2
Apply fluid dynamics equations	Apply (C3)	PO1

Evaluate losses in pipe and channel flows	Analyze (C4)	PO2
Relate fluid mechanics to turbomachinery	Analyze (C4)	PO2

MEC 324: Safety and Environmental Engineering

CLO	Bloom's Level	Mapped PO(s)
Identify hazards in engineering environments	Analyze (C4)	PO6
Apply industrial safety principles	Apply (C3)	PO6
Assess environmental impacts of engineering activities	Evaluate (C5)	PO6
Comply with safety and environmental regulations	Apply (C3)	PO6, PO8

MEA 321: Applied Thermodynamics

CLO	Bloom's Level	Mapped PO(s)
Apply thermodynamic laws to engineering systems	Apply (C3)	PO1
Analyze energy conversion processes	Analyze (C4)	PO1, PO2
Evaluate performance of thermodynamic cycles	Evaluate (C5)	PO2
Solve practical thermodynamic problems	Apply (C3)	PO1

HND II – SEMESTER ONE

CLO–PO Mapping with Bloom's Taxonomy Levels

MTH 412: Numerical Methods

CLO	Bloom's Level	Mapped PO(s)
Apply numerical techniques to engineering equations	Apply (C3)	PO1
Analyze numerical errors and solution accuracy	Analyze (C4)	PO2
Solve differential equations numerically	Apply (C3)	PO1
Interpret numerical results for engineering decisions	Analyze (C4)	PO2

MEC 411: CAD/CAM

CLO	Bloom's Level	Mapped PO(s)
Develop mechanical component models using CAD tools	Create (C6)	PO3, PO5
Apply CAM concepts to manufacturing processes	Apply (C3)	PO5
Generate CNC tool paths from CAD models	Apply (C3)	PO5
Integrate CAD/CAM systems into production workflows	Analyze (C4)	PO3, PO5

MEC 412: Fluid Power Machines

CLO	Bloom's Level	Mapped PO(s)

Explain principles of fluid power machines	Understand (C2)	PO1
Analyze performance of pumps and compressors	Analyze (C4)	PO2
Apply fluid power systems in industrial applications	Apply (C3)	PO3
Troubleshoot fluid power systems	Analyze (C4)	PO2, PO5

MEC 413: Operations Management

CLO	Bloom's Level	Mapped PO(s)
Apply operations management principles	Apply (C3)	PO8
Analyze production planning and inventory systems	Analyze (C4)	PO8
Improve productivity using operations strategies	Evaluate (C5)	PO8
Assess facility layout and capacity decisions	Analyze (C4)	PO8

MEC 414: Engineering Materials and Applications

CLO	Bloom's Level	Mapped PO(s)
Classify engineering materials and properties	Understand (C2)	PO1
Select materials for mechanical applications	Analyze (C4)	PO3
Analyze material failure mechanisms	Analyze (C4)	PO2
Apply material testing data to design decisions	Apply (C3)	PO4

MEC 400: Final Year Project (Semester One Phase)

CLO	Bloom's Level	Mapped PO(s)
Identify and define an engineering problem	Analyze (C4)	PO2
Apply engineering principles to project execution	Apply (C3)	PO1, PO3
Conduct independent technical analysis	Analyze (C4)	PO4
Communicate project progress effectively	Apply (C3)	PO7

AUTOMOTIVE ENGINEERING TECHNOLOGY OPTION

MEA 411: Vehicle Chassis and Body Technology

CLO	Bloom's Level	Mapped PO(s)
Explain chassis and body construction principles	Understand (C2)	PO1
Analyze structural behavior of vehicle chassis	Analyze (C4)	PO2
Evaluate vehicle safety and crashworthiness	Evaluate (C5)	PO6
Apply materials selection to chassis design	Apply (C3)	PO3

MEA 413: Automotive Air Conditioning Systems

CLO	Bloom's Level	Mapped PO(s)

Explain refrigeration principles in automotive AC	Understand (C2)	PO1
Analyze AC system performance	Analyze (C4)	PO2
Diagnose and service AC systems	Apply (C3)	PO5
Apply environmental regulations in servicing	Apply (C3)	PO6

MEA 414: Workshop Management

CLO	Bloom's Level	Mapped PO(s)
Manage workshop operations efficiently	Apply (C3)	PO8
Apply maintenance planning and cost control	Apply (C3)	PO8
Enforce safety and quality standards	Evaluate (C5)	PO6, PO8
Supervise technical personnel	Apply (C3)	PO8

MANUFACTURING ENGINEERING TECHNOLOGY OPTION

MEM 411: Metrology

CLO	Bloom's Level	Mapped PO(s)
Apply precision measurement techniques	Apply (C3)	PO4
Use metrological instruments accurately	Apply (C3)	PO5
Interpret limits, fits, and tolerances	Analyze (C4)	PO3
Perform quality inspection	Apply (C3)	PO4

MEM 412: Testing and Failure of Materials

CLO	Bloom's Level	Mapped PO(s)
Conduct mechanical material testing	Apply (C3)	PO4
Analyze material failure modes	Analyze (C4)	PO2
Apply non-destructive testing methods	Apply (C3)	PO4
Interpret test results for design improvement	Evaluate (C5)	PO3

MEM 413: Machine Elements Design II

CLO	Bloom's Level	Mapped PO(s)
Design machine elements under dynamic loading	Create (C6)	PO3
Analyze fatigue and reliability	Analyze (C4)	PO2
Apply design standards and codes	Apply (C3)	PO3
Evaluate life expectancy of components	Evaluate (C5)	PO3

MEM 415: CNC Programming and Robotics

CLO	Bloom's Level	Mapped PO(s)

Develop CNC programs for machining	Create (C6)	PO5
Operate and troubleshoot CNC machines	Apply (C3)	PO5
Explain fundamentals of industrial robotics	Understand (C2)	PO5
Apply automation concepts in manufacturing	Apply (C3)	PO3, PO5

PLANT ENGINEERING TECHNOLOGY OPTION

EEE 442: Electrical Power and Machines

CLO	Bloom's Level	Mapped PO(s)
Explain electrical power generation principles	Understand (C2)	PO1
Analyze operation of motors and transformers	Analyze (C4)	PO2
Apply motor control techniques	Apply (C3)	PO5
Apply electrical safety standards	Apply (C3)	PO6

MEP 411: Refrigeration and Air-Conditioning

CLO	Bloom's Level	Mapped PO(s)
Analyze refrigeration and AC cycles	Analyze (C4)	PO1
Design basic refrigeration/AC systems	Create (C6)	PO3
Perform installation and maintenance	Apply (C3)	PO5
Evaluate system efficiency	Evaluate (C5)	PO2

MEP 412: Mechanical Equipment in Buildings

CLO	Bloom's Level	Mapped PO(s)
Identify building mechanical equipment	Understand (C2)	PO1
Analyze operation of building services	Analyze (C4)	PO2
Apply installation codes and standards	Apply (C3)	PO6
Plan maintenance of building systems	Apply (C3)	PO8

HND II – SEMESTER TWO

CLO–PO Mapping with Bloom's Taxonomy Levels

MTH 422: Statistical Methods in Engineering

CLO	Bloom's Level	Mapped PO(s)
Apply probability and statistical concepts to engineering data	Apply (C3)	PO1
Analyze engineering data using statistical tools	Analyze (C4)	PO2

Apply quality control charts to processes	Apply (C3)	PO4
Interpret statistical results for engineering decisions	Evaluate (C5)	PO2

MEC 421: Quality Assurance

CLO	Bloom's Level	Mapped PO(s)
Explain quality concepts and standards	Understand (C2)	PO8
Apply quality management systems in industry	Apply (C3)	PO8
Conduct inspection and quality control activities	Apply (C3)	PO4
Implement continuous improvement strategies	Evaluate (C5)	PO8

MEC 422: Industrial Engineering

CLO	Bloom's Level	Mapped PO(s)
Apply work study and method engineering techniques	Apply (C3)	PO8
Analyze time and motion study data	Analyze (C4)	PO2
Incorporate ergonomics into system design	Apply (C3)	PO6
Optimize industrial operations	Evaluate (C5)	PO8

MEC 423: Materials Handling

CLO	Bloom's Level	Mapped PO(s)
Explain principles of materials handling systems	Understand (C2)	PO1
Select appropriate materials handling equipment	Apply (C3)	PO3
Design basic materials handling layouts	Create (C6)	PO3
Apply safety and cost optimization principles	Apply (C3)	PO6

MEC 424: Piping Design

CLO	Bloom's Level	Mapped PO(s)
Apply piping standards and codes	Apply (C3)	PO6
Design piping systems for industrial applications	Create (C6)	PO3
Analyze pressure losses and pipe stresses	Analyze (C4)	PO2
Select piping materials and components	Analyze (C4)	PO3

MEC 400: Final Year Project (Completion Phase)

CLO	Bloom's Level	Mapped PO(s)
Implement and complete an engineering project	Create (C6)	PO3
Analyze results and validate outcomes	Analyze (C4)	PO2, PO4
Prepare comprehensive technical reports	Create (C6)	PO7
Defend project work professionally	Evaluate (C5)	PO7, PO8

AUTOMOTIVE ENGINEERING TECHNOLOGY OPTION

MEA 421: Engine and Transmission Design

CLO	Bloom's Level	Mapped PO(s)
Design basic engine components	Create (C6)	PO3
Analyze transmission elements under load	Analyze (C4)	PO2
Select materials and lubrication systems	Analyze (C4)	PO3
Apply design standards and reliability principles	Apply (C3)	PO3, PO6

MEA 422: Automotive Tribology

CLO	Bloom's Level	Mapped PO(s)
Explain tribological principles	Understand (C2)	PO1
Analyze friction and wear mechanisms	Analyze (C4)	PO2
Select appropriate lubricants	Apply (C3)	PO3
Evaluate tribology-related failures	Evaluate (C5)	PO2

MEA 423: Vehicle Diagnosis and Maintenance

CLO	Bloom's Level	Mapped PO(s)
Diagnose mechanical and electronic faults	Analyze (C4)	PO2, PO5
Apply preventive and corrective maintenance	Apply (C3)	PO5
Use diagnostic tools and manuals	Apply (C3)	PO5
Implement safe maintenance practices	Apply (C3)	PO6

MEA 424: Transport Management

CLO	Bloom's Level	Mapped PO(s)
Explain principles of transport management	Understand (C2)	PO8
Analyze vehicle operating and maintenance costs	Analyze (C4)	PO8
Apply scheduling and routing techniques	Apply (C3)	PO8
Comply with transport regulations and safety	Apply (C3)	PO6, PO8

MANUFACTURING ENGINEERING TECHNOLOGY OPTION

MEM 421: Machine Tools System

CLO	Bloom's Level	Mapped PO(s)
Explain machine tool structures and functions	Understand (C2)	PO1
Analyze kinematics and drive systems	Analyze (C4)	PO2

Evaluate machine tool accuracy and rigidity	Evaluate (C5)	PO2
Apply maintenance and safety practices	Apply (C3)	PO6

MEM 422: Machine Tools Processes

CLO	Bloom's Level	Mapped PO(s)
Analyze machining processes	Analyze (C4)	PO2
Select cutting tools and machining parameters	Apply (C3)	PO3
Evaluate surface finish and dimensional accuracy	Evaluate (C5)	PO2
Optimize machining processes	Evaluate (C5)	PO3

MEM 423: Press and Cutting Tools Design

CLO	Bloom's Level	Mapped PO(s)
Design press and cutting tools	Create (C6)	PO3
Analyze forces in press operations	Analyze (C4)	PO2
Select tool materials and heat treatment	Analyze (C4)	PO3
Apply safety and tool-life considerations	Apply (C3)	PO6

MEM 424: Machine Assembly, Installation and Commissioning

CLO	Bloom's Level	Mapped PO(s)
Assemble mechanical systems to specification	Apply (C3)	PO3
Apply alignment and installation techniques	Apply (C3)	PO5
Conduct commissioning tests	Apply (C3)	PO4
Troubleshoot installation problems	Analyze (C4)	PO2

MEM 425: Jigs and Fixtures Design

CLO	Bloom's Level	Mapped PO(s)
Design jigs and fixtures	Create (C6)	PO3
Analyze locating and clamping systems	Analyze (C4)	PO2
Improve accuracy and productivity	Evaluate (C5)	PO3
Apply safety and cost considerations	Apply (C3)	PO6

PLANT ENGINEERING TECHNOLOGY OPTION

MEP 421: Process, Construction and Mining Equipment

CLO	Bloom's Level	Mapped PO(s)
Identify process and mining equipment	Understand (C2)	PO1
Analyze operating principles and performance	Analyze (C4)	PO2

Select equipment for applications	Apply (C3)	PO3
Apply safe operation and maintenance practices	Apply (C3)	PO6

MEP 422: Maintenance Management

CLO	Bloom's Level	Mapped PO(s)
Explain maintenance management principles	Understand (C2)	PO8
Develop maintenance plans and schedules	Create (C6)	PO8
Manage maintenance resources and spares	Apply (C3)	PO8
Evaluate maintenance performance	Evaluate (C5)	PO8

MEP 423: Power Plant Engineering

CLO	Bloom's Level	Mapped PO(s)
Explain power plant operating principles	Understand (C2)	PO1
Analyze energy conversion processes	Analyze (C4)	PO2
Evaluate plant performance and efficiency	Evaluate (C5)	PO2
Apply environmental and safety standards	Apply (C3)	PO6

MEP 424: Electro-Mechanical Controls

CLO	Bloom's Level	Mapped PO(s)
Explain electro-mechanical control principles	Understand (C2)	PO1
Analyze control circuits and system behavior	Analyze (C4)	PO2
Apply PLCs and control devices	Apply (C3)	PO5
Troubleshoot control system faults	Analyze (C4)	PO2, PO5

8. Minimum Required Workshop and Laboratory Equipment

A. Mechanical Engineering Workshop

- Centre lathes, milling machines, drilling machines
- CNC lathe and CNC milling machine
- Shaping, grinding, and slotting machines
- Welding equipment (arc, MIG, TIG, gas welding)
- Sheet metal tools and presses
- Fitting tools (vices, files, hacksaws, taps, dies)
- Heat treatment furnace
- Surface plate and marking tools
- Safety equipment (PPE, fire extinguishers, guards)

B. Materials and Metrology Laboratory

- Universal testing machine (UTM)
- Hardness testers (Brinell, Rockwell, Vickers)
- Impact testing machine
- Metallurgical microscope
- Vernier calipers, micrometers, height gauges
- Dial indicators and comparators
- Slip gauges and angle gauges

C. Thermo-Fluids Laboratory

- Heat engines test rigs (petrol and diesel engines)
- Refrigeration and air-conditioning test units
- Boilers and steam tables apparatus
- Centrifugal and reciprocating pumps test rigs
- Flow measurement devices (Venturi, orifice, rotameter)
- Air compressors and blowers

D. Instrumentation and Control Laboratory

- Pressure, temperature, flow, and level sensors
- Data acquisition systems
- Control trainers (PID, open/closed loop systems)
- MATLAB/Simulink-enabled computers

E. Automotive and Autotronics Laboratory

- Engine test benches
- Vehicle diagnostic scanners (OBD)
- Transmission and brake system trainers
- Automotive electrical and electronic trainers
- Hybrid/electric vehicle demonstration kits

F. CAD/CAM and Computing Laboratory

- Networked computers with licensed CAD/CAM software
- MATLAB, Simulink, SPSS, MS Project
- CNC programming and simulation software
- 3D printers and additive manufacturing tools

9. Graduation Requirements

- Successful completion of all prescribed courses
- Pass in SIWES and final year project
- Fulfilment of minimum credit requirements

10. Sydney Accord Alignment Statement

This BMAS ensures that HND Mechanical Engineering Technology graduates possess the

competencies, practical skills, and professional attributes required of Engineering Technologists, consistent with Sydney Accord standards and suitable for COREN and NBTE accreditation.

BENCHMARK MINIMUM ACADEMIC ND

PROFESSIONAL STANDARD

FOR

HIGHER NATIONAL DIPLOMA (HND)

IN

CIVIL ENGINEERING TECHNOLOGY

GENERAL INFORMATION

1.0 **CERTIFICATION AND TITLE OF THE PROGRAMME**:
The certificate to be awarded and the programme title shall read:

"HIGHER NATIONAL DIPLOMA IN CIVIL ENGINEERING TECHNOLOGY"

A transcript showing all the courses taken and grades obtained shall be issued on demand.

2. Programme Aim

The programme aims to produce graduates who can effectively support engineering operations in **manufacturing, automotive, power, oil and gas, construction, utilities, and allied industries**, and who can adapt to technological changes through continuous professional development.

3. Programme Educational Objectives

(HND Mechanical Engineering Technology)

The PEOs of the HND Mechanical Engineering Technology programme are:

PEO 1 – Engineering Technology Practice

Apply engineering technology principles, standards, and modern tools to install, operate, test, maintain, and improve engineering systems in industrial and service environments.

PEO 2 – Technical Problem Solving

Identify and solve broadly-defined engineering problems using practical skills, standard methods, manuals, codes, and established engineering practices.

PEO 3 – Professionalism, Safety, and Ethics

Demonstrate professional ethics, workplace safety consciousness, quality assurance, and compliance with industry regulations and standards.

PEO 4 – Teamwork, Communication, and Supervision

Work effectively as technologists, supervisors, or team leaders, and communicate technical information clearly through reports, drawings, and oral presentations.

PEO 5 – Career Development and Lifelong Learning

Engage in **continuous professional development**, certification, entrepreneurship, or further education to adapt to technological changes and career progression.

4. Programme Outcomes

- Graduates of the programme should be able to:
- **SA1:** Apply knowledge of mathematics, natural science, computing and engineering fundamentals and an engineering specialization as specified in SK1 to SK4 respectively to defined and applied engineering procedures, processes, systems or methodologies.
- **SA2:** Identify, formulate, research literature and analyze *broadly-defined* engineering problem searching substantiated conclusions using analytical tools appropriate to the discipline or area of specialization. (SK1 to SK4)
- **SA3:** Design solutions for *broadly-defined* engineering technology problems and *contribute to* the design of systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (SK5)
- **SA4:** Conduct investigations of *broadly-defined* engineering problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions (SK8)
- **SA5:** Select and apply, and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *broadly-defined* engineering problems (SK2 and SK6)
- **SA6:** When solving broadly-defined engineering problems, analyze and evaluate sustainable development impacts* to: society, the economy, sustainability, health and safety, legal frameworks, and the environment (SK1, SK5, and SK7)
- **SA7:** Understand and commit to professional ethics and norms of engineering technology practice including compliance with national and international laws. Demonstrate an understanding of the need for diversity and inclusion (SK9)
- **SA8:** Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (SK9)
- **SA9:** Communicate effectively and inclusively on *broadly-defined* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, taking into account cultural, language, and learning differences.

- **SA10:** Apply knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.

- SA11: Recognize the need for, and have the ability for i) independent and life-long learning and ii) critical thinking in the face of new specialist technologies (SK8

a. Goals and Objectives of the Programme:

The Higher National DIPLOMA Programme in Civil Engineering Technology is aimed at producing technologists with a good mastery of engineering knowledge and skill in executing civil engineering works.

The objectives, the HND diPOmates should be able to:

i. Design simple structural elements and prepare detailed drawings of such elements with minimum supervision;
ii. Carry out supervision and prepare progress reports on Civil Engineering works;
iii. Maintain comprehensive records of work-in-progress for the parties concerned.
iv. Carry out accurate interpretation of technical data related to Civil Engineering works;
v. Test, analyse and interpret the result of materials tested for Civil Engineering works
vi. Carry out engineering surveys
vii. Design simple transportation schemes and prepare working drawings for their construction;
viii. Supervise civil engineering construction works.
ix. Design simple water and waste water schemes and distribution networks;
x. Prepare Bill of Engineering Measurements and Evaluation (BEME) and specifications for Civil Engineering works;
xi. Operate and maintain water works, waste water and solid waste installation and irrigation projects;
xii. Carry out environmental engineering and pollution control studies;
xiii. Management of Engineering facilities with emphasis on maintenance.

5. ENTRY REQUIREMENTS:

a. Higher National DiPOma:

Applicants with all the following qualifications may be considered for admission into the Higher National DIPLOMA programmes by direct entry:

i. The entry requirement for the National DIPLOMA Programme.
ii. National DIPLOMA in Civil Engineering Technology with a minimum of lower credit pass; and
iii. A minimum of one- year Post-National DIPLOMA cognate work experience in the field of Civil Engineering including three months of certified computer training.

6. CURRICULUM

a. The curriculum of the HND programme consists of four main components. These are:
   i. General Studies/Education
   ii. Foundation Courses

iii. Professional Courses
iv. Student Projects.

b. The General Education component shall include courses in: Management Courses and Engineer in society. These are compulsory.

c. The General Education component shall account for not more than 5% of total contact hours for the programme.

d. **Foundation Courses** include courses in Geo-informatics, Engineering Drawing and Mathematics. The number of hours will vary with the programme and may account for about 15-20% of the total contact hours.

e. **Professional Courses** are courses which give the student the theory and practical skills he needs to practice his field of calling at the technician/technologist level. These may account for between 70-80% of the contact hours depending on the programme.

f. The student's projects shall be taken and graded during the second year of the programme.

7. CURRICULUM STRUCTURE

The structure of the HND programme consists of four semesters of classroom, laboratory and workshop activities in the college and a student project. Each semester shall be of 17 weeks duration made up as follows:

15 contact weeks of teaching, i.e lecture recitation and practical exercises, etc. and 2 weeks for tests, quizzes, examinations and registration. Project shall be submitted at the end of the second semester of the final year.

8. ACCREDITATION

The programme offered shall be accredited by the NBTE before the diPOmates shall be awarded the DIPLOMA certificate. Details about the process of accrediting a programme for the award of the ND or HND are available from the Executive Secretary, Programmes Department, National Board for Technical Education, POt 'B' Bida Road, P.M.B. 2239, Kaduna, Nigeria.

9. CONDITIONS FOR THE AWARD OF THE HND

Institutions offering accredited programmes will award the Higher National DIPLOMA to candidates who successfully complete the programme after passing prescribed course work, examinations, DIPLOMA project and the student project. Such candidates should have completed a minimum of between 90 and 100 semester credit units depending on the programme. DIPLOMA Certificates shall be awarded

based on the following classification:-

Distinction	-	CGPA 3.50 - 4.0
Upper Credit	-	CGPA 3.00 - 3.49
Lower Credit	-	CGPA 2.50 - 2.99
Pass	-	CGPA 2.00 - 2.49

10. GUIDANCE NOTES FOR TEACHERS TEACHING THE PROGRAMME

a. The new curriculum is drawn in unit courses. This is in keeping with the provisions of the National Policy on Education which stress the need to introduce the semester credit units which will enable a student who so wish to transfer the units already completed in an institution of similar standard from which he is transferring.

b. In designing the units, the principle of the modular system by product has been adopted; thus making each of the professional modules, when completed, provide the student with technician operative skills, which can be used for emPOyment purposes.

c. As the success of the credit unit system depends on the articulation of programmes between the institutions and industry, the curriculum content has been written in behavioural objectives, so that it is clear to all, the expected performance of the student who successfully completed some of the courses or the diPOmates of the programme. There is a slight departure in the presentation of the performance based curriculum which requires the conditions under which the performance is expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme to write their own curriculum stating the conditions existing in their institution under which the performance can take place and to follow that with the criteria for determining an acceptable level of performance. Departmental submission on the final curriculum may be vetted by the Academic Board of the institution. Our aim is to continue to see to it that a solid internal evaluation system exists in each institution for ensuring minimum standard and quality of education in the programmes offered throughout the polytechnic system.

d. The teaching of the theory and practical work should, as much as possible, be integrated. Practical exercise, especially those in professional courses and laboratory work should not be taught in isolation from the theory. For each course, there should be a balance of theory to practice depending on the course objectives and content.

HIGHER NATIONAL

DIPLOMA IN CIVIL ENGINEERING

TECHNOLOGY YEAR ONE
SEMESTER ONE

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
SUG 306	Engineering Survey II	1	0	3	2	4	SUG 208
CEC 301	Hydraulics	1	0	3	2	4	CEC 201
CEC 303	Concrete Technology	1	0	3	2	4	CEC 104
CEC 305	Theory of Structures II	2	1	0	3	3	CEC 205
CEC 307	Soil Mechanics II	1	1	3	3	5	CEC 212
CEC 309	Construction Technology	2	0	0	2	2	CEC 216
CEC 311	Civil Engineering Quantities & specifications	2	0	0	2	2	CEC 214
MTH 311	Advanced Algebra	2	0	0	2	2	MTH 112
CEC 313	Engineer in Society	2	0	0	2	2	-
CEC 315	Computer Aided Design Drafting in Civil Engineering	0	0	3	2	4	ICT 202
	TOTAL	**14**	**2**	**15**	**21**	**31**	

SEMESTER TWO

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
CEC 302	Hydrology and Hydrogeology	1	0	2	2	3	CEC 201
CEC 304	Water and Waste Water Engineering I	2	0	3	3	5	CEC 202
CEC 306	Design of structural Elements	1	1	2	3	4	CEC 206 & 305
CEC 308	Foundation Engineering	1	1	3	3	5	CEC 307
CEC 310	Advanced Construction Technology	2	0	0	2	2	CEC 309
CEC 312	Computer Aided Design & Drafting	0	0	3	1	3	ICT 302A
CEC 314	Transportation Engineering	2	0	2	3	4	CEC 204 & 307
GNS 413	Industrial Management	2	0	0	2	2	-
GIT 203	Database Creating and usage in Geo-Informatics	1	0	3	2	4	GIT 201
	TOTAL	**12**	**2**	**18**	**21**	**32**	

HIGHER NATIONAL

DIPLOMA IN CIVIL

ENGINEERING

TECHNOLOGY YEAR TWO
SEMESTER ONE

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
CEC 401	Project and Research Methods	1	0	5	2	6	

CEC 403	Statistical Methods in Engineering	2	1	0	3	3	
CEC 405	Advanced Reinforced and Pre-stressed Concrete Design	1	0	3	2	4	CEC 306
CEC 407	Foundation Design	2	1	1	3	4	CEC 308
CEC 409	Design in structural Steel & Timber	1	0	3	2	4	CEC 306
CEC 411	Traffic Engineering	2	0	0	2	2	CEC 314
CEC 413	Highway Engineering	2	0	2	3	4	CEC 314
CEC 417	Environmental Engineering and Pollution Control	2	0	3	3	5	CEC 304
CEC 421	Hydraulics Structures	2	1	0	3	3	CEC304 & 306
	TOTAL	**15**	**3**	**17**	**23**	**35**	

SEMESTER TWO

Course Code	Course Title	L	T	P	CU	CH	Prerequisite
CEC 402	Project	0	2	6	4	8	CEC 401
CEC 428	Engineering Management	2	0	0	2	2	-
CEC 412	Alternative Transportation System	2	1	0	3	3	CEC411& 413
CEC 414	Infrastructure Planning & Management	2	0	0	2	2	
CEC 424	Irrigation and Drainage	2	0	2	3	4	CEC425 & 417
CEC 426	Water and Waste Water Engineering II	2	0	0	2	2	CEC 304
		10	3	8	16	21	
	ELECTIVES						
CEC 406	Matrix and Energy Methods in Structures	2	0	1	2	2	CEC 305
CEC 410	Geotechnical Engineering	2	0	1	2	2	CEC 307& 308
CEC 422	Water Resources Management	2	0	1	2	2	-
CEC 416	Transportation Planning	2	0	1	2	2	CEC 314
	TOTAL	**12**	**3**	**9**	**18**	**24**	

Course Contents and Course Learning Outcomes

1 HND I – SEMESTER ONE

SUG 306: Engineering Survey II

Course Contents

- Advanced leveling and contouring
- Traversing: open and closed traverse
- Computation and adjustment of survey errors
- Tacheometry and applications
- Setting out of engineering works (roads, buildings, pipelines)

Course Learning Outcomes

1. Apply advanced leveling and traversing techniques to engineering surveys.

2. Compute and adjust survey measurements to minimize errors.
3. Use tacheometric methods for distance and elevation determination.
4. Set out civil engineering projects accurately on site.

CEC 301: Hydraulics

Course Contents

- Properties of fluids
- Fluid statics and pressure measurement
- Fluid kinematics and flow patterns
- Bernoulli's equation and energy losses
- Flow measurement in pipes and channels

Course Learning Outcomes

1. Explain fundamental properties and behavior of fluids.
2. Analyze fluid flow using continuity and energy equations.
3. Determine pressure forces and losses in pipe systems.
4. Apply flow measurement techniques in hydraulic systems.

CEC 303: Concrete Technology

Course Contents

- Properties and testing of cement and aggregates
- Concrete mix design methods
- Fresh and hardened concrete properties
- Concrete production, placing, curing, and quality control
- Special concretes and admixtures

Course Learning Outcomes

1. Identify and test materials used in concrete production.
2. Design concrete mixes to specified strength requirements.
3. Evaluate fresh and hardened concrete properties.
4. Apply quality control procedures in concrete works.

CEC 305: Theory of Structures II

Course Contents

- Analysis of statically indeterminate structures
- Continuous beams and frames

- Influence lines for indeterminate structures
- Slope-deflection and moment distribution methods

Course Learning Outcomes

1. Analyze indeterminate beams and frames using classical methods.
2. Apply moment distribution techniques to structural systems.
3. Interpret influence lines for structural analysis.
4. Evaluate internal forces in complex structural members.

CEC 307: Soil Mechanics II

Course Contents

- Shear strength of soils
- Consolidation and settlement analysis
- Bearing capacity theories
- Soil compaction and stabilization
- Laboratory and field soil tests

Course Learning Outcomes

1. Determine shear strength parameters of soils.
2. Analyze consolidation and settlement behavior of soil layers.
3. Evaluate bearing capacity of shallow foundations.
4. Interpret laboratory and field soil test results.

CEC 309: Construction Technology

Course Contents

- Construction materials and methods
- Site organization and temporary works
- Earthworks and foundation construction
- Building construction processes
- Health, safety, and environmental practices

Course Learning Outcomes

1. Describe construction methods for civil engineering projects.
2. Apply site organization and safety principles.
3. Identify appropriate construction techniques for building works.
4. Explain the use of materials in construction operations.

CEC 311: Civil Engineering Quantities and Specifications

Course Contents

- Principles of quantity surveying
- Measurement of building and civil works
- Bills of quantities preparation
- Specifications and contract documents
- Cost control fundamentals

Course Learning Outcomes

1. Measure quantities for basic civil engineering works.
2. Prepare simple bills of quantities.
3. Interpret engineering specifications and drawings.
4. Apply basic cost control principles in projects.

MTH 311: Advanced Algebra

Course Contents

- Matrices and determinants
- Systems of linear equations
- Vector algebra
- Eigenvalues and eigenvectors
- Applications in engineering problems

Course Learning Outcomes

1. Solve systems of equations using matrix methods.
2. Apply vector algebra to engineering applications.
3. Use eigenvalues in solving engineering problems.
4. Analyze algebraic models relevant to civil engineering.

CEC 313: Engineer in Society

Course Contents

- Role of engineers in society
- Professional ethics and responsibility
- Engineering laws and regulations
- Sustainable development concepts
- Health, safety, and environmental issues

Course Learning Outcomes

1. Explain the societal role and responsibilities of engineers.
2. Apply ethical principles in engineering practice.
3. Interpret basic engineering laws and regulations.
4. Relate engineering practice to sustainable development.

CEC 315: Computer Aided Design Drafting in Civil Engineering

Course Contents

- Introduction to CAD software
- Engineering drawing standards
- 2D drafting of civil engineering components
- Layering, dimensioning, and annotation
- POtting and file management

Course Learning Outcomes

1. Use CAD software for civil engineering drawings.
2. Produce standard 2D engineering drawings.
3. Apply dimensioning and annotation techniques.
4. Manage and present CAD drawings professionally.

HND I – SEMESTER TWO

CEC 302: Hydrology and Hydrogeology

Course Contents

- Hydrologic cycle and precipitation
- Runoff estimation and flood analysis
- Groundwater occurrence and flow
- Wells and aquifers
- Water resources assessment

Course Learning Outcomes

1. Explain hydrologic and hydrogeologic processes.
2. Estimate runoff and analyze flood events.
3. Evaluate groundwater flow and aquifer properties.
4. Apply hydrologic data in water resources planning.

CEC 304: Water and Wastewater Engineering I

Course Contents

- Water sources and quality standards
- Water treatment processes
- Distribution systems
- Introduction to wastewater characteristics
- Public health considerations

Course Learning Outcomes

1. Identify water sources and quality requirements.
2. Explain water treatment unit operations.
3. Describe water distribution systems.
4. Relate water supply to public health protection.

CEC 306: Design of Structural Elements

Course Contents

- Design philosophy and codes
- Design of beams, slabs, and columns
- Load estimation and combinations
- Structural detailing principles

Course Learning Outcomes

1. Apply design codes to structural elements.
2. Design basic reinforced concrete members.
3. Estimate loads acting on structures.
4. Prepare basic structural detailing drawings.

CEC 308: Foundation Engineering

Course Contents

- Types of foundations
- Site investigation methods
- Shallow and deep foundation analysis
- Bearing capacity and settlement
- Foundation construction methods

Course Learning Outcomes

1. Select appropriate foundation types for structures.
2. Interpret site investigation data.
3. Analyze bearing capacity and settlement.
4. Describe foundation construction techniques.

CEC 310: Advanced Construction Technology

Course Contents

- Modern construction methods
- Mechanized construction equipment
- Construction planning and scheduling
- Quality assurance and control
- Sustainable construction practices

Course Learning Outcomes

1. Explain modern construction techniques.
2. Select appropriate construction equipment.
3. Apply basic planning and scheduling methods.
4. Incorporate quality and sustainability principles in construction.

CEC 312: Computer Aided Design and Drafting

Course Contents

- Advanced CAD commands
- 3D modeling basics
- Civil engineering detailing
- CAD standards and collaboration
- Printing and presentation

Course Learning Outcomes

1. Produce advanced CAD drawings for civil works.
2. Develop basic 3D models of engineering components.
3. Apply CAD standards in documentation.
4. Present engineering drawings professionally.

CEC 314: Transportation Engineering

Course Contents

- Transportation systems and modes

- Highway planning principles
- Traffic characteristics and surveys
- Pavement materials and types
- Road safety fundamentals

Course Learning Outcomes

1. Describe components of transportation systems.
2. Analyze traffic flow characteristics.
3. Identify pavement materials and structures.
4. Explain basic road safety principles.

GNS 413: Industrial Management

Course Contents

- Principles of management
- Organizational structures
- Production and operations management
- Human resource management
- Industrial relations

Course Learning Outcomes

1. Explain basic management principles.
2. Describe organizational and production systems.
3. Apply management concepts to engineering organizations.
4. Understand human and industrial relations in industry.

GIT 203: Database Creating and Usage in Geo-Informatics

Course Contents

- Introduction to databases
- Data types and structures
- Database creation and management
- GIS data handling
- Applications in geo-informatics

Course Learning Outcomes

1. Create and manage basic engineering databases.
2. Apply database concepts to geo-informatics data.
3. Organize and retrieve spatial data efficiently.
4. Use databases for engineering decision support.

HND II – SEMESTER ONE

CEC 401: Project and Research Methods

Course Contents

- Nature and scope of engineering research
- Problem identification and formulation
- Literature review techniques
- Research methodology and data collection
- Technical report writing and referencing

Course Learning Outcomes

1. Identify and formulate civil engineering research problems.
2. Apply appropriate research methodologies to engineering studies.
3. Conduct literature reviews using standard sources.
4. Prepare structured technical research reports.

CEC 403: Statistical Methods in Engineering

Course Contents

- Probability concepts and distributions
- Descriptive and inferential statistics
- Regression and correlation analysis
- Hypothesis testing
- Applications in civil engineering

Course Learning Outcomes

1. Apply statistical techniques to engineering data.
2. Analyze experimental and field data using probability concepts.
3. Perform regression and correlation analyses.
4. Interpret statistical results for engineering decision-making.

CEC 405: Advanced Reinforced and Prestressed Concrete Design

Course Contents

- Design philosophy and codes of practice

- Analysis and design of reinforced concrete structures
- Prestressing principles and systems
- Design of prestressed concrete members
- Detailing and durability considerations

Course Learning Outcomes

1. Apply design codes to reinforced concrete structures.
2. Design prestressed concrete elements under service and ultimate loads.
3. Analyze structural behavior of reinforced and prestressed members.
4. Prepare structural detailing for concrete structures.

CEC 407: Foundation Design

Course Contents

- Advanced site investigation techniques
- Design of shallow foundations
- Design of pile and deep foundations
- Foundation settlement and stability analysis
- Construction and quality control

Course Learning Outcomes

1. Design shallow and deep foundations for civil structures.
2. Interpret geotechnical investigation data for foundation design.
3. Analyze settlement and stability of foundation systems.
4. Apply construction and quality control principles in foundation works.

CEC 409: Design in Structural Steel and Timber

Course Contents

- Properties of steel and timber
- Design philosophies and codes
- Design of steel beams, columns, and connections
- Design of timber structural members
- Structural detailing and fabrication

Course Learning Outcomes

1. Apply design codes to steel and timber structures.
2. Design basic steel structural members and connections.
3. Design timber elements for building applications.

4. Prepare detailing drawings for steel and timber structures.

CEC 411: Traffic Engineering

Course Contents

- Traffic flow theory
- Traffic surveys and data analysis
- Intersection design and control
- Traffic signs, signals, and markings
- Road safety and accident analysis

Course Learning Outcomes

1. Analyze traffic flow characteristics and parameters.
2. Conduct and interpret traffic surveys.
3. Design basic traffic control systems.
4. Evaluate road safety and accident data.

CEC 413: Highway Engineering

Course Contents

- Highway planning and alignment
- Pavement materials and design
- Construction of flexible and rigid pavements
- Highway drainage and maintenance
- Quality control in highway construction

Course Learning Outcomes

1. Explain highway planning and alignment principles.
2. Design basic highway pavement structures.
3. Apply construction methods for highway works.
4. Evaluate maintenance and quality control practices.

CEC 417: Environmental Engineering and Pollution Control

Course Contents

- Environmental systems and sustainability
- Air, water, and noise pollution

- Waste management techniques
- Environmental impact assessment (EIA)
- Pollution control regulations

Course Learning Outcomes

1. Identify sources and effects of environmental pollution.
2. Apply pollution control methods in engineering projects.
3. Conduct basic environmental impact assessments.
4. Interpret environmental regulations and standards.

CEC 421: Hydraulic Structures

Course Contents

- Dams and reservoirs
- Spillways and energy dissipators
- Weirs, barrages, and canals
- Hydraulic design principles
- Structural safety and maintenance

Course Learning Outcomes

1. Explain the functions of major hydraulic structures.
2. Apply hydraulic principles to the design of structures.
3. Analyze flow behavior in hydraulic installations.
4. Assess safety and maintenance requirements of hydraulic structures.

HND II – SEMESTER TWO

CEC 402: Project

Course Contents

- Selection of project topic
- Design, analysis, or experimental work
- Data collection and analysis
- Technical report preparation
- Oral presentation and defense

Course Learning Outcomes

1. Apply engineering knowledge to solve a practical civil engineering problem.

2. Conduct design or experimental analysis independently.
3. Prepare a comprehensive technical project report.
4. Present and defend project findings effectively.

CEC 428: Engineering Management

Course Contents

- Principles of engineering management
- Project planning and scheduling
- Cost estimation and control
- Quality management systems
- Risk and safety management

Course Learning Outcomes

1. Apply management principles to engineering projects.
2. Develop basic project plans and schedules.
3. Perform cost estimation and control.
4. Apply quality and risk management concepts.

CEC 412: Alternative Transportation Systems

Course Contents

- Overview of alternative transport modes
- Rail, inland waterways, and pipelines
- Non-motorized transportation systems
- Sustainable transportation concepts
- Comparative performance analysis

Course Learning Outcomes

1. Describe various alternative transportation systems.
2. Compare performance characteristics of transport modes.
3. Analyze sustainability aspects of transportation systems.
4. Recommend appropriate transport solutions for given scenarios.

CEC 414: Infrastructure Planning and Management

Course Contents

- Infrastructure systems and planning concepts
- Feasibility studies and appraisal
- Asset management and maintenance planning
- Public–private partnership (PPP) models
- Infrastructure policy and governance

Course Learning Outcomes

1. Explain infrastructure planning principles.
2. Conduct basic feasibility and appraisal studies.
3. Apply asset management concepts to infrastructure systems.
4. Evaluate infrastructure governance and policy issues.

CEC 424: Irrigation and Drainage

Course Contents

- Irrigation methods and systems
- Crop water requirements
- Design of irrigation canals and structures
- Surface and subsurface drainage
- Operation and maintenance of irrigation schemes

Course Learning Outcomes

1. Explain principles of irrigation and drainage.
2. Estimate crop water requirements.
3. Design basic irrigation and drainage systems.
4. Apply operation and maintenance practices in irrigation projects.

CEC 426: Water and Wastewater Engineering II

Course Contents

- Wastewater collection systems
- Sewage treatment processes
- Sludge treatment and disposal
- Effluent standards and reuse
- Operation and maintenance of treatment plants

Course Learning Outcomes

1. Explain wastewater collection and treatment processes.
2. Analyze sewage treatment unit operations.

3. Apply effluent standards to wastewater management.
4. Describe operation and maintenance of treatment facilities.

1. PROGRAMME OUTCOMES (POs)

HND Civil Engineering Technology

Graduates of the programme should be able to:

PO Code	Programme Learning Outcome
PO1	Apply mathematics, science, and engineering fundamentals to solve civil engineering problems.
PO2	Analyze and solve well-defined civil engineering problems using established methods.
PO3	Design civil engineering components and systems to meet specified requirements.
PO4	Conduct standard tests, measurements, and experiments and interpret results.
PO5	Use modern engineering tools, ICT, and software relevant to civil engineering practice.
PO6	Demonstrate professional ethics, safety consciousness, and societal responsibility.
PO7	Communicate technical information effectively using drawings, reports, and presentations.
PO8	Apply basic management and entrepreneurial principles in engineering practice.

2. HND I – SEMESTER ONE

CLO–PO Mapping with Bloom's Taxonomy

SUG 306: Engineering Survey II

CLO	Bloom's Level	Mapped PO(s)
Apply advanced leveling and traversing techniques	Apply	PO1, PO2
Compute and adjust survey errors	Analyze	PO2, PO4
Use tacheometric methods for measurements	Apply	PO4, PO5
Set out civil engineering works accurately	Apply	PO3, PO7

CEC 301: Hydraulics

CLO	Bloom's Level	Mapped PO(s)
Explain fundamental fluid properties	Understand	PO1
Analyze fluid flow using equations	Analyze	PO1, PO2
Determine pressure forces and losses	Apply	PO2

CLO	Bloom's Level	Mapped PO(s)
Apply flow measurement techniques	Apply	PO4, PO5

CEC 303: Concrete Technology

CLO	Bloom's Level	Mapped PO(s)
Identify and test concrete materials	Apply	PO4
Design concrete mixes	Apply	PO3
Evaluate concrete properties	Analyze	PO2
Apply quality control procedures	Apply	PO4, PO6

CEC 305: Theory of Structures II

CLO	Bloom's Level	Mapped PO(s)
Analyze indeterminate structures	Analyze	PO1, PO2
Apply moment distribution methods	Apply	PO2
Interpret influence lines	Analyze	PO2
Evaluate internal forces	Analyze	PO2, PO3

CEC 307: Soil Mechanics II

CLO	Bloom's Level	Mapped PO(s)
Determine soil shear strength	Apply	PO4
Analyze consolidation and settlement	Analyze	PO2
Evaluate bearing capacity	Analyze	PO2, PO3
Interpret soil test results	Analyze	PO4

CEC 309: Construction Technology

CLO	Bloom's Level	Mapped PO(s)
Describe construction methods	Understand	PO2
Apply site safety principles	Apply	PO6
Identify construction techniques	Understand	PO3
Explain material usage	Understand	PO1

CEC 311: Civil Engineering Quantities & Specifications

CLO	Bloom's Level	Mapped PO(s)
Measure quantities for works	Apply	PO2
Prepare bills of quantities	Apply	PO7
Interpret specifications	Analyze	PO7
Apply cost control principles	Apply	PO8

MTH 311: Advanced Algebra

CLO	Bloom's Level	Mapped PO(s)
Solve systems using matrices	Apply	PO1
Apply vector algebra	Apply	PO1
Use eigenvalues in problems	Apply	PO1
Analyze algebraic models	Analyze	PO2

CEC 313: Engineer in Society

CLO	Bloom's Level	Mapped PO(s)
Explain engineers' societal role	Understand	PO6
Apply ethical principles	Apply	PO6
Interpret engineering regulations	Understand	PO6
Relate engineering to sustainability	Analyze	PO6

CEC 315: CAD Drafting in Civil Engineering

CLO	Bloom's Level	Mapped PO(s)
Use CAD software	Apply	PO5
Produce engineering drawings	Apply	PO7
Apply dimensioning standards	Apply	PO7
Manage CAD files	Apply	PO5

3. HND I – SEMESTER TWO

CLO–PO Mapping with Bloom's Taxonomy

CEC 302: Hydrology and Hydrogeology

CLO	Bloom's Level	Mapped PO(s)
Explain hydrologic processes	Understand	PO1
Estimate runoff and floods	Apply	PO2
Evaluate groundwater systems	Analyze	PO2
Apply hydrologic data	Apply	PO3

CEC 304: Water & Wastewater Engineering I

CLO	Bloom's Level	Mapped PO(s)
Identify water sources and standards	Understand	PO1
Explain treatment processes	Understand	PO2
Describe distribution systems	Understand	PO3
Relate water supply to health	Analyze	PO6

CEC 306: Design of Structural Elements

CLO	Bloom's Level	Mapped PO(s)
Apply design codes	Apply	PO3
Design RC elements	Apply	PO3
Estimate structural loads	Apply	PO2
Prepare detailing drawings	Apply	PO7

CEC 308: Foundation Engineering

CLO	Bloom's Level	Mapped PO(s)
Select foundation types	Apply	PO3
Interpret site investigation data	Analyze	PO4
Analyze bearing capacity	Analyze	PO2
Describe construction techniques	Understand	PO3

CEC 310: Advanced Construction Technology

CLO	Bloom's Level	Mapped PO(s)
Explain modern techniques	Understand	PO2
Select construction equipment	Apply	PO3
Apply planning methods	Apply	PO8
Incorporate sustainability principles	Apply	PO6

CEC 312: Computer Aided Design & Drafting

CLO	Bloom's Level	Mapped PO(s)
Produce advanced CAD drawings	Apply	PO5, PO7
Develop 3D models	Apply	PO5
Apply CAD standards	Apply	PO7
Present drawings	Apply	PO7

CEC 314: Transportation Engineering

CLO	Bloom's Level	Mapped PO(s)
Describe transport systems	Understand	PO1
Analyze traffic characteristics	Analyze	PO2
Identify pavement structures	Understand	PO3
Explain road safety principles	Understand	PO6

GNS 413: Industrial Management

CLO	Bloom's Level	Mapped PO(s)
Explain management principles	Understand	PO8
Describe production systems	Understand	PO8
Apply management concepts	Apply	PO8

CLO	Bloom's Level	Mapped PO(s)
Understand industrial relations	Understand	PO6

GIT 203: Database Creating & Usage in Geo-Informatics

CLO	Bloom's Level	Mapped PO(s)
Create engineering databases	Apply	PO5
Apply databases to GIS data	Apply	PO5
Organize spatial data	Apply	PO4
Use databases for decision support	Analyze	PO2

1. PROGRAMME OUTCOMES (POs)

HND Civil Engineering Technology

PO Code	Programme Learning Outcome
PO1	Apply mathematics, science, and engineering fundamentals to solve civil engineering problems.
PO2	Analyze and solve well-defined civil engineering problems using established methods.
PO3	Design civil engineering components, systems, and processes to meet specified needs.
PO4	Conduct standard tests, investigations, and interpret engineering data.
PO5	Use modern engineering tools, ICT, and software relevant to civil engineering practice.
PO6	Demonstrate professional ethics, environmental awareness, safety, and societal responsibility.
PO7	Communicate effectively using engineering drawings, reports, and oral presentations.
PO8	Apply basic management, entrepreneurship, and project management principles.

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2. HND II – SEMESTER ONE

CLO–PO Mapping with Bloom's Taxonomy

CEC 401: Project and Research Methods

CLO	Bloom's Level	Mapped PO(s)
Identify and formulate research problems	Analyze	PO2
Apply appropriate research methodologies	Apply	PO4
Conduct literature reviews	Analyze	PO4
Prepare technical research reports	Create	PO7

CEC 403: Statistical Methods in Engineering

CLO	Bloom's Level	Mapped PO(s)
Apply statistical techniques to engineering data	Apply	PO1
Analyze experimental and field data	Analyze	PO2
Perform regression and correlation analyses	Apply	PO2
Interpret statistical results	Evaluate	PO2

CEC 405: Advanced Reinforced & Prestressed Concrete Design

CLO	Bloom's Level	Mapped PO(s)
Apply design codes to RC structures	Apply	PO3
Design prestressed concrete elements	Create	PO3
Analyze behavior of RC and PSC members	Analyze	PO2
Prepare structural detailing	Apply	PO7

CEC 407: Foundation Design

CLO	Bloom's Level	Mapped PO(s)
Design shallow and deep foundations	Create	PO3
Interpret geotechnical investigation data	Analyze	PO4
Analyze settlement and stability	Analyze	PO2
Apply construction quality control	Apply	PO6

CEC 409: Design in Structural Steel and Timber

CLO	Bloom's Level	Mapped PO(s)
Apply design codes for steel and timber	Apply	PO3
Design steel structural members	Create	PO3
Design timber structural elements	Create	PO3
Prepare structural detailing drawings	Apply	PO7

CEC 411: Traffic Engineering

CLO	Bloom's Level	Mapped PO(s)
Analyze traffic flow characteristics	Analyze	PO2
Conduct and interpret traffic surveys	Apply	PO4
Design basic traffic control systems	Create	PO3

CLO	Bloom's Level	Mapped PO(s)
Evaluate road safety performance	Evaluate	PO6

CEC 413: Highway Engineering

CLO	Bloom's Level	Mapped PO(s)
Explain highway planning principles	Understand	PO1
Design basic pavement structures	Create	PO3
Apply highway construction methods	Apply	PO3
Evaluate maintenance and quality control	Evaluate	PO6

CEC 417: Environmental Engineering & Pollution Control

CLO	Bloom's Level	Mapped PO(s)
Identify sources and effects of pollution	Understand	PO6
Apply pollution control methods	Apply	PO6
Conduct basic environmental impact assessments	Analyze	PO4
Interpret environmental regulations	Evaluate	PO6

CEC 421: Hydraulic Structures

CLO	Bloom's Level	Mapped PO(s)
Explain functions of hydraulic structures	Understand	PO1
Apply hydraulic principles in design	Apply	PO3
Analyze flow behavior in structures	Analyze	PO2
Assess safety and maintenance needs	Evaluate	PO6

3. HND II – SEMESTER TWO

CLO–PO Mapping with Bloom's Taxonomy

CEC 402: Project

CLO	Bloom's Level	Mapped PO(s)
Solve a practical engineering problem	Create	PO3
Conduct independent analysis or experimentation	Analyze	PO4
Prepare a comprehensive project report	Create	PO7

CLO	Bloom's Level	Mapped PO(s)
Present and defend project work	Evaluate	PO7

CEC 428: Engineering Management

CLO	Bloom's Level	Mapped PO(s)
Apply management principles to projects	Apply	PO8
Develop project plans and schedules	Create	PO8
Perform cost estimation and control	Apply	PO8
Apply quality and risk management	Apply	PO6, PO8

CEC 412: Alternative Transportation Systems

CLO	Bloom's Level	Mapped PO(s)
Describe alternative transport modes	Understand	PO1
Compare transportation system performance	Analyze	PO2
Analyze sustainability aspects	Analyze	PO6
Recommend suitable transport solutions	Evaluate	PO3

CEC 414: Infrastructure Planning & Management

CLO	Bloom's Level	Mapped PO(s)
Explain infrastructure planning principles	Understand	PO8
Conduct feasibility and appraisal studies	Analyze	PO2
Apply asset management concepts	Apply	PO8
Evaluate infrastructure governance issues	Evaluate	PO6

CEC 424: Irrigation and Drainage

CLO	Bloom's Level	Mapped PO(s)
Explain irrigation and drainage principles	Understand	PO1
Estimate crop water requirements	Apply	PO2
Design irrigation and drainage systems	Create	PO3
Apply operation and maintenance practices	Apply	PO6

CEC 426: Water & Wastewater Engineering II

CLO	Bloom's Level	Mapped PO(s)
Explain wastewater treatment processes	Understand	PO1
Analyze sewage treatment operations	Analyze	PO2
Apply effluent standards	Apply	PO6
Describe plant operation and maintenance	Apply	PO6

1. Laboratory and Workshop Equipment

General Facilities

- Engineering drawing tables and stools
- Workbenches with vices
- Computer lab with high-performance workstations
- Projectors and demonstration screens
- Safety equipment (first aid kits, fire extinguishers, PPE: helmets, gloves, goggles, boots)

Surveying Laboratory

- Total stations (electronic theodolite + EDM)
- Automatic levels and dumpy levels
- Tripods and levelling staffs
- Handheld GPS/GNSS units
- Plane tables with alidades
- Tacheometers
- Measuring tapes (metric, 30 m/50 m)
- Pegs and ranging rods
- Plumb bobs and clinometers
- Solar and magnetic compasses

Materials Testing Laboratory

Concrete and Masonry

- Compression testing machine (2000 kN or higher)
- Concrete mixer
- Concrete slump test apparatus
- Concrete sieves set
- Air content meter
- Flexural testing machine
- Moulds for concrete cubes/cylinders/slabs
- Vibrating table or poker vibrator

Cement and Aggregates

- Vicat apparatus
- Blaine air permeability apparatus
- Sieve shaker with standard sieves
- Los Angeles abrasion machine
- Aggregate impact tester
- Specific gravity apparatus
- Fineness modulus equipment

Soil Mechanics Laboratory

- Soil compaction apparatus (Proctor)
- Soil sieves and sieve shaker
- Atterberg limits apparatus
- Direct shear test machine
- Unconfined compression test machine
- Consolidation test apparatus
- Triaxial test set-up
- Permeability test rigs (constant/variable head)
- Moisture content cans and ovens

Hydraulics Laboratory

- Bernoulli's apparatus
- Flow measurement tanks and flumes
- Pipe flow rigs (with manometers)
- Weirs and orifice experimental setups
- Pump test rigs
- Reynold's apparatus
- Water storage and recirculation system

CAD / Computer Lab

- Licensed CAD and BIM software (AutoCAD, Civil 3D or equivalents)
- High-resolution monitors
- POtter/large-format printer
- Scanner for drawing digitisation
- External storage and backup servers

Structural Engineering Laboratory

- Beam testing frame with loading kit
- Strain gauges and data acquisition system
- Tension/compression testing machines
- Vernier calipers, micrometers
- Bolt and joint test rigs
- Material property kits (steel, timber)

Transportation/Highway Laboratory

- Wheel tracking test equipment
- Marshall stability apparatus
- Bitumen penetration, softening point, ductility test sets
- Aggregate classification and gradation tools
- Traffic counting and speed study equipment (counters, radar guns)

Water and Wastewater Engineering Laboratory

- Water quality testing kits (pH, turbidity, dissolved oxygen, conductivity)
- Jar test apparatus
- Filtration and sedimentation tanks (pilot setup)
- Sludge handling and dewatering rigs
- Bacteriological test sets (Coliform testing)
- Flow measurement devices (weirs, flumes)

Construction Technology Workshop

- Brick/block making machine
- Concrete block moulds
- Hand tools: trowels, spirit levels, plumb lines, hammers
- Portable power tools (drills, saws, grinders)
- Scaffolding demonstration setup
- Temporary works mock-ups

Engineering Management / Project Centre

- Project presentation boards
- Model display area
- Conference rooms with presentation systems

- Library access terminals

2. Suggested Textbooks and Reference Materials

Surveying

- *Elementary Surveying: An Introduction to Geomatics* — Wolf and Ghilani
- *Surveying and Leveling for Civil Engineers* — Kanetkar & Kulkarni
- *Engineering Surveying* — Moffit & Bossler

Strength of Materials and Structures

- *Mechanics of Materials* — Beer & Johnston
- *Structural Analysis* — Hibbeler
- *Reinforced Concrete Design* — Nilson, Darwin & Dolan

Concrete & Construction Materials

- *Concrete Technology* — A. M. Neville & J. J. Brooks
- *Properties of Concrete* — A. M. Neville
- *Construction Materials, Methods and Techniques* — Chudley & Greeno

Soil Mechanics & Geotechnical Engineering

- *Principles of Geotechnical Engineering* — Braja M. Das
- *Soil Mechanics in Engineering Practice* — Terzaghi, Peck & Mesri

Hydraulics, Hydrology & Water Engineering

- *Fluid Mechanics and Hydraulics for Engineers* — Finnemore & Franzini
- *Hydrology and Floodplain Analysis* — Bedient, Huber & Vieux
- *Water Supply and Sewerage* — Fair, Geyer & Okun

Transportation & Highway Engineering

- *Traffic Engineering* — Garber & Hoel
- *Principles of Highway Engineering and Traffic Analysis* — Mannering & Washburn

Environmental Engineering

- *Environmental Engineering: Fundamentals, Sustainability, Design* — Mackenzie Davis & David Cornwell
- *Wastewater Engineering: Treatment and Resource Recovery* — Metcalf & Eddy

CAD / Design

- *AutoCAD Civil 3D Fundamentals* — Ascent Training Guide

- *Engineering Drawing and Design* — D. A. Jolley

Management and Professional Studies

- *Construction Management: Principles and Practice* — Chitkara
- *Project Management for Engineering and Construction* — Peurifoy & Kerzner
- *Engineering Economy* — Blank & Tarquin

3. Optional Digital and e-Learning Resources

- AutoDesk Learning and Certification portal
- NPTEL/edX Civil Engineering courses
- BS/ASTM/ISO standards databases
- African Development Bank and World Bank manuals

BENCHMARK MINIMUM ACADEMIC ND PROFESSIONAL STANDARD

FOR

HIGHER NATIONAL DIPLOMA (HND)

IN

ELECTRICAL/ELECTRONIC ENGINEERING TECHNOLOGY

General Information

The Higher National Diploma (HND) programme in Electrical/Electronic Engineering Technology is designed to impart on the students specialised and useable skills in this field of Engineering. There are three options currently available in the programme, viz:-

(a) Electronics and Telecommunications
(b) Electrical Power and Machines
(c) Instrumentation and Control

A student is required to specialise in one option

GENERAL INFORMATION

2.0 **CERTIFICATION AND TITLE OF THE PROGRAMME**:

The certificate to be awarded and the programme title shall read:

"HIGHER NATIONAL DIPLOMA IN ELECTRICAL/ELECTRONIC ENGINEERING TECHNOLOGY"

A transcript showing all the courses taken and grades obtained shall be issued on demand.

2. Programme Aim

The programme aims to produce graduates who can effectively support engineering operations in **manufacturing, automotive, power, oil and gas, construction, utilities, and allied industries**, and who can adapt to technological changes through continuous professional development.

3. Programme Educational Objectives

(HND Electrical/Electronic Engineering Technology)

The PEOs of the HND Mechanical Engineering Technology programme are:

PEO 1 – Engineering Technology Practice

Apply engineering technology principles, standards, and modern tools to install, operate, test, maintain, and improve engineering systems in industrial and service environments.

PEO 2 – Technical Problem Solving

Identify and solve broadly-defined engineering problems using practical skills, standard methods, manuals, codes, and established engineering practices.

PEO 3 – Professionalism, Safety, and Ethics

Demonstrate professional ethics, workplace safety consciousness, quality assurance, and compliance with industry regulations and standards.

PEO 4 – Teamwork, Communication, and Supervision

Work effectively as technologists, supervisors, or team leaders, and communicate technical information clearly through reports, drawings, and oral presentations.

PEO 5 – Career Development and Lifelong Learning

Engage in continuous professional development, certification, entrepreneurship, or further education to adapt to technological changes and career progression**.**

11. Programme Outcomes

- Graduates of the programme should be able to:
- **SA1:** Apply knowledge of mathematics, natural science, computing and engineering fundamentals and an engineering specialization as specified in SK1 to SK4 respectively to defined and applied engineering procedures, processes, systems or methodologies.
- **SA2:** Identify, formulate, research literature and analyze *broadly-defined* engineering problem searching substantiated conclusions using analytical tools appropriate to the discipline or area of specialization. (SK1 to SK4)
- **SA3:** Design solutions for *broadly-defined* engineering technology problems and *contribute to* the design of systems, components or processes to meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required (SK5)
- **SA4:** Conduct investigations of *broadly-defined* engineering problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions (SK8)

- **SA5:** Select and apply, and recognize limitations of appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to *broadly-defined* engineering problems (SK2 and SK6)
- **SA6:** When solving broadly-defined engineering problems, analyze and evaluate sustainable development impacts* to: society, the economy, sustainability, health and safety, legal frameworks, and the environment (SK1, SK5, and SK7)
- **SA7:** Understand and commit to professional ethics and norms of engineering technology practice including compliance with national and international laws. Demonstrate an understanding of the need for diversity and inclusion (SK9)
- **SA8:** Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (SK9)
- **SA9:** Communicate effectively and inclusively on *broadly-defined* engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, taking into account cultural, language, and learning differences.
- **SA10:** Apply knowledge and understanding of engineering management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.
- SA11: Recognize the need for, and have the ability for i) independent and life-long learning and ii) critical thinking in the face of new specialist technologies (SK8

a. .

Electric Power and Machine

The programme is designed to produce Higher Technicians in Electrical Engineering for the manufacturing, power generation, transmission, distribution and utilization industries. On completion, the Diplomate should be able to:-

a. Solve practical problems in electrical engineering by analysis and experimentation;
b. Design complex electrical installation, wiring and circuit projects using appropriate connections;
c. Erect, assemble and install electrical equipment and system;
d. Prepare detailed bills of quantities and specifications related to electrical engineering works.
e. Commission and operate relevant equipment and installations

Instrumentation and Control

The programme is aimed to produce a higher technician in instrumentation and control who will be knowledgeable and skilful in the installation and repairs of instruments.

On completion of the programme, the Diplomate should be able to:

1. Assemble and install instrument and control systems
2. Design simple instrumentation and measuring systems;
3. Analyse and solve practical problems in analytical instruments and control systems

Entry Requirement

The general entry requirements for the HND programme include:

1. All the requirements for admission into the ND programme;
2. A minimum of lower credit pass (CGPA 2.50 and above) in the ND examination in Electrical/Electronic Engineering Technology;
3. A minimum of one year cognate work experience

1. Programme Outcomes (POs)

Graduates of HND Electrical/Electronics Engineering should be able to:

PO Code	Programme Outcome (PO)
PO1	Apply mathematics, science, and engineering fundamentals to solve electrical/electronic problems
PO2	Identify, analyze, and solve well-defined electrical/electronic engineering problems
PO3	Design basic electrical/electronic systems, components, or processes
PO4	Conduct experiments, measurements, and interpret engineering data
PO5	Use modern engineering tools, software, and equipment
PO6	Apply professional ethics, safety, and societal responsibilities
PO7	Communicate effectively through technical reports and presentations
PO8	Function effectively as an individual or team member in engineering tasks
PO9	Demonstrate entrepreneurship, management, and lifelong learning skills

2. Bloom's Taxonomy Levels (Reference)

Level	Description
BT1	Remember
BT2	Understand
BT3	Apply
BT4	Analyze
BT5	Evaluate
BT6	Create

Curriculum

The curriculum of the HND programmes consists of three main components: These are:

i. General Studies/Education
ii. Foundation Courses
iii. Professional Courses

The General Studies/Education component shall include courses in Communication Skills in English, Engineers in the Society, Industrial Management etc. The General Education component shall account for not more than 15% of the total contact hours for the programme.

Foundation Courses include courses in Mathematics and Statistics. The number of hours may account for about 10-15 percent of the total hours. The professional courses are courses which give the students the theory and practical skills he needs to practice his field of specialisation. They may account for between 60- 70 percent of the contact hours.

Curriculum Structure

The structure of the HND programme is similar to that of the ND except that SIWES at the end of the first year is not compulsory.

Accreditation

Each option of the programme shall be accredited by NBTE before the Diplomates can be awarded the Higher National Diploma Certificate. Details about the process of accrediting a programme for the award of the HND are available from the Executive Secretary, Programmes Division, National Board for Technical Education, POt B Bida Road, P. M. B. 2239, Kaduna.

Condition for the award of the HND

Institution offering accredited programmes will award the Higher National Diploma to candidates who successfully completed the programme after passing prescribed course work, examinations, and Diploma project. Such candidates should have completed a minimum of between 72 and 80 Semester Credit Units. Diploma shall be classified as follows:

1. Distinction:-GPA of 3.50 and above
2. Upper Credit:- GPA of 3.00 and 3.49
3. Lower Credit:- GPA of 2.50 and 2.99
4. Pass:- GPA of 2.00 and 2.49

5. Fail:- GPA of below and 2.00

Guidance Note for Teachers Teaching the Programme

The new curriculum is drawn in unit courses. This is in keeping with the provisions of the National Policy on Education which stress the need to introduce the semester credit units which will enable a student who so wish to transfer the units already completed in an institution of similar standard from which he is transferring.

In designing the units, the principle of the modular system by product has been adopted; thus making each of the professional modules, when completed provide the student with technician operative skills, which can be used for emPOyment purposes.

As the success of the credit unit system depends on the articulation of programmes between the institutions and industry, the curriculum content has been written in behavioural objectives, so that it is clear to all the expected performance of the student who successfully completed some of the courses or the Diplomates of the programme.

There is a slight departure in the presentation of the performance based curriculum which requires the conditions under which the performances are expected to be carried out and the criteria for the acceptable levels of performance. It is a deliberate attempt to further involve the staff of the department teaching the programme to write their own curriculum stating the conditions existing in their institution under which the performance can take place and to follow that with the criteria for determining an acceptable level of performance. Departmental submission on the final curriculum may be vetted by the Academic Board of the institution.

Our aim is to continue to see to it that a solid internal evaluation system exists in each institution for ensuring minimum standard and quality of education in the programmes offered throughout the Polytechnic system.

The teaching of the theory and practical work should, as much as possible, be integrated. Practical exercises, especially those in professional courses and laboratory work should not be taught in

isolation from the theory. For each course, there should be a balance of theory to practice in the ratio of 50:50 or 60:40 or the reverse.

Log book

A personal Log-book to be kept by the students shall contain all the day-to-day, weekly summary, and Semester Summary, or all the practical activities from day one to the end of the programme. This is to be checked and endorsed by the lecturers concerned at the end of every week

Curriculum Table

HND PROGRAMME IN ELECTRICAL ENGINEERING TECHNOLOGY

FIRST SEMESTER HND I

Course Code	Course Title	L	T	P	CU	CH
MTH 311	Advanced Algebra	2	1	-	3	3

SDV 210	Business Entrepreneurship	2	-	-	2	2
MEC 311	Engineer in Society	2	-	-	2	2
EEC 315	Electrical Material Science	2		-	2	2
EEI 311	Electrical Measurement and Control III	2	-	3	4	4
EEC 313	Electric Circuit Theory III	2	1	-	3	3
ICT 302	Computer Packages	2	-	3	5	5
EEE 314	Analogue Electronics III	2	-	2	5	5
	TOTAL	16	2	8	26	26

SECOND SEMESTER HND I

Course Code	Course Title	L	T	P	CU	CH
MTH 312	Advanced Calculus	2	1	-	3	3
GNS 413	Industrial Management	2	-	-	2	2
EEC 324	Testing Method and Reliability	2	-	-	2	2
EEC 325	Electrical Circuit Theory IV	2	-	-	3	3
EEP 328	Electrical Design and Drawing I	1	-	3	4	4
EEE 325	Digital Communication I	1	1	3	4	4
EEP 326	Electric Power Systems III	2	-	3	5	5
EEP 327	Electric Machines III	2	-	3	5	5
ICT 321	Data Communication and Networking	1	-	2	3	3
	TOTAL	15	2	14	31	31

INSTRUMENTATION AND CONTROL

THIRD SEMESTER HND II

Course Code	Course Title	L	T	P	CU	CH

EEI 435	Instrumentation Design and Drafting	1	-	3	4	4
EEI 437	Pneumatic Instrumentation	1	-	2	3	3
EEC 431	Electromagnetic Field Theory	2	-	-	2	2
MTH 321	Numerical Methods	2		-	2	2
EEE 435	Digital Communication II	1	-	3	3	3
EEE 434	Analogue Electronics IV	2	-	3	5	5
EEC 433	Control Engineering	2	-	3	5	5
EEI 431	Electrical Measurement and Control IV	1	-	2	3	3
EEC 437	Project	-	-	3	3	3
	TOTAL	12	-	19	31	31

FOURTH SEMESTER HND II

Course Code	Course Title	L	T	P	CU	CH
EEI 442	Electronic Instrumentation	1	-	2	3	3
EEI 444	Process Measurement	2	-	3	5	5
EEI 446	Instruments Maintenance and Repairs	-	-	3	3	3
MTH 313	Statistical Methods	2		-	2	2
ICT 301	Introduction to Computer Programming (C++)	1	-	3	4	4
EEC 447	Project	-	-	3	3	3
	TOTAL	6	2	14	20	20

ELECTRONICS AND TELECOMMUNICATION

THIRD SEMESTER HND II

Course Code	Course Title	L	T	P	CU	CH
MTH 321	Numerical Methods	2	-	-	2	2
EEC 431	Electromagnetic Field Theory	2	-	-	2	2
EEE 437	Electronic Design and Drafting	1	-	3	4	4
EEE 435	Digital Communication II	1	-	3	4	4
EEE 434	Analogue Electronic IV	2	-	3	5	5
EEI 431	Electronic Measurement & Control IV	1	-	2	3	3
EEE 438	Microprocessor Applications	1	-	3	4	4
EEC 433	Control Engineering System	2	-	3	5	5
EEC 437	Project	-	-	3	3	3
	TOTAL	12		20	32	32

FOURTH SEMESTER HND II

Course Code	Course Title	L	T	P	CU	CH
MTH 313	Statistical Methods	2	1	0	3	3
EEE 446	Electronic Maintenance & Repairs	-	-	4	4	4
EEE 445	Digital Communication III	2	-	3	5	5
EEE 447	Computer Hardware Maintenance & Repairs	-	-	2	2	2
ICT 301	Introduction to Programming (C++)	1	-	3	4	4
EEC 447	Project II	-	-	3	3	3
	TOTAL	5	1	15	2	2

POWER AND MACHINE

THIRD SEMESTER HND II

Course Code	Course Title	L	T	P	CU	CH
MTH 321	Numerical Methods	2	-	-	2	2
EEP 436	Electrical Power System IV	2	-	3	5	5
EEP 439	Electric Machines IV	2	-	3	5	5
EEP 438	Electrical Design & Drafting II	1	-	3	4	4
EEC 431	Electromagnetic Field Theory	1	1	-	2	2
EEC 433	Control Engineering	1	-	3	4	4
EEI 431	Electrical Measurement & Control IV	1	-	2	3	3
EEC 437	Project I	-	-	3	3	3
	TOTAL	10	1	17	28	28

FOURTH SEMESTER HND II

Course Code	Course Title	L	T	P	CU	CH
MTH 313	Statistical Methods	2	-	-	2	2
EEP 446	Electric Power System V	2	1	-	3	3
EEP 447	Electrical Machines V	2	-	3	5	5
EEP 444	Electrical Maintenance and Repairs	1	-	3	4	4
ICT 301	Introduction to Programming (C++)	1	-	3	4	4
EEC 447	Project II	-	-	3	3	3
	TOTAL	8	1	12	21	21

Computer Courses

Microprocessor Application

General Objective:

PRACTICALS

At the end of the course students will be able to:

1. Expand memory of a Computer
2. Design and Construct simple MPU based Controllers.
3. Assemble and Perform system setup of a Computer.

LIST OF PRACTICALS

WEEK

1 - 4 Design and Construction of Switching Circuits with Multiplexers 5 - 8 Memory Expansion

9 - 15 Design and Construction of MPU based PID Controllers

General Objectives:

On completion of this course, the student should be able to:-

1. Understand Structured logic Devices
2. Know the techniques of structured sequential logic Design
3. Distinguish between the various software systems available in the present day computer systems.
4. Know how the computer architecture is organised.
5. Understand a typical microprocessor structure and operation
6. Understand the internal structure and operations of the MC 6800 and 8080 A microprocessor units (MPUS) and their generations.

HND ELECTRICAL / ELECTRONICS ENGINEERING

COURSE CONTENTS AND COURSE LEARNING OUTCOMES (CLOs)

HND I – FIRST SEMESTER

MTH 311: Advanced Algebra

Course Content

- Complex numbers and applications in AC circuit analysis
- Matrices and determinants
- Systems of linear equations
- Eigenvalues and eigenvectors
- Vector algebra
- Laplace transforms and engineering applications

Course Learning Outcomes
Upon completion, students should be able to:

1. Apply complex numbers to analyze electrical engineering problems.
2. Solve systems of linear equations using matrix methods.
3. Use eigenvalues and eigenvectors in engineering applications.

4. Apply Laplace transforms to solve transient electrical circuits.

SDV 210: Business Entrepreneurship

Course Content

- Entrepreneurship concepts and enterprise development
- Business opportunity identification
- Business plan preparation
- Small and medium-scale enterprises (SMEs)
- Financial management and marketing basics
- Ethics and legal issues in business

Course Learning Outcomes
Students will be able to:

1. Explain fundamental principles of entrepreneurship.
2. Identify viable business opportunities in engineering practice.
3. Prepare a basic business plan for a technical enterprise.
4. Demonstrate understanding of ethical and legal business practices.

MEC 311: Engineer in Society

Course Content

- Role of engineers in societal development
- Professional ethics and responsibility
- Health, safety, and environmental considerations
- Sustainable development
- Engineering laws and regulations

Course Learning Outcomes
Students should be able to:

1. Explain the social responsibilities of engineers.
2. Apply professional ethics in engineering practice.
3. Assess health, safety, and environmental impacts of engineering projects.
4. Demonstrate awareness of engineering regulations and standards.

EEC 315: Electrical Material Science

Course Content

- Atomic structure and bonding
- Conducting, insulating, and semiconducting materials
- Magnetic materials
- Dielectric materials
- Material selection for electrical applications

Course Learning Outcomes
Students will be able to:

1. Classify electrical materials based on properties and applications.
2. Explain electrical, magnetic, and dielectric behavior of materials.
3. Select appropriate materials for electrical engineering applications.
4. Evaluate material performance under operating conditions.

EEI 311: Electrical Measurement and Control III

Course Content

- Measuring instruments and transducers
- Errors and calibration
- AC/DC bridges
- Control system fundamentals
- Sensors and signal conditioning

Course Learning Outcomes
Students should be able to:

1. Use electrical measuring instruments accurately.
2. Analyze sources of measurement errors and calibration techniques.
3. Apply transducers and sensors in measurement systems.
4. Explain basic control system concepts.

EEC 313: Electric Circuit Theory III

Course Content

- Network theorems
- AC circuit analysis
- Resonance in RLC circuits
- Power factor and power measurement
- Transient analysis

Course Learning Outcomes
Students will be able to:

1. Apply network theorems to circuit analysis.
2. Analyze AC circuits under steady-state conditions.
3. Evaluate resonance and power factor in electrical circuits.
4. Solve transient circuit problems.

ICT 302: Computer Packages

Course Content

- Operating systems
- Word processing
- Spreadsheets and data analysis
- Presentation software
- Engineering documentation

Course Learning Outcomes
Students should be able to:

1. Use computer packages for engineering documentation.
2. Perform basic data analysis using spreadsheets.
3. Prepare professional engineering reports and presentations.
4. Apply ICT tools effectively in academic and industrial environments.

EEE 314: Analogue Electronics III

Course Content

- Semiconductor devices
- Amplifier circuits
- Frequency response of amplifiers
- Oscillators
- Power amplifiers

Course Learning Outcomes
Students will be able to:

1. Explain the operation of semiconductor devices.
2. Design and analyze amplifier circuits.
3. Evaluate frequency response of electronic amplifiers.
4. Implement basic oscillator and power amplifier circuits.

HND I – SECOND SEMESTER

MTH 312: Advanced Calculus

Course Content

- Functions of several variables
- Partial differentiation
- Multiple integrals
- Vector calculus
- Engineering applications

Course Learning Outcomes
Students should be able to:

1. Apply calculus to solve engineering problems.
2. Use partial derivatives in electrical field analysis.
3. Evaluate multiple integrals in engineering applications.
4. Apply vector calculus in electromagnetic problems.

GNS 413: Industrial Management

Course Content

- Management principles
- Production planning and control
- Human resource management
- Quality assurance
- Industrial safety

Course Learning Outcomes
Students will be able to:

1. Explain basic industrial management principles.
2. Apply production planning and control techniques.
3. Demonstrate understanding of quality and safety management.
4. Function effectively in an industrial organizational setting.

EEC 324: Testing Method and Reliability

Course Content

- Electrical testing techniques
- Reliability concepts
- Failure analysis
- Quality control
- Standards and codes

Course Learning Outcomes
Students should be able to:

1. Perform standard electrical testing procedures.
2. Analyze reliability and failure rates of components.
3. Apply quality control techniques in electrical systems.
4. Interpret relevant electrical standards and codes.

EEP 328: Electrical Design and Drawing I

Course Content

- Electrical symbols and standards
- Wiring diagrams
- Installation drawings
- Layout and schematics
- CAD introduction

Course Learning Outcomes
Students will be able to:

1. Interpret electrical drawings and schematics.
2. Prepare basic electrical design layouts.
3. Apply electrical symbols and standards correctly.
4. Use drafting tools for electrical design documentation.

EEE 325: Digital Communication I

Course Content

- Overview of communication systems
- Analog and digital signals
- Sampling theorem and quantization
- Pulse modulation techniques (PAM, PWM, PPM)
- Pulse Code Modulation (PCM)
- Time Division Multiplexing (TDM)
- Introduction to noise in communication systems
- Basic digital communication laboratory experiments

Course Learning Outcomes (CLOs)

At the end of the course, students should be able to:

1. Explain the basic principles and components of digital communication systems.
2. Apply sampling and quantization techniques to analog signals.
3. Analyze pulse modulation and PCM systems.
4. Perform basic laboratory experiments on digital communication systems and interpret results.

EEP 326: Electric Power Systems III

Course Content

- Structure of electric power systems
- Power generation systems (thermal, hydro, gas)
- Transmission line parameters
- Per-unit system of calculations
- Power system components (generators, transformers, transmission lines)
- Load characteristics and load curves
- Power system protection basics
- Power system earthing

Course Learning Outcomes (CLOs)

Students should be able to:

1. Describe the structure and components of electric power systems.
2. Analyze power generation and transmission systems.
3. Apply the per-unit system in power system calculations.
4. Explain basic protection and earthing practices in power systems.

EEP 327: Electric Machines III

Course Content

- Review of AC machines
- Construction and principles of synchronous machines
- Synchronous generators and motors
- Starting and speed control of synchronous motors
- Losses and efficiency of AC machines
- Testing and performance characteristics
- Practical laboratory tests on AC machines

Course Learning Outcomes (CLOs)

On completion of the course, students should be able to:

1. Explain the construction and operating principles of synchronous machines.
2. Analyze performance characteristics of AC machines.
3. Conduct standard tests on electric machines.
4. Evaluate efficiency and losses in electric machines.

ICT 321: Data Communication and Networking

Course Content

- Fundamentals of data communication
- Data transmission media
- Network topologies and architectures
- OSI and TCP/IP models
- Switching and routing concepts
- Introduction to computer networks (LAN, MAN, WAN)
- Basic network configuration and troubleshooting

Course Learning Outcomes (CLOs)

Students should be able to:

1. Explain the fundamentals of data communication and networking.
2. Describe network models, topologies, and transmission media.
3. Analyze basic switching and routing concepts.
4. Perform simple network configuration and troubleshooting tasks.

HND II ELECTRICAL / ELECTRONICS ENGINEERING

COURSE CONTENTS AND COURSE LEARNING OUTCOMES (CLOs)

OPTION A: INSTRUMENTATION AND CONTROL

THIRD SEMESTER (HND II)

EEI 435: Instrumentation Design and Drafting

Course Content

- Principles of instrumentation design
- Instrument symbols and standards (ISA, ISO)
- Process and instrumentation diagrams (P&ID)
- Layout design of instrumentation systems
- Control panel and loop diagrams
- Computer-aided drafting for instrumentation

Course Learning Outcomes
Students should be able to:

1. Interpret standard instrumentation symbols and P&IDs.
2. Design basic instrumentation layouts for industrial processes.
3. Prepare control panel and loop diagrams.
4. Apply CAD tools for instrumentation drafting.

EEI 437: Pneumatic Instrumentation

Course Content

- Fundamentals of pneumatics
- Compressors and air preparation systems
- Pneumatic valves and actuators
- Pneumatic control circuits
- Industrial pneumatic applications

Course Learning Outcomes
Students will be able to:

1. Explain the principles of pneumatic systems.
2. Identify and select pneumatic components.
3. Design simple pneumatic control circuits.
4. Maintain pneumatic instrumentation systems.

EEC 431: Electromagnetic Field Theory

Course Content

- Electric and magnetic fields
- Gauss's, Faraday's, and Ampere's laws
- Maxwell's equations
- Electromagnetic waves
- Applications in electrical engineering

Course Learning Outcomes
Students should be able to:

1. Analyze electric and magnetic field phenomena.
2. Apply Maxwell's equations to engineering problems.
3. Explain electromagnetic wave propagation.
4. Relate field theory to practical electrical systems.

MTH 321: Numerical Methods

Course Content

- Errors and approximations
- Numerical solution of equations
- Interpolation and extrapolation
- Numerical differentiation and integration
- Applications in engineering analysis

Course Learning Outcomes
Students will be able to:

1. Apply numerical techniques to solve engineering problems.
2. Analyze errors in numerical computations.
3. Use numerical methods for differential equations.
4. Implement numerical solutions in engineering applications.

EEE 435: Digital Communication II

Course Content

- Digital modulation techniques
- Pulse code modulation
- Noise in digital systems
- Error detection and correction
- Digital transmission systems

Course Learning Outcomes
Students should be able to:

1. Explain digital modulation techniques.
2. Analyze noise effects in digital communication systems.
3. Apply error detection and correction methods.
4. Evaluate performance of digital transmission systems.

EEE 434: Analogue Electronics IV

Course Content

- Operational amplifiers
- Active filters
- Waveform generators
- Voltage regulators
- Analog integrated circuits

Course Learning Outcomes
Students will be able to:

1. Analyze operational amplifier circuits.
2. Design active filters and regulators.
3. Implement analog signal processing circuits.
4. Troubleshoot analogue electronic systems.

EEC 433: Control Engineering

Course Content

- Control system components
- Mathematical modeling of systems
- Transfer functions
- Stability analysis
- Feedback and control strategies

Course Learning Outcomes
Students should be able to:

1. Model dynamic systems mathematically.
2. Analyze stability of control systems.
3. Design basic feedback control systems.
4. Apply control strategies to engineering problems.

EEI 431: Electrical Measurement and Control IV

Course Content

- Advanced measurement techniques
- Digital measuring instruments
- Data acquisition systems
- Industrial control applications
- Instrumentation standards

Course Learning Outcomes
Students will be able to:

1. Use advanced electrical measuring instruments.
2. Apply data acquisition techniques.
3. Integrate measurement systems with control applications.
4. Interpret industrial instrumentation standards.

EEC 437: Project I

Course Content

- Project identification
- Literature review
- Methodology development
- Design and implementation
- Technical reporting

Course Learning Outcomes
Students should be able to:

1. Identify and define engineering problems.
2. Apply engineering principles to project design.
3. Execute practical engineering projects.
4. Produce structured technical reports.

FOURTH SEMESTER (HND II)

EEI 442: Electronic Instrumentation

Course Content

- Electronic measurement principles
- Transducers and sensors
- Signal conditioning circuits
- Industrial instrumentation systems

Course Learning Outcomes
Students will be able to:

1. Explain principles of electronic instrumentation.
2. Select appropriate sensors and transducers.
3. Design signal conditioning circuits.
4. Apply electronic instrumentation in industry.

EEI 444: Process Measurement

Course Content

- Measurement of temperature, pressure, flow, and level
- Process sensors
- Industrial measurement techniques
- Calibration methods

Course Learning Outcomes
Students should be able to:

1. Measure key industrial process variables.
2. Select suitable process sensors.
3. Apply calibration techniques.
4. Interpret process measurement data.

EEI 446: Instruments Maintenance and Repairs

Course Content

- Maintenance strategies
- Fault diagnosis
- Instrument repair techniques
- Preventive maintenance
- Safety practices

Course Learning Outcomes
Students will be able to:

1. Diagnose faults in instrumentation systems.
2. Perform maintenance and repairs on instruments.
3. Apply preventive maintenance strategies.
4. Observe safety procedures during maintenance.

MTH 313: Statistical Methods

Course Content

- Probability theory
- Statistical distributions
- Regression and correlation
- Quality control statistics

Course Learning Outcomes
Students should be able to:

1. Apply statistical tools to engineering data.
2. Analyze variability and uncertainty.
3. Perform regression and correlation analysis.
4. Apply statistics in quality control.

ICT 301: Introduction to Computer Programming (C++)

Course Content

- Programming fundamentals
- Control structures
- Arrays and functions
- File handling
- Engineering applications

Course Learning Outcomes
Students will be able to:

1. Write basic C++ programs.
2. Apply programming logic to engineering problems.
3. Use C++ for data processing.
4. Develop simple engineering software applications.

EEC 447: Project II

Course Content

- Final design implementation
- Testing and evaluation
- Documentation and presentation

Course Learning Outcomes
Students should be able to:

1. Complete an engineering design project independently.
2. Test and evaluate system performance.
3. Document technical work professionally.
4. Defend project outcomes effectively.

HND II – POWER AND MACHINES

Electrical / Electronics Engineering

THIRD SEMESTER (HND II)

MTH 321: Numerical Methods

Course Content

- Sources and types of numerical errors
- Root-finding methods (bisection, Newton–Raphson)
- Solution of simultaneous linear equations
- Numerical differentiation and integration
- Numerical solution of ordinary differential equations

- Engineering applications in power and machines analysis

Course Learning Outcomes (CLOs)

Upon completion of the course, students should be able to:

1. Apply numerical methods to solve engineering mathematical problems.
2. Analyze and estimate numerical errors in engineering computations.
3. Use numerical techniques to solve differential equations related to power systems.
4. Apply numerical tools to practical electrical engineering problems.

EEP 436: Electric Power Systems IV

Course Content

- Power system network representation
- Transmission line modeling (short, medium, long lines)
- Power flow and load flow analysis
- Power system faults and fault calculations
- Symmetrical components
- Stability concepts in power systems
- Practical laboratory analysis of power networks

Course Learning Outcomes (CLOs)

Students should be able to:

1. Model and analyze electric power transmission systems.
2. Perform power flow and fault analysis in power systems.
3. Apply symmetrical components in unbalanced system analysis.
4. Explain stability issues in electric power systems.

EEP 439: Electric Machines IV

Course Content

- Construction and principle of induction machines
- Three-phase induction motors
- Torque–slip characteristics
- Losses and efficiency of induction machines
- Starting and speed control methods
- Industrial applications of induction motors

Course Learning Outcomes (CLOs)

Students should be able to:

1. Explain the construction and operating principles of induction machines.
2. Analyze performance characteristics of induction motors.
3. Evaluate losses and efficiency in induction machines.
4. Apply suitable starting and speed control methods for industrial motors.

EEP 438: Electrical Design and Drafting II

Course Content

- Advanced electrical symbols and standards
- Power installation layouts
- Substation and switchgear drawings
- Cable sizing and routing
- Earthing and protection layouts
- Computer-aided electrical design (CAD)

Course Learning Outcomes (CLOs)

Students should be able to:

1. Prepare detailed electrical power installation drawings.
2. Apply electrical design standards and codes correctly.
3. Design substation and switchgear layouts.
4. Use CAD tools for electrical power system drafting.

EEC 431: Electromagnetic Field Theory

Course Content

- Electric field intensity and flux density
- Magnetic field concepts
- Faraday's and Ampere's laws
- Maxwell's equations
- Energy storage in electric and magnetic fields
- Applications in machines and power systems

Course Learning Outcomes (CLOs)

Students should be able to:

1. Analyze electric and magnetic field behavior.
2. Apply Maxwell's equations to electrical engineering problems.

3. Explain electromagnetic principles in electrical machines.
4. Relate field theory to power system applications.

EEC 433: Control Engineering

Course Content

- Control system components and classification
- Mathematical modeling of control systems
- Transfer functions and block diagrams
- Time-domain analysis
- Stability concepts
- Applications in power and machine control

Course Learning Outcomes (CLOs)

Students should be able to:

1. Model electrical and mechanical control systems.
2. Analyze stability and transient response of control systems.
3. Design basic control systems for electrical machines.
4. Apply control principles in power engineering applications.

EEI 431: Electrical Measurement and Control IV

Course Content

- Advanced electrical measurement techniques
- Digital measuring instruments
- Power and energy measurement
- Data acquisition systems
- Industrial measurement applications

Course Learning Outcomes (CLOs)

Students should be able to:

1. Use advanced instruments for electrical measurements.
2. Measure electrical power and energy accurately.
3. Apply data acquisition techniques in power systems.

4. Integrate measurement systems with control applications.

EEC 437: Project I

Course Content

- Project topic selection
- Problem definition and objectives
- Literature review
- Design methodology
- Implementation and testing
- Interim technical reporting

Course Learning Outcomes (CLOs)

Students should be able to:

1. Identify and define practical power engineering problems.
2. Apply engineering knowledge to project design.
3. Implement and test engineering solutions.
4. Prepare structured technical project reports.

FOURTH SEMESTER (HND II)

MTH 313: Statistical Methods

Course Content

- Probability concepts
- Random variables and distributions
- Sampling techniques
- Statistical inference
- Regression and correlation
- Quality control applications

Course Learning Outcomes (CLOs)

Students should be able to:

1. Apply statistical techniques to engineering data.
2. Analyze variability and uncertainty in measurements.
3. Perform regression and correlation analysis.
4. Apply statistical tools in quality and reliability analysis.

EEP 446: Electric Power Systems V

Course Content

- Power system planning and operation
- Economic dispatch of generation
- Power system control and monitoring
- Power system protection schemes
- Smart grid concepts
- Nigerian power system overview

Course Learning Outcomes (CLOs)

Students should be able to:

1. Explain power system planning and operational strategies.
2. Apply economic dispatch principles.
3. Analyze power system protection schemes.
4. Explain modern power system and smart grid concepts.

EEP 447: Electrical Machines V

Course Content

- DC machines construction and operation
- Characteristics of DC generators and motors
- Starting and speed control of DC motors
- Special electrical machines
- Applications in industrial drives

Course Learning Outcomes (CLOs)

Students should be able to:

1. Explain operating principles of DC machines.
2. Analyze characteristics of DC motors and generators.
3. Apply appropriate speed control techniques.
4. Evaluate industrial applications of electrical machines.

EEP 444: Electrical Maintenance and Repairs

Course Content

- Maintenance strategies (preventive, corrective)
- Fault diagnosis in power equipment
- Repair of motors, transformers, and switchgear
- Testing and commissioning
- Safety practices in maintenance

Course Learning Outcomes (CLOs)

Students should be able to:

1. Diagnose faults in electrical power equipment.
2. Perform maintenance and repair of electrical machines.
3. Apply testing and commissioning procedures.
4. Observe safety standards during electrical maintenance.

ICT 301: Introduction to Programming (C++)

Course Content

- Fundamentals of programming
- C++ syntax and structure
- Control statements
- Arrays and functions
- Simple engineering applications

Course Learning Outcomes (CLOs)

Students should be able to:

1. Write basic programs using C++.
2. Apply programming logic to engineering problems.
3. Use C++ for numerical and data processing tasks.
4. Develop simple programs for power engineering applications.

EEC 447: Project II

Course Content

- Final system design and implementation
- Performance testing and evaluation
- Technical documentation
- Oral presentation and defense

Course Learning Outcomes (CLOs)

Students should be able to:

1. Complete an independent power engineering project.
2. Test and evaluate system performance.
3. Produce professional technical documentation.
4. Defend engineering solutions orally and in writing.

HND I ELECTRICAL / ELECTRONICS ENGINEERING

COURSE-BY-COURSE CLO–PO MATRICES

MTH 311 – Advanced Algebra

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain complex numbers and algebraic concepts	PO1	BT2
CLO2	Apply matrix methods to engineering problems	PO1, PO2	BT3
CLO3	Analyze systems using eigenvalues and vectors	PO1, PO2	BT4
CLO4	Solve engineering problems using Laplace transforms	PO1, PO2	BT4

SDV 210 – Business Entrepreneurship

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain entrepreneurship principles	PO9	BT2
CLO2	Identify viable engineering business opportunities	PO9	BT3
CLO3	Develop a basic technical business plan	PO3, PO9	BT6
CLO4	Apply ethical and legal principles in business	PO6	BT3

MEC 311 – Engineer in Society

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain the role of engineers in society	PO6	BT2
CLO2	Apply professional ethics in engineering practice	PO6	BT3
CLO3	Analyze safety and environmental impacts	PO6	BT4
CLO4	Communicate societal responsibilities effectively	PO7	BT3

EEC 315 – Electrical Material Science

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Classify electrical materials	PO1	BT2
CLO2	Explain electrical and magnetic properties	PO1	BT2
CLO3	Select materials for electrical applications	PO2, PO3	BT3
CLO4	Evaluate material performance in service	PO2	BT5

EEI 311 – Electrical Measurement & Control III

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain measurement principles	PO1	BT2
CLO2	Use electrical measuring instruments	PO4	BT3
CLO3	Analyze measurement errors and calibration	PO4	BT4
CLO4	Apply sensors in control systems	PO3, PO5	BT3

EEC 313 – Electric Circuit Theory III

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain network theorems	PO1	BT2
CLO2	Analyze AC circuits	PO2	BT4
CLO3	Solve transient circuit problems	PO2	BT4
CLO4	Evaluate power and resonance conditions	PO2	BT5

ICT 302 – Computer Packages

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain basic computer applications	PO5	BT2
CLO2	Use software for data analysis	PO5	BT3
CLO3	Prepare engineering documents	PO7	BT3
CLO4	Apply ICT tools to engineering tasks	PO5	BT3

EEE 314 – Analogue Electronics III

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain semiconductor devices	PO1	BT2
CLO2	Analyze amplifier circuits	PO2	BT4
CLO3	Design basic electronic circuits	PO3	BT6
CLO4	Troubleshoot analogue circuits	PO2, PO5	BT4

MTH 312 – Advanced Calculus

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain multivariable calculus concepts	PO1	BT2
CLO2	Apply calculus in engineering analysis	PO1, PO2	BT3
CLO3	Analyze vector calculus problems	PO1	BT4
CLO4	Solve engineering field problems	PO2	BT4

GNS 413 – Industrial Management

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain management principles	PO9	BT2
CLO2	Apply production planning techniques	PO9	BT3
CLO3	Analyze quality and safety systems	PO6	BT4
CLO4	Work effectively in industrial teams	PO8	BT3

EEC 324 – Testing Methods & Reliability

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain electrical testing methods	PO1	BT2
CLO2	Perform electrical tests	PO4	BT3
CLO3	Analyze reliability and failures	PO2	BT4
CLO4	Apply standards and quality control	PO6	BT3

EEP 328 – Electrical Design & Drawing I

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Interpret electrical drawings	PO3	BT2
CLO2	Prepare basic electrical layouts	PO3	BT6
CLO3	Apply electrical symbols and standards	PO6	BT3
CLO4	Use drafting tools effectively	PO5	BT3

EEE 325 – Digital Communication I

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain digital communication principles	PO1	BT2
CLO2	Apply sampling and PCM techniques	PO1, PO2	BT3
CLO3	Analyze modulation and noise effects	PO2	BT4
CLO4	Conduct digital communication experiments	PO4, PO5	BT5

EEP 326 – Electric Power Systems III

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain power system structure	PO1	BT2
CLO2	Analyze generation and transmission	PO2	BT4
CLO3	Apply per-unit calculations	PO1, PO2	BT3
CLO4	Explain protection and earthing	PO6	BT3

EEP 327 – Electric Machines III

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain AC machine principles	PO1	BT2
CLO2	Analyze machine performance	PO2	BT4
CLO3	Conduct machine tests	PO4	BT3
CLO4	Evaluate efficiency and losses	PO2	BT5

ICT 321 – Data Communication & Networking

CLO	Course Learning Outcome	Mapped POs	Bloom's Level
CLO1	Explain data communication concepts	PO1	BT2
CLO2	Describe network models and media	PO1	BT2
CLO3	Configure basic networks	PO5	BT3
CLO4	Troubleshoot network faults	PO2, PO5	BT4

HND II – INSTRUMENTATION AND CONTROL

COURSE-BY-COURSE CLO–PLO MATRICES

Programme Learning Outcomes (PLOs) – Reference

PLO Code	Programme Learning Outcome
PLO1	Apply mathematics, science, and engineering fundamentals
PLO2	Identify, analyze, and solve well-defined engineering problems
PLO3	Design basic engineering systems and components
PLO4	Conduct experiments and interpret data
PLO5	Use modern engineering tools and equipment
PLO6	Apply ethics, safety, and professional responsibility
PLO7	Communicate effectively in technical contexts
PLO8	Work effectively as an individual or team member
PLO9	Demonstrate management, entrepreneurship, and lifelong learning skills

THIRD SEMESTER (HND II)

EEI 435 – Instrumentation Design and Drafting

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Interpret standard instrumentation symbols and P&IDs	PLO1	BT2
CLO2	Design basic instrumentation and control layouts	PLO3	BT6
CLO3	Prepare loop and control panel diagrams	PLO3, PLO5	BT6
CLO4	Apply CAD tools for instrumentation drafting	PLO5	BT3

EEI 437 – Pneumatic Instrumentation

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain principles of pneumatic systems	PLO1	BT2
CLO2	Identify and select pneumatic components	PLO2	BT3
CLO3	Design simple pneumatic control circuits	PLO3	BT6
CLO4	Maintain pneumatic instrumentation systems	PLO4, PLO6	BT3

EEC 431 – Electromagnetic Field Theory

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain electric and magnetic field concepts	PLO1	BT2
CLO2	Apply Maxwell's equations to engineering problems	PLO1, PLO2	BT3
CLO3	Analyze electromagnetic wave propagation	PLO2	BT4
CLO4	Relate field theory to instrumentation applications	PLO2	BT4

MTH 321 – Numerical Methods

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain numerical approximation techniques	PLO1	BT2
CLO2	Apply numerical methods to solve engineering equations	PLO1, PLO2	BT3
CLO3	Analyze numerical errors and stability	PLO2	BT4
CLO4	Use numerical tools for instrumentation problems	PLO5	BT3

EEE 435 – Digital Communication II

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain advanced digital communication concepts	PLO1	BT2
CLO2	Apply digital modulation techniques	PLO1, PLO2	BT3
CLO3	Analyze noise and error control schemes	PLO2	BT4
CLO4	Evaluate digital communication system performance	PLO2	BT5

EEE 434 – Analogue Electronics IV**CLO**	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain operational amplifier principles	PLO1	BT2
CLO2	Analyze analogue electronic circuits	PLO2	BT4
CLO3	Design analogue signal processing circuits	PLO3	BT6
CLO4	Troubleshoot analogue instrumentation circuits	PLO2, PLO5	BT4

EEC 433 – Control Engineering

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain control system components and concepts	PLO1	BT2
CLO2	Model dynamic control systems mathematically	PLO1, PLO2	BT3
CLO3	Analyze system stability and response	PLO2	BT4
CLO4	Design basic feedback control systems	PLO3	BT6

EEI 431 – Electrical Measurement and Control IV

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain advanced electrical measurement principles	PLO1	BT2
CLO2	Use digital instruments and DAQ systems	PLO4, PLO5	BT3
CLO3	Analyze measurement data and errors	PLO4	BT4
CLO4	Integrate measurement systems with control applications	PLO3, PLO5	BT3

EEC 437 – Project I

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Identify and define an instrumentation problem	PLO2	BT3
CLO2	Apply engineering principles to project design	PLO3	BT6
CLO3	Conduct experiments and analyze results	PLO4	BT4
CLO4	Prepare technical project documentation	PLO7	BT3

FOURTH SEMESTER (HND II)

EEI 442 – Electronic Instrumentation

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain electronic instrumentation principles	PLO1	BT2
CLO2	Select appropriate sensors and transducers	PLO2	BT3
CLO3	Design signal conditioning circuits	PLO3	BT6
CLO4	Apply electronic instrumentation in industry	PLO5	BT3

EEI 444 – Process Measurement

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain measurement of process variables	PLO1	BT2
CLO2	Select sensors for industrial processes	PLO2	BT3
CLO3	Apply calibration techniques	PLO4	BT3
CLO4	Interpret process measurement data	PLO4	BT4

EEI 446 – Instruments Maintenance and Repairs

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain maintenance strategies for instruments	PLO6	BT2
CLO2	Diagnose faults in instrumentation systems	PLO2	BT4
CLO3	Perform maintenance and repair procedures	PLO4, PLO5	BT3
CLO4	Apply safety practices during maintenance	PLO6	BT3

MTH 313 – Statistical Methods

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain probability and statistical concepts	PLO1	BT2
CLO2	Apply statistics to engineering data	PLO1, PLO2	BT3
CLO3	Analyze data using regression and correlation	PLO2	BT4
CLO4	Apply statistics in quality control	PLO6	BT3

ICT 301 – Introduction to Programming (C++)

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Explain basic programming concepts	PLO5	BT2
CLO2	Write simple C++ programs	PLO5	BT3
CLO3	Apply programming to engineering problems	PLO2, PLO5	BT3
CLO4	Develop simple engineering applications	PLO3, PLO5	BT6

EEC 447 – Project II

CLO	Course Learning Outcome	Mapped PLOs	Bloom's Level
CLO1	Implement a complete instrumentation project	PLO3	BT6
CLO2	Test and evaluate system performance	PLO4	BT5
CLO3	Prepare comprehensive technical documentation	PLO7	BT3
CLO4	Defend project outcomes professionally	PLO7, PLO8	BT5

List of Minimum Resources

COMPUTER TECHNOLOGY LABORATORIES

Additional facilities required for the computer technology option.

The following experimental logic modules are recommended.

Section A:

Introduction to Digital Circuits with the following experimental modules.

1. The logic checker/logic probes
2. The waveform or clock generation circuits
3. The pull-up circuit
4. The pull-down circuit
5. The push button switch module
6. The inverter circuit and their use in driving LEDs
7. The high/low signal display module
8. The numerical display Module using 7-segment display
9. Binary to 7-segment conversion module
10. Semi-conductor switch module
11. Digital counter circuit module

11 Binary to decimal conversion logic module
12 Debouncing circuits
13 Hexadecimal to binary conversion module
14 The latch module
15 One pulse generating circuits and power-up one-shorts
16 Flip-flops and registers
17 Presettable counter circuits
18 Adder circuits
19 Subtractor circuits
20 Combinatorial logic circuit components to facilitate Turth-Table NAND, NOR, EX-OR¸EX-NOR

21 An assortment of TTL, TTL/S C-MOS, P-MOS,& ECL logic Ics to facilitate students design and Implementation of registers, modulus counters and pattern generators.

Computer Maintenance workshop LAB/WORKSHOP EQUIPMENT

1.	Working mini computer	1
2.	Microcomputers (5 disused & 3 working)	8
3.	Models of vital areas of the mainframe computer system and peripherals e.g.:	
i.	Tape read/write heads	2
ii.	Erase head	2
iii.	Write head	2
iv.	Read head	2
4.	Disk drive head and carriage assembly	3
5.	Disk packs	10
6.	Disk drive machines	1
7.	Printers	2
8.	POtters	1 old
9.	Tape reels	5
10.	Computer motor	variety
11.	Scanners	
12.	Digitizel	

DIGITAL SYSTEMS AND MICROPROCESSORS LABORATORY REQUIREMENTS

1. Structured Logic Devices: An assortment of:
a. 1-out of 2 multiplexers
b. 1-out of 4 multiplexers
c. 1-out of 8 multiplexers
d. 1-out of 16 multiplexers
e. 1-to-2 line decoder/demultiplier
f. 2-to-4 line decoder/demultiplier
g. 3-to-8 line decoder/demultiplier
h. 4-to-16 line decoder/demultiplier
2. An assortment of Erasable and Re-programmable Read Only Memories of different memory storage capacities.
3. An assortment of Field Programmable Logic Arrays (FPLAs) to facilitate use in experiments.
4. An assortment of Photo-electric devices: photo-transistors, diacs, photo-thyristors, slotted opto-couples, source/sensor pairs.

Interface modules for practical as follows:

5. Melody module	2
6. Amplifier module	3
7. Speaker module	3
8. Optical switch module	3
9. Relay module	2
10. Piezoelectric buzzer module	2
11. The symbol display module	2
12. The sound module	2
13. Variable width one-shot pulse module	1
14. The DC motor module	1
15. The AC motor module	1
16. The stepper motor module	1
17. Temperature sensor module	2
18. The digital comparator module	2
19. Analogue comparator module	1
20. Digital to Analog converter module	2

21. Analog to digital converter module	1
22. Digital thermometer module	1
23. Music synthesizer module	1
24. Digital revolution counter	1
25. Digital clock module	1
26. One-clip microcomputer digital temperature Controller	1
27. Bare-board (not enclosed) microcomputer trainer kits	3
28. Wire wrap guns	3
29. Wire wrap boards	3
30. Hand tools: cutters, pliers, wire strippers, assorted screw-drivers, etc.	
31. An assortment of edge connectors	
32. Soldering stations	1

TOOLS	
1. Logic pulser	5
2. Logic probe	5
3. Logic clips	5
4. Volt-Ohmmeter	5
5. Digital voltmeter	5
6. Oscilloscopes	5
7. Current tracers	-
8. Logic analysers	5 (various models)
9. Diskette aligners	2

MEASUREMENT AND INSTRUMENTATION WORKSHOP

(Control & Instrumentation Option Only)

1. Electric Furnace for Temperature Instrument 1 set
2. Adjustable drawing table 1 set
3. Oil Bath 1 set
4. Oven 1 set
5. Oscilloscope 2 sets
6. Portable Digital Multimeter 1 set
7. Digital Thermometer 1 set
8. Digital Thermometer (type 2804 or equivalent) 1 set
9. Digital Manometer 4 sets
10. D. C. Power Supplies 2 sets
11. Electronic Universal Counter 1 set
12. Digital LCR Meter 2 sets
13. Function Generator 1 set
14. Wheatstone Bridge 1 set
15. Cold Junction Boxes 2 sets
16. PH meter checker 1 set
17. Conductivity meter with cell 1 set
18. Slide Resistors 7 sets
19. Direct reading clip on current mete. 2 sets
20. Circuit tester 3 sets
21. Slidacs model SD-2620S (variacs) 2 sets
22. Slidacs model SD-2610S 2 sets
23. Slidacs model SD-1320S 2 sets
24. Slidacs model SD-135S 2 sets
25. Slidacs model SD-135S 2 sets
26. Portable Tachometer Generator 6 sets

27. Vibration detector 1 set
28. Megger 1 set
29. manual Optical Radiation Pyrometer 1 set
30. Portable circuit tester (multimeters) 20 sets
31. Universal Battery Charger 2 sets
32. Vacuum Pressure guage tester 1 set
33. Dead weight tester 1 set
34. Pnuematic pressure test pump 2 sets
35. Vernier calipers 4 sets
36. Outside calipers 4 sets
37. Inside calipers 4 sets
38. Inside micrometers 6 sets
39. External micrometers 6 sets
40. Platform beam scale with weights 1 set
41. Scoop type beam scale 1 set
42. Thermometers 0 - 100oC 15 sets
43. Standard mercury thermometer set 15 sets
44. Stop watches 4 sets
45. Time limited hand tachometers 4 sets
46. Stainless steel measuring tapes 2 sets
47. Stainless steel compass 2 sets
48. Stainless steel rules 4 sets
49. Thickness gauges set 4 sets
50. Automatic rewind and lock tape rules 2 sets
51. Precision levels 1 set
52. Aneroid barometer 1 set
53. Plunger pump for pressure test 1 set
54. Han pump for pressure test 3 sets
55. Buffer tank for pressure test pump 1 set
56. Bakery compressor 2 sets
57. Carriers (carts) 600kg 2 sets
58. Pump for control value leakage test 1 set
59. Carriers (carts) 800kg 2 sets
60. V blocks with clamp 2 sets
61. Portable Electric drills 2 sets
62. Portable Electric grinders 3 sets
63. Bench type drilling machine 1 set
64. Bench type grinder with mounting frame 2 sets
65. Straight shank drills 48 sets
66. Drill stand for drill 4 sets
67. Machinist bench vices 3 sets
68. Pipe vice with legs 3 sets
69. Pin vises 3 sets
70. Metal reel with cable 3 sets
71. Steel wire ropes 4 sets
72. Hemp ropes 2 sets
73. Nylon ropes 2 sets
74. Vinyl hose 100 meters
75. Ladder slide type 1 set
76. Ladder step type 1 set

77. Lever grease injectors 3 sets
78. ½ inch square drive socket wrench sets 20 sets
79. ½ inch square drive preset type torque wrenches 7 sets
80. Pipe wrenches 10 sets
81. Adjustable spanner 12 sets
82. Non sparking pipe wrenches 8 sets
83. Non sparking adjustable wrenches 3 sets
84. Hand type dice & wrench sets 180mm size 3 sets
85. Hand type dice & wrench sets W size 3 sets
86. Hand type dice & wrench sets UNF size 3 sets
87. T handle wrenches with ratchet 5mm 3 sets
88. T handle wrenches with ratchet 6mm 3 sets
89. T handle wrenches with ratchet 9mm 3 sets
90. Pipe taps dice and wrench sets NPT 3 sets
91. Hexagon wrench key sets mm 10 sets
92. Hexagon wrench key sets inch5 sets
93. 12-points double offset box wrenches 27 sets
94. T type wrench sets 20 sets
95. Y type wrench sets 20 sets
96. Open ended spanners 33 sets
97. Ring shock spanner 15 sets
98. Combination slip joint pliers 10 sets
99. Heavy duty pump pliers 5 sets
100. Insulated long nose pliers with slide cutter 5 sets
101. Insulated side cutting pliers 200mm 5 sets
102. Side cutting pliers 200mm 4 sets
103. Terminal climping tools 4 sets
104. Insulated combination wire stripping nippers 5 sets
105. Diagonal cutters 5 sets
106. Wire strippers kits with blades5 sets
107. Impact type screw drivers (190mm) 5 sets
108. Impact type screw drivers (240mm) 5 sets
109. Box drivers 60 sets
110. Miniature precision screw drivers 10 sets
111. General purpose screw drivers10 sets
112. Stubby drivers (+) & (-) 20 sets
113. Insulated screw drivers (+) & (-) 40 sets
114. Screw drivers (non sparking tool) (+) * (-) 36 sets
115. Pipe cutter for copper tube 20 sets
116. Gasket cutters 2 sets
117. Glass cutter 1 set
118. Scissors 5 sets
119. Tinners scissors 5 sets
120. Hacksaw frames with 30 blades 3 sets
121. Holes saws 20 sets
122. Pipe cutter for steel pipe 1 set
123. Hi duty tube cutters (with spare wheel) 2 sets
124. Cold chisels 8 sets
125. Concrete hand chisels 4 sets
126. Cold chisels (non sparking) 20 x 200 4 sets

127. Cold chisels (non sparking) 27 x 200 4 sets
128. Chisels for woodwork (small) 2 sets
129. Chisels for woodwork (large) 2 sets
130. Centre punch sets 10 sets
131. Number figure punches set 5 sets
132. Letter punch sets 5 sets
133. Machinist hammers with handle 450kg 3 sets
134. Machinist hammers with handle 675kg 3 sets
135. Machinist hammers with hand 900kg 3 sets
136. Plastic head mamers 20mm 1 set
137. Plastic head hammers 35mm 1 set
138. Plastic head hammers 50mm 1 set
139. Needle file sets 5 sets
140. Machinist files 10 sets
141. Wood hammers 5 sets
142. Hammers with handle non sparking 16 sets
143. Machinist files (smooth) 10 sets
144. Small bench anvils 2 sets
145. Gasoline torches 2 sets
146. Oil stones fine 1 set
147. Oil stones coarse 1 set
148. Oil stones medium 1 set
149. Pipe benders 3 sets
150. ½ inch square drive deep sockets 8 sets
151. Oster type die stock with ratche 2 sets
152. Super fine set of needle files 10 sets
153. Wooden file handles 10 sets
154. Electric soldering iron with vacuum pump 2 sets
155. Taper pin reamer sets 2 sets
156. Reburring reamers for vinyl pipe
157. 1/8" - 11/4" 2 sets
158. ½" - 2" 2 sets
159. Washing pans 10 sets
160. Universal pulling & lifting machine 2 sets
161. Spar geared chain hoists (2.5m) 2 sets
162. Spar geared chain hoists (3m) 2 sets
163. Hand magnets with switch 5 sets
164. Screw shackles 10 sets
165. Hydraulic oil jacks 2 sets
166. Flaring tools for copper with case 2 sets
167. Universal fibre scope 1 set
168. Transformer 230/100-115-120 V IKVA 20 sets
169. C-Type screw clamps 2 sets
170. Vises for drilling machine 2 sets
171. ½" square drive rachet socket handles 5 sets
172. Cotton gloves 8 sets
173. Rubber gloves 8 sets
174. Leather gloves 8 sets
175. Goggle with adjustable head band 20 sets
176. Automatic rewind and lock tape rules 20 sets

177. Insulated screw driver sets 20 sets
178. Knives for Electricians20 sets
179. Adjustable wrenches (20mm) 20 sets
180. Insulated side cutting pliers 20 sets
181. Insulated long nose pliers with side cutter 20 sets
182. Insulated combination wire stripping nippers 20 sets
183. Tweezers 20 sets
184. Rosin core solder for electronic/electric components 20 sets
185. Electric soldering iron sets with vacuum pump 20 sets
186. Hexagon wrench key sets 20 sets
187. Steel tool boxes 20 sets
188. Heavy duty pump pliers 20 sets
189. Pipe wrenches 20 sets
190. Overhead stand 9 sets
191. New clamp 14 sets
192. Steel spanner 32 sets
193. Check meter for D.P. cell 3 sets
194. Air connection set 10 sets
195. Manometer 2 sets
196. Mechanical tool set 10 sets
197. Electrical tool set 10 sets
198. Series service kit 10 sets
199. Tool set 10 sets
200. Control relay calibration tool 2 sets
201. Standby manual control station 5 sets
202. Circlip pliers/snap ring pliers 10 sets
203. Vacuum blower 2 sets
204. Gear-puller 2 sets
205. D.P. Cell Assorted
206. Used Instrument (Assorted)
207. Used generators (Assorted)
208. Compound gauges Assorted
209. Coil winding equipment
210. Selective level meter 5 sets
211. Digital phase meters 10 sets
212. Used power transformers Assorted
213. Training stand for level 4
214. Training stand for pressure control 4
215. Training stand for rate & flow 2

List of Books (ND & HND)

Recommended List of Books for Electronics:

1. Operational Amplifiers - G.B. Clayton
2. Advance Industrial Electronics - Morris
3. Digital Integrated Electronics - Taub & Schilling
4. Integrated Electronics - Millman - Halkias
5. Introduction to Switching Theory and Logical Design - F.J. Hill, G.R. Peterson
6. Introduction to Digital Computer Technology - Mashelsky
7. Systematic Analogue Computer Programme - Charleswor Fletcher.

Radar and Wave

1. Radar Detection and Tracking System - S. A. Hovanessian
2. Introduction to Radar System - Skoluik
3. Foundation of Microwave Engineering - Collin
4. Microwave Transmission - J. A. Staniforth

Communication Engineering

1. Transmission Systems - M. T. Hills, B.G. Evans
2. Telecommunication - Brown & Glazier
3. Electronics & Radio Engineering - Terman
4. Electronics Communication System - Kennedy
5. Principles of Communication System - Taub & Schilling
6. Radio & Line TX A & B - D. C. Green
7. Principles of Digital Communication G. J. - Marshall
8. Signal Processing, Modulation and Noise - Betts.
9. Electrical Communication - Meadow
10. Signals, Antena, Wave Transmission, Noise, Modulation - F. R. Connors.

Recommended List of Books for Circuit Theory

1. Circuit Devices and Systems - Smith
2. Telecommunication Principles for final students 1 & 2 - Knight
3. Advanced Electrical Engineering - Morton
4. Problems in Electrical Circuit Theory - R. G. Meadows
5. Network Analysis and Synthesis - KUO
6. Higher Electrical Engineering - Shepherd, Morton, Spence.
7. Networks - By F.R. Connor
8. Circuit Theory - Vol. 1 & 2
9. Electrical Technology - E. Hughes.

Electrical Machines

1. Electrical Machinery - Fritzgerald and Kuo
2. Electrical Machines - Drapper
3. Alternating Current Machine - M. G. Say
4. Direct Current Machine - M.G. Say and E. O. Taylor

5. Introduction to Electrical Machines - Daniel
6. Electrical Technology (ND only) - Hughes
7. Higher Electrical Engineering by Shepherd, Morton, Spence

Electrical Power Engineering

1. Electric Power Systems (Third Ed.) - B. M. Weedy
2. Electrical Power Systems, Vols. I & II - A. E. Guile & W. Paterson
3. Electric Power Transmission and Distribution - P. J. Freeman
4. Generation, Transmission and Utilization of Electrical Energy - A. T. Starr
5. Transmission and Distribution of Electrical Power - H. T. Cotton
6. Elements of Power System Analysis (4th Ed) - William T. Stephenson
7. Electric Power System: Design and Analysis - Mohammed El-Hawary
8. Electrical Power System: Wadhwa CL
9. Electric Energy Systems Theory: an introduction - Elgend O. I.
10. Elements of Power Systems - O. I. Elgend

Electric Field Theory (HND)

1. The electromagnetic Field in its Engineering Aspects - Carter. G. W. (Longmans)
2. Introductory Engineering Electromagnetic - Popovic
3. Applied Electromagnetic

Control Engineering (HND)

1. Control System Engineering - Magrath, L. J. & Copal, M., Viley Eastern Ltd., New Delhi, 1st Ed. 1975.
2. Control Engineering - Morris, N. M., Mc-Graw Hill, 3rd Ed., U. K.
3. Feedback Control Theory for Engineers - Atkinson, P., Heinemann, 2nd Ed., 1972
4. Theory and Problems of Feedback Control System - (Schaum's Outline Series), Di Stefeno J.J., Stubberud, A.R.,
5. William, L. J., McGraw-Hill, 1st Ed., 1967.
6. Control System for Technicians p Eryan, G.F. ELBS & Holder & Stoughton, 2nd Ed. 1970.
7. Control, System engineering (with notes and worked examples - C. O. Oroge, UPL Ibadan 1986.

Electrical/Electronic Drafting and Design

1. Basic Electronic and Electrical Drafting - Bethuma, J. D., Prentice-Hall, 1980 Ed.
2. Electrical and Electronics Drawing - Baer, C. J. McGraw-Hill, 2nd Ed. 1966.

LIST OF BOOKS FOR COMPUTER TECHNOLOGY COURSES

1. Title: Advanced Microprocessors Architecture Author: L. Gminiera & A. Valenzane

Publisher: Addison Wesley

2. Title: Digital Signal Processing Author: R. A. Roberts & C. T. Muuis Publisher: Addison Wesley
3. Title: Microprocessor Systems 16-bit Approach Author: W. J. Eccles

Publisher: Addison Wesley

4. Title: Microprocessor Systems 16-bit Approach Author: H. S. Stone

Publisher: AddisonWesley

5. Title: Introduction to Robotics Author: H. S. Stone

Publisher: Addision Wesley

6. Title: Pulse Digital and Switching Waveforms Author: Millman and Taub

Publisher: Addison Wesley

7. Title: FORTRAN 77

Author: Donald M. Munno Publisher: Harnold

8. Title: Digital Integrated Electronics Author: Taub

Publisher: TAB Books

9. Title: Computer Technicians Handbook Author: Margolis A.

Publisher: TAB Books

10. Title: Interfacing Techniques Author: Joseph Carr

Publisher: TAB Books

11. Title: Computer Peripherals

Author: Barry Wilkinson/David Horrocks Publisher: Edward Arnold

12. Title: Computing with Fortran IV Author: Practical Course, Donald M. Monro Publisher: Edward Arnold
13. Title: Digital Control

Author: A.M. Zikil; Ellis Harwood Publisher: Edward Arnold

14. Title: Computer Interfacing: Connection to the Real World Author: M. D. Cripps

Publisher: Edward Arnold

15. Title: Basic Control System Technology Author: C. J. Chesmond

Publisher: Edward Arnold

16. Title: Control Applications of Microcomputers Author: P.M. Mitchel

Publisher: Edward Arnold

17. Title: Microprocessor and their Manufacturing Applications Author: A. K. Kochlan/N.D. Burns

Publisher: Edward Arnold

18. Title: Digital Techniques: From problem specification to realization Author: Thijssen A.P./Vink, H.A. et al

Publisher: Edward Arnold

19. Title: Checking Experiments in Sequential Machines Author: A. Bhattacharyya

Publisher: Wiley

20. Title: Security for Computer Networks Author: D. W. Davies/W.L. Price Publisher: Wiley
21. Title: Microprocessor System Design Techniques Author: R. Barnett

Publisher: Wiley

22. Title: The Fifth Generation: The Future of Computer Technology Author: H.S. U.

Publisher: Wiley

23. Title: Control Applications of Microcomputers Author: P. Mitchel

Publisher: Hodder Stoughton.

24. Title: Computer Peripherals

Author: Barry Wilkinson/David Horrocks Publisher: Hodder Stoughton.

25. Title: Basic Principles and Practices of Microprocessors Author: D. E. Heffer/G.A. King/D.C. Keith

Publisher: Hodder Stoughton.