Lecturers' Handbook

Chemical Engineering (Petroleum Refining and Petrochemical option)

Faculty of Engineering, Akpakip Oro University (AOU)

For teaching staff and laboratory supervisors

Draft for departmental approval

1. Purpose and Responsibilities

This handbook supports teaching staff delivering the Chemical Engineering (Petroleum Refining and Petrochemical option) programme. It sets out the outcome mapping, teaching schemes, lesson-planning expectations, laboratory procedures, assessment design and marking standards. It is a working guide and does not replace the university's regulations.

- Deliver courses against the learning outcomes in the Students' Handbook.
- Publish the week-by-week scheme and assessment plan to students in the first week.
- Design assessments that test the stated outcomes at the appropriate level.
- Mark consistently, moderate with colleagues and give timely, specific feedback.
- Supervise projects, SIWES placements and laboratory work to the standards set here.

2. Programme Outcome Mapping

Each graduate competency is developed across several courses. The mapping below is generated from the course list and must be checked against the CCMAS mapping before accreditation.

Competency	Main contributing courses
Chemistry foundations	CHE 103, CHE 111, CHE 201, CHE 209, CHE 202, CHE 210, CHE 207
Process calculations and thermodynamics	CHE 205, CHE 212, CHE 303, CHE 211
Transport phenomena	CHE 206, CHE 214, CHE 213, CHE 301, CHE 309
Reaction engineering	CHE 302, CHE 310, CHE 402
Separation and unit operations	CHE 305, CHE 311, CHE 505
Equipment and plant design	CHE 306, CHE 312, CHE 406, CHE 509, CHE 510, CHE 511
Process control and optimisation	CHE 304, CHE 413, CHE 504, CHE 216, CHE 405
Refining and petroleum processing	CHE 313, CHE 314, CHE 401, CHE 409, CHE 501, CHE 411
Petrochemicals and polymers	CHE 315, CHE 403, CHE 404, CHE 410, CHE 502
Professional practice	CHE 316, CHE 412, CHE 407, CHE 512, CHE 513, CHE 416, CHE 104

3. Teaching Schemes

For each semester, the table shows the delivery mode and assessment method. Contact hours and rooms are set by the timetable.

Year 1: Engineering Foundations

Semester 1

Code	Course	Units	Delivery	Assessment
CHE 101	Mathematics I	3	Lecture	CA 30 / Exam 70
CHE 102	General Physics I	3	Lecture	CA 30 / Exam 70
CHE 103	General Chemistry I	3	Lecture	CA 30 / Exam 70
CHE 104	Introductory Engineering	2	Lecture	CA 50 / Exam 50
CHE 105	Introduction to Computing	2	Lecture	CA 60 / Exam 40
CHE 106	Communication in English	2	Lecture	CA 60 / Exam 40
CHE 107	Engineering Laboratory Practicals	1	Lecture with lab / practical	Lab reports 100
CHE 108	Introduction to Chemical Engineering	2	Lecture	CA 40 / Exam 60

Semester 2

Code	Course	Units	Delivery	Assessment
CHE 109	Mathematics II	3	Lecture	CA 30 / Exam 70
CHE 110	General Physics II	3	Lecture	CA 30 / Exam 70
CHE 111	General Chemistry II	2	Lecture	CA 30 / Exam 70
CHE 112	Engineering Drawing and Graphics	2	Lecture with lab / practical	Coursework 60 / Exam 40
CHE 113	Programming and Engineering Computation	2	Lecture	CA 50 / Exam 50
CHE 114	Nigerian Peoples and Cultures	2	Lecture	CA 40 / Exam 60
CHE 115	Chemistry Practicals	1	Lecture with lab / practical	Lab reports 100
CHE 116	Engineering Workshop and Safety	2	Lecture with lab / practical	Practical 70 / Exam 30

Year 2: Core Engineering

Semester 3

Code	Course	Units	Delivery	Assessment
CHE 201	Organic Chemistry I	3	Lecture	CA 30 / Exam 70
CHE 202	Physical Chemistry I	3	Lecture	CA 30 / Exam 70
CHE 203	Engineering Mathematics	3	Lecture	CA 30 / Exam 70
CHE 204	Engineering Mechanics: Statics	2	Lecture	CA 30 / Exam 70
CHE 205	Material and Energy Balances	3	Lecture	CA 30 / Exam 70
CHE 206	Fluid Mechanics I	3	Lecture	CA 30 / Exam 70
CHE 207	Analytical Chemistry	2	Lecture	CA 40 / Exam 60
CHE 208	Engineering Materials	2	Lecture	CA 40 / Exam 60

Semester 4

Code	Course	Units	Delivery	Assessment
CHE 209	Organic Chemistry II	3	Lecture	CA 30 / Exam 70
CHE 210	Physical Chemistry II	3	Lecture	CA 30 / Exam 70
CHE 211	Numerical Methods for Engineers	3	Lecture	CA 40 / Exam 60
CHE 212	Thermodynamics I	3	Lecture	CA 30 / Exam 70
CHE 213	Heat Transfer	3	Lecture	CA 30 / Exam 70
CHE 214	Fluid Mechanics II	3	Lecture	CA 30 / Exam 70
CHE 215	Chemical Engineering Laboratory I	2	Lecture with lab / practical	Lab reports 100
CHE 216	Process Instrumentation Fundamentals	2	Lecture	CA 40 / Exam 60

Year 3: Specialist Foundations

Semester 5

Code	Course	Units	Delivery	Assessment
CHE 301	Mass Transfer I	3	Lecture	CA 30 / Exam 70
CHE 302	Chemical Reaction Engineering I	3	Lecture	CA 30 / Exam 70
CHE 303	Thermodynamics II	3	Lecture	CA 30 / Exam 70

Code	Course	Units	Delivery	Assessment
CHE 304	Process Dynamics and Control	3	Lecture	CA 30 / Exam 70
CHE 305	Unit Operations I (Separation)	3	Lecture	CA 30 / Exam 70
CHE 306	Process Equipment Design I	3	Lecture	CA 40 / Exam 60
CHE 307	Chemical Engineering Laboratory II	2	Lecture with lab / practical	Lab reports 100
CHE 308	Engineering Statistics and Research Methods	2	Lecture	CA 40 / Exam 60

Semester 6

Code	Course	Units	Delivery	Assessment
CHE 309	Mass Transfer II	3	Lecture	CA 30 / Exam 70
CHE 310	Chemical Reaction Engineering II	3	Lecture	CA 30 / Exam 70
CHE 311	Unit Operations II	3	Lecture	CA 30 / Exam 70
CHE 312	Process Equipment Design II	3	Lecture	CA 30 / Exam 70
CHE 313	Petroleum Chemistry and Hydrocarbon Fundamentals	3	Lecture	CA 30 / Exam 70
CHE 314	Petroleum Refining Processes I	3	Lecture	CA 30 / Exam 70
CHE 315	Petrochemical Processes I	3	Lecture	CA 30 / Exam 70
CHE 316	Process Safety and Hazard Analysis	2	Lecture	CA 40 / Exam 60

Year 4: Advanced Design and Industrial Practice

Semester 7

Code	Course	Units	Delivery	Assessment
CHE 401	Petroleum Refining Processes II	3	Lecture	CA 30 / Exam 70
CHE 402	Catalysis and Catalytic Processes	3	Lecture	CA 30 / Exam 70
CHE 403	Petrochemical Processes II	3	Lecture	CA 30 / Exam 70
CHE 404	Polymer Science and Engineering	3	Lecture	CA 30 / Exam 70
CHE 405	Process Simulation and Design	3	Lecture	Coursework 60 / Exam 40
CHE 406	Plant Design and Economics	3	Lecture	Design project 60 / Exam 40
CHE 407	Environmental Engineering	2	Lecture	CA 40 / Exam 60
CHE 408	Research Project I	2	Studio / project supervision	Proposal 100

Semester 8

Code	Course	Units	Delivery	Assessment
CHE 409	Petroleum Product Quality and Blending	3	Lecture	CA 30 / Exam 70
CHE 410	Petrochemical Process Analysis	3	Lecture	CA 30 / Exam 70
CHE 411	Gas Processing and Treatment	3	Lecture	CA 30 / Exam 70
CHE 412	Process Safety Engineering	3	Lecture	CA 30 / Exam 70
CHE 413	Industrial Process Control	3	Lecture	CA 30 / Exam 70
CHE 414	Corrosion and Materials in Process Plants	2	Lecture	CA 40 / Exam 60
CHE 415	Process Economics and Management	2	Lecture	CA 40 / Exam 60

Code	Course	Units	Delivery	Assessment
CHE 416	Industrial Training (SIWES)	3	Industrial placement	Logbook 40 / Report 40 / Assessor 20

Year 5: Specialisation, Integration and Professional Readiness

Semester 9

Code	Course	Units	Delivery	Assessment
CHE 501	Advanced Refinery Operations	3	Lecture	CA 30 / Exam 70
CHE 502	Advanced Petrochemical Technology	3	Lecture	CA 30 / Exam 70
CHE 503	Energy Policy and Regulation	2	Lecture	CA 40 / Exam 60
CHE 504	Process Optimisation	3	Lecture	CA 30 / Exam 70
CHE 505	Advanced Separation Processes	3	Lecture	CA 30 / Exam 70
CHE 506	Research Project II	3	Studio / project supervision	Project 100
CHE 507	Bioprocess Engineering	2	Lecture	CA 40 / Exam 60
CHE 508	Technical Elective I	2	Lecture	CA 40 / Exam 60

Semester 10

Code	Course	Units	Delivery	Assessment
CHE 509	Integrated Process Plant Design	3	Lecture	Design project 100
CHE 510	Refinery Plant Design	2	Lecture	CA 40 / Exam 60
CHE 511	Petrochemical Plant Design	2	Lecture	CA 40 / Exam 60
CHE 512	Environmental Impact and Sustainability	2	Lecture	CA 40 / Exam 60
CHE 513	Engineering Professional Practice and Ethics	2	Lecture	CA 50 / Exam 50
CHE 514	Risk Management in Process Industries	2	Lecture	CA 40 / Exam 60
CHE 515	Final-Year Design Project and Defence	4	Studio / project supervision	Project 60 / Defence 40
CHE 516	Technical Elective II	2	Lecture	CA 40 / Exam 60

4. Lesson Planning

Every lecture and practical session should have a written lesson plan, kept with the course file and sampled during moderation.

Lesson plan template

- **Course and week:** code, title, week number.
- **Learning outcome(s):** the outcome(s) this session addresses.
- **Prerequisites, resources and activities:** what students must know, what is needed, and the timed outline.
- **Check for understanding:** at least one formative question or task.
- **Homework or preparation:** the task and its due date.

Worked example: Material balance on a recycle process (2-hour session)

Time	Activity	Check for understanding
0 to 10 min	Starter: recall of the general material balance equation	Quick oral questions

Time	Activity	Check for understanding
10 to 40 min	Explanation: process units, recycle and purge streams	Students draw the boundaries for a given flowsheet
40 to 65 min	Worked example: solve a recycle problem with a purge stream	Pairs solve a similar problem
65 to 95 min	Group problem: find the purge rate for a stated composition limit	Each group presents its result
95 to 110 min	Short quiz on the session content	Marks recorded for formative tracking
110 to 120 min	Summary; homework on a reactor with a recycle loop	Homework due next session

5. Laboratory and Practical Instructions

Standard references are given for orientation. Confirm the current edition and the department's approved procedure before issuing instructions to students.

5.1 Binary distillation and vapour-liquid equilibrium (Chemical Engineering Laboratory II)

Aim. Measure the separation achieved in a laboratory distillation column and compare it with the McCabe-Thiele prediction.

Equipment.

- Laboratory distillation column
- Heater and reboiler
- Thermometers and sampling points
- Refractometer or gas chromatograph

Procedure.

1. Set the reflux ratio and heat input and wait for steady state.
2. Sample the distillate and bottoms and measure their compositions.
3. Repeat at a second reflux ratio.
4. Construct the McCabe-Thiele diagram and compare the number of stages.

Safety.

- Flammable liquids: keep away from ignition sources and work under the fume hood.
- Never run the column without cooling water flowing through the condenser.

Report requirements. Include the operating conditions, measured compositions, the McCabe-Thiele diagram and the sources of error.

5.2 Batch reactor kinetics (Chemical Reaction Engineering I)

Aim. Determine the rate constant and order of a reaction from concentration-time data in a batch reactor.

Equipment.

- Stirred batch reactor
- Temperature controller
- Sampling equipment
- Titration or spectroscopic analysis

Procedure.

1. Charge the reactor and bring it to the set temperature.
2. Take samples at timed intervals and quench them immediately.
3. Analyse the samples to obtain concentration against time.
4. Fit the rate law to the data and determine the rate constant.

Safety.

- Wear gloves and eye protection when handling reagents.
- Quench reactions only as the procedure states.

Report requirements. Include the concentration-time data, the fitted rate law and the rate constant with its uncertainty.

5.3 Pipe flow and pump performance (Fluid Mechanics II)

Aim. Measure the head loss in a pipe and the performance curve of a centrifugal pump.

Equipment.

- Pipe loop with pressure taps
- Centrifugal pump
- Flowmeter and manometer
- Pressure gauges

Procedure.

1. Measure the pressure drop along the pipe at three flow rates.
2. Compare the measured head loss with the Darcy-Weisbach prediction.
3. Measure the pump head and flow at several speeds or valve settings.
4. Plot the pump curve and identify the best efficiency point.

Safety.

- Check the pump is primed before starting; never run it dry.
- Keep hands clear of the coupling and the rotating shaft.

Report requirements. Include the head loss and pump curves, the friction factor, the best efficiency point and a discussion of the errors.

5.4 Gasoline and diesel product tests (Petroleum Product Quality and Blending)

Aim. Measure the key specifications of refined fuel samples against standard limits.

Equipment.

- Hydrometer or density meter
- Flash point apparatus
- Viscometer
- Distillation apparatus

Procedure.

1. Measure the density of each sample and calculate the API gravity.
2. Determine the flash point using the prescribed apparatus.
3. Measure the kinematic viscosity at the specified temperature.
4. Compare each result with the specification and state whether the product passes.

Safety.

- Flash point testing involves flammable vapours: keep ignition sources away.
- Dispose of fuel samples into the labelled waste container.

Report requirements. Include the test results, the specification limits, a pass or fail statement for each property, and the test method references.

6. Assessment Design

6.1 Assessment blueprint for written examinations

Cognitive level	Typical weight	Typical question form
Remember	10%	Definitions, standard values, short recall
Understand	20%	Explain principles, interpret results
Apply	40%	Calculations, applying standards and methods
Analyse	20%	Multi-step problems and system analysis
Evaluate	10%	Design choices, critique, justification

6.2 Continuous assessment

- Each course should have at least two CA components, spread across the semester.
- At least one CA item should test an outcome the exam does not.
- Publish all CA marking schemes before the task is issued.

7. Rubrics

Each criterion is scored from 1 to 4. The total is converted to the mark scale in the regulations.

7.1 Design project rubric

Criterion	4 Excellent	3 Good	2 Satisfactory	1 Unsatisfactory
Design concept	Clear, justified and suited to the brief	Sound with minor gaps	Partly justified	Unclear or unsuitable
Calculations or analysis	Complete, correct and checked	Minor errors, method correct	Method partly correct	Major errors or missing
Use of standards	Correct standards applied and cited	Mostly applied correctly	Some misapplied	Not used
Drawings, code or specifications	Clear, complete, to convention	Minor omissions	Incomplete	Not usable
Safety and sustainability	Addressed in depth	Addressed adequately	Mentioned only	Not addressed

7.2 Laboratory report rubric

Criterion	4 Excellent	3 Good	2 Satisfactory	1 Unsatisfactory
Method	Complete and reproducible	Mostly complete	Partly complete	Not usable
Data and analysis	Accurate and correctly processed	Minor errors	Several errors	Major errors
Discussion	Insightful, error sources analysed	Adequate	Superficial	Absent
Presentation	Clear and professional	Mostly clear	Hard to follow	Poor

7.3 Oral defence rubric

Criterion	4 Excellent	3 Good	2 Satisfactory	1 Unsatisfactory
Explanation	Clear and complete	Clear with minor gaps	Partial	Unclear
Response to questions	Confident, accurate, reasoned	Mostly accurate	Some accurate	Mostly inaccurate
Professional judgement	Justifies trade-offs well	Justifies most decisions	Limited	None

8. Marking, Moderation and Feedback

- Mark against the published scheme, and record the reason for any deduction.
- Moderate a sample of at least 10% of scripts or reports across the mark range, with a second marker.
- Return feedback within the period set by the regulations, identifying strengths and next steps.
- Record any change to a published mark, with the reason and the approver.

9. Supervision of Projects and SIWES

- Supervisors meet each student at least every two weeks and keep a meeting log.
- Projects require an approved written proposal before execution.
- Check each SIWES placement before the student starts; review the logbook and report, and complete the assessor's form.

10. Quality Assurance and Accreditation Readiness

- Keep a course file for each course: specification, scheme, assessment items, marking schemes, moderation records and feedback.
- Maintain records of equipment, calibration and maintenance for each laboratory.
- Invite an external examiner to review standards and assessment, and act on their report.
- Update the CCMAS mapping whenever a course changes.

11. Academic Integrity and Professional Ethics

- Explain the university's academic integrity policy at the start of every course.
- Report suspected misconduct through the department to the appropriate committee.
- Model professional ethics, including honest reporting of data and clear acknowledgement of sources.