Lecturers' Handbook

Mechatronics and Robotics Engineering

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 Mechatronics and Robotics Engineering 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
Mechanical design	MRE 201, MRE 209, MRE 202, MRE 210, MRE 304, MRE 311
Electrical and electronic systems	MRE 204, MRE 208, MRE 305, MRE 212, MRE 307, MRE 205
Control systems	MRE 301, MRE 309, MRE 406, MRE 405
Sensors, actuators and embedded systems	MRE 302, MRE 310, MRE 213, MRE 314
Industrial automation	MRE 303, MRE 313, MRE 401, MRE 407, MRE 411, MRE 510
Robotics	MRE 306, MRE 312, MRE 402, MRE 403, MRE 410, MRE 501
Intelligent and autonomous systems	MRE 404, MRE 409, MRE 413, MRE 505
Design and integration	MRE 509, MRE 414, MRE 412, MRE 515
Professional practice	MRE 104, MRE 106, MRE 416, MRE 513, MRE 415

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
MRE 101	Mathematics I	3	Lecture	CA 30 / Exam 70
MRE 102	General Physics I	3	Lecture	CA 30 / Exam 70
MRE 103	General Chemistry I	2	Lecture	CA 30 / Exam 70
MRE 104	Introductory Engineering	2	Lecture	CA 50 / Exam 50
MRE 105	Introduction to Computing	2	Lecture	CA 60 / Exam 40
MRE 106	Communication in English	2	Lecture	CA 60 / Exam 40
MRE 107	Engineering Laboratory Practicals	1	Lecture with lab / practical	Lab reports 100
MRE 108	Introduction to Mechatronics and Robotics	2	Lecture	CA 40 / Exam 60

Semester 2

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

Year 2: Core Engineering

Semester 3

Code	Course	Units	Delivery	Assessment
MRE 201	Engineering Mechanics: Statics	3	Lecture	CA 30 / Exam 70
MRE 202	Strength of Materials I	3	Lecture	CA 30 / Exam 70
MRE 203	Engineering Mathematics	3	Lecture	CA 30 / Exam 70
MRE 204	Electrical Circuits I	3	Lecture	CA 30 / Exam 70
MRE 205	Digital Logic Design	3	Lecture	CA 40 / Exam 60
MRE 206	Computer-Aided Design	2	Lecture	Coursework 100
MRE 207	Engineering Materials	2	Lecture	CA 40 / Exam 60
MRE 208	Electronic Devices I	3	Lecture	CA 30 / Exam 70

Semester 4

Code	Course	Units	Delivery	Assessment
MRE 209	Engineering Mechanics: Dynamics	3	Lecture	CA 30 / Exam 70
MRE 210	Machine Elements	3	Lecture	CA 30 / Exam 70
MRE 211	Numerical Methods for Engineers	3	Lecture	CA 40 / Exam 60
MRE 212	Electrical Machines I	3	Lecture	CA 30 / Exam 70
MRE 213	Microcontrollers and Embedded Programming	3	Lecture	CA 40 / Exam 60
MRE 214	Fluid Mechanics I	3	Lecture	CA 30 / Exam 70
MRE 215	Signals and Systems I	3	Lecture	CA 30 / Exam 70
MRE 216	Mechatronics Laboratory I	2	Lecture with lab / practical	Lab reports 100

Year 3: Specialist Foundations

Semester 5

Code	Course	Units	Delivery	Assessment
MRE 301	Control Systems I	3	Lecture	CA 30 / Exam 70
MRE 302	Sensors and Transducers	3	Lecture	CA 40 / Exam 60

Code	Course	Units	Delivery	Assessment
MRE 303	Industrial Automation and PLCs	3	Lecture with lab / practical	Practical 40 / Exam 60
MRE 304	Kinematics of Machines	3	Lecture	CA 30 / Exam 70
MRE 305	Analogue Electronics	3	Lecture	CA 30 / Exam 70
MRE 306	Robot Fundamentals and Kinematics	3	Lecture	CA 30 / Exam 70
MRE 307	Electrical Drives	2	Lecture	CA 40 / Exam 60
MRE 308	Engineering Statistics and Research Methods	2	Lecture	CA 40 / Exam 60

Semester 6

Code	Course	Units	Delivery	Assessment
MRE 309	Control Systems II	3	Lecture	CA 30 / Exam 70
MRE 310	Actuators and Power Electronics	3	Lecture	CA 30 / Exam 70
MRE 311	Mechanism Design	3	Lecture	CA 30 / Exam 70
MRE 312	Robot Dynamics	3	Lecture	CA 30 / Exam 70
MRE 313	SCADA and Industrial Networks	3	Lecture with lab / practical	Practical 40 / Exam 60
MRE 314	Embedded Systems Design	3	Lecture	CA 40 / Exam 60
MRE 315	Mechatronics Laboratory II	2	Lecture with lab / practical	Lab reports 100
MRE 316	Engineering Economics	2	Lecture	CA 40 / Exam 60

Year 4: Advanced Design and Industrial Practice

Semester 7

Code	Course	Units	Delivery	Assessment
MRE 401	Hydraulics and Pneumatics	3	Lecture	CA 30 / Exam 70
MRE 402	Industrial Robotics	3	Lecture	CA 40 / Exam 60
MRE 403	Robot Control	3	Lecture	CA 30 / Exam 70
MRE 404	Machine Vision	3	Lecture	CA 40 / Exam 60
MRE 405	Mechatronic System Modelling	3	Lecture	CA 30 / Exam 70
MRE 406	Instrumentation and Data Acquisition	2	Lecture	CA 40 / Exam 60
MRE 407	Industrial Automation Systems Design	3	Lecture	Design project 60 / Exam 40
MRE 408	Research Project I	2	Studio / project supervision	Proposal 100

Semester 8

Code	Course	Units	Delivery	Assessment
MRE 409	Artificial Intelligence for Robotics	3	Lecture	CA 30 / Exam 70
MRE 410	Mobile Robotics	3	Lecture	CA 30 / Exam 70
MRE 411	Industrial Internet of Things	3	Lecture	CA 40 / Exam 60
MRE 412	Robot Programming and Simulation	2	Lecture with lab / practical	Practical 60 / Exam 40
MRE 413	Autonomous Systems	3	Lecture	CA 30 / Exam 70
MRE 414	Mechatronics Systems Integration	3	Lecture	CA 40 / Exam 60
MRE 415	Safety Systems and Machine Guarding	2	Lecture	CA 40 / Exam 60

Code	Course	Units	Delivery	Assessment
MRE 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
MRE 501	Advanced Robotics	3	Lecture	CA 30 / Exam 70
MRE 502	Human-Robot Interaction	2	Lecture	CA 40 / Exam 60
MRE 503	Advanced Industrial Automation	3	Lecture	CA 30 / Exam 70
MRE 504	Industrial IoT Analytics	2	Lecture	CA 40 / Exam 60
MRE 505	Control of Autonomous Systems	3	Lecture	CA 30 / Exam 70
MRE 506	Research Project II	3	Studio / project supervision	Project 100
MRE 507	Engineering Project Management	2	Studio / project supervision	CA 40 / Exam 60
MRE 508	Technical Elective I	2	Lecture	CA 40 / Exam 60

Semester 10

Code	Course	Units	Delivery	Assessment
MRE 509	Integrated Mechatronics System Design	3	Lecture	Design project 100
MRE 510	Industrial Automation Commissioning	2	Lecture	CA 40 / Exam 60
MRE 511	Robot Deployment and Integration	2	Lecture	CA 40 / Exam 60
MRE 512	Environmental Impact and Sustainability	2	Lecture	CA 40 / Exam 60
MRE 513	Engineering Professional Practice and Ethics	2	Lecture	CA 50 / Exam 50
MRE 514	Safety and Risk Management	2	Lecture	CA 40 / Exam 60
MRE 515	Final-Year Design Project and Defence	4	Studio / project supervision	Project 60 / Defence 40
MRE 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: PID tuning of a DC motor position loop (2-hour session)

Time	Activity	Check for understanding
0 to 10 min	Starter: recall of the PID terms and their effects	Quick oral questions

Time	Activity	Check for understanding
10 to 40 min	Explanation: proportional, integral and derivative action on a position loop	Students predict the effect of each gain
40 to 65 min	Worked example: tune the gains from a step response	Pairs compare two tuning results
65 to 95 min	Hardware exercise: tune the rig and record the step response	Each pair reports overshoot and settling time
95 to 110 min	Short quiz on the session content	Marks recorded for formative tracking
110 to 120 min	Summary; homework on the effect of sensor noise on derivative action	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 Start-stop motor circuit in ladder logic (Industrial Automation and PLCs)

Aim. Write and test a ladder logic program for a start-stop motor circuit with timers and counters.

Equipment.

- PLC training station
- Programming software
- Push buttons and indicator lamps
- Contactor and motor model

Procedure.

1. Draw the ladder diagram for start-stop with a seal-in contact.
2. Add an on-delay timer and a counter, and test each condition.
3. Download the program and test every input combination.
4. Document the I/O list and the test results.

Safety.

- Verify emergency-stop circuits before energising the motor model.
- Never change wiring with power applied.

Report requirements. Include the ladder diagram, the I/O list, the test table and any faults found and corrected.

5.2 DC motor position control with PID (Control Systems I)

Aim. Tune a PID controller for a DC motor position loop and record its step response.

Equipment.

- DC motor with encoder
- Motor driver
- Microcontroller or control interface
- Data logger or software

Procedure.

1. Identify the open-loop response with a step input.
2. Set proportional gain only and record the response.
3. Add integral and derivative action, tuning each in turn.
4. Record overshoot, settling time and steady-state error for the final tuning.

Safety.

- Limit motor travel with mechanical stops and software limits.
- Keep hands clear of the moving shaft.

Report requirements. Include the step responses, the gains used, the performance measures and a comment on the trade-offs.

5.3 Forward kinematics of a robot arm (Robot Fundamentals and Kinematics)

Aim. Verify the forward kinematics of a three-joint planar arm by measurement.

Equipment.

- Planar robot arm with joint encoders
- Measuring scale or ruler
- Calculator or software

Procedure.

1. Set the joint angles to the specified values and record them.
2. Measure the end-effector position from the base frame.
3. Calculate the position from the link lengths and the joint angles.
4. Compare the measured and calculated positions and compute the error.

Safety.

- Keep clear of the arm during motion.
- Use the emergency stop before adjusting the joints.

Report requirements. Include the link parameters, the measured and calculated positions, and the error analysis.

5.4 Ultrasonic and encoder sensor interfacing (Microcontrollers and Embedded Programming)

Aim. Read an ultrasonic sensor and a rotary encoder with a microcontroller and log the data.

Equipment.

- Microcontroller board
- Ultrasonic sensor
- Rotary encoder
- Serial interface and PC

Procedure.

1. Wire the sensors to the correct pins and confirm the supply voltages.
2. Program the microcontroller to read the distance and the encoder count.
3. Log the readings over a serial connection and check their accuracy.
4. Document the calibration and the noise observed.

Safety.

- Check wiring and voltage levels before connecting the board to the PC.
- Do not connect 5 V sensors to 3.3 V inputs.

Report requirements. Include the wiring diagram, the code summary, the calibration results and the logged data.

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.