2023-2027

SCHOOL OF SCIENCE AND TECHNOLOGY
PAN-ATLANTIC UNIVERSITY

Programme Manual

B.Eng. Mechanical Engineering

SST • School of Science and Technology • Pan-Atlantic University
Km 52 Lekki-Epe Expressway, Ibeju-Lekki, Lagos, Nigeria

Version 2024-08-07

1. Vision/Mission/Core Values of the University

1.1 Vision of the University: The vision of Pan-Atlantic University is to create a university of international standard capable of having a positive influence on higher education in Africa.

1.2 The Mission of Pan-Atlantic University: To form competent and committed professionals and encourage them to serve with personal initiative and social responsibility the community in which they work, thereby helping to build a better society in Nigeria and Africa at large.

1.3 The Core Values:

- Community
- Respect
- Integrity
- Spirit of Service
- Professionalism

2.0 Vision and Mission of the department.

2.1 Vision of the Department: The vision of the Mechanical Engineering Department is to become a premier unit that significantly enhances higher education in Africa by leading in mechanical engineering excellence, driving innovation, and contributing to meaningful progress across the continent

2.2 Mission of the Department

The School of Science and Technology (SST) is a community of people committed to creating and transmitting knowledge and competencies in science, engineering and technology by "*forming competent and socially responsible science and engineering professionals who are committed to the promotion of the common good of society and the advancement of the scientific and engineering profession*".

In order to achieve the above mission, the school seeks to:

- *Provide hands-on, practice-based, student-centred and industry-relevant programs that address technical expertise, industrial management and ethical responsibility.*
- *Develop partnerships and engage with relevant stakeholders through applied research that provides solutions to industry and societal problems and enhance engineering pedagogy.*
- *Provide entrepreneurship education along with science and engineering education.*

- *Make intellectual contributions which:*
    a) *Support the practice of science, engineering and technology;*
    b) *Contribute to the advancement of the science, engineering and technology disciplines; and*
    c) *Create high quality teaching materials.*
- *Produce graduates who will lead efforts to achieve ever greater scientific, engineering and technology development with high ethical standards.*

2.3 Hands-on training: Student-centred with strong ties to industry

To ensure the industry relevance of engineering programmes our pedagogy will be in line with the world-class global best practices of having engineering education delivery process that are student-centred with strong ties to industry driven by our Programme Educational Objectives (PEOs).

Programme Educational Objectives (PEOs): The SST Programme Educational Objectives will be periodically reviewed with the full involvement of all key stakeholders including faculty members, students, advisory board members, alumni, and employers of graduates. Presently, the career and professional accomplishments that our programmes are preparing graduates to attain within 3-5 years of graduation are:

Table 1: Programme Educational Objectives (PEOs)

Start-ups & innovative Entrepreneurs	Graduates will become principals in the industries associated with engineering and professional engineers starting-up and growing their own new firms. They will become recognised experts working in government, consulting firms, and international organisations around the country and around the world addressing some of the most challenging problems of our times. With reputation as a source of innovative solutions to complex problems, technology leaders in start-up tech companies based on societal demands, national needs, and competitive international markets.
Researchers	Graduates will become leading researchers who create and disseminate new knowledge in engineering. They will complete masters and Ph.D. programmes at respected universities by conducting original research in related disciplines or in interdisciplinary topics, contribute to the scientific community with novel research activities, and continue their field in permanent academic positions work in engineering, research and development, production, operations and management departments of Nigerian, African or international companies as engineers who can solve technical problems, take initiative, develop and execute projects, collaborate with others in a team and take the responsibilities of a leader.

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Lifelong Learning	Graduates will pursue lifelong learning in generating innovative engineering solutions using research and complex problem-solving skills.
Ethical Professional Engineer	Graduates will demonstrate technical competency and leadership to be working as engineering professionals (registered engineers), acting ethically, adhering to standards, and be committed to the welfare of employees and the general population.

The PEOs are published in the programme manual and the University website. The web link is shown below.

https://sst.pau.edu.ng/sst-program-manuals/Programme-Educational-Objectives.pdf

Table 2- Mapping of PEOs to the Vision and Mission of the University.

PEOs	**Vision and Mission**				
	International Standards	**Positive Influence and Service**	**Competent and Committed Professionals**	**Social Responsibility**	**Building a Better Society**
Start-ups & Innovative Entrepreneurs					

Researchers					
Lifelong Learning					
Ethical Professional Engineer					

Programme Outcomes (POs): At graduation, our students are expected to know and able to do the following:

Table 3.- Graduate Attributes_ Programme Outcomes (POs)

WA1: Engineering knowledge	Apply knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialization as specified in WK1 to WK4 respectively to develop solutions to complex engineering problems.
WA2: Problem Analysis	Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences with holistic considerations for sustainable development*(WK1 to WK4)
WA3: Design and development of solutions	Design creative solutions for complex engineering problems and design 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 (WK5)
WA4: Investigation	Conduct investigations of complex engineering problems using research methods including research-based knowledge, design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions (WK8).
WA5: Modern Tool Usage	Create, select and apply and recognize limitations of appropriate techniques, resources and modern engineering and IT tools, including prediction and modelling, to complex engineering problems (WK2 and WK6)
WA6: The Engineer and Society for Environment & Sustainability	When solving complex engineering problems, analyze and evaluate sustainable developments impacts* to: society, the economy, sustainability, health and safety, legal frameworks, and the environment (WK1, WK5 and WK7)

WA7: Ethics	Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK9).
WA8: Individual and Teamwork	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 (WK9).
WA9: Communication	Communicate effectively and inclusively on complex 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.
WA10: Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects in multi-disciplinary environments.
WA11: Lifelong learning	Recognize the need for, and have the preparation and ability for (i) Independent and life-long learning (ii) Adaptability to new and emerging technologies and (iii) Critical thinking in the broadest context of technological change (WK8).

KNOWLEDGE AND ATTITUDE PROFILE

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net-zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development*

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.
*Represented by the 17 UN Sustainable Development Goals (UN-SDG)

The Graduate Attributes(POs) are available in the PAU website.

https://sst.pau.edu.ng/program_manuals/Programme-Outcomes.pdf

Table 4: Mapping of Programme Outcomes (POs) to Programme Educational Objectives (PEOs)

Student Outcomes	**Start-ups & Innovative Entrepreneurs**	**Researchers**	**Lifelong Learning**	**Ethical Professional Engineer**
WA1: Engineering knowledge				
WA2: Problem Analysis				
WA3: Design and development of solutions				
WA4: Investigation				
WA5: Modern Tool Usage				
WA6: The Engineer and Society for Environment & Sustainability				
WA7: Ethics				
WA8: Individual and Teamwork				
WA9: Communication				
WA10: Project Management and Finance				
WA11: Lifelong learning				

1.2 About the Programme

The programme will prepare students for careers in the vast areas where mechanical engineering is applied, such as in aviation/aerospace, power plants, biotechnology, shipbuilding, oil and gas rigs and platforms, vehicle design & assembly, railway, military hardware, industrial robotics/automation, general maintenance, consumer product manufacturing, healthcare, mechanized agriculture, HVAC and construction industries, among others. In reality, mechanical engineers can work anywhere, given the versatility of the field. With the skills students will acquire in this programme, they will be better equipped to contribute to improving national productivity and economic growth in general while earning a decent living.

1.3 Basic Principles

The following are the basic principles which will inform the teaching imparted in the B.Eng. programmes of the School of Science and Technology:

- Human beings are moral beings whose behaviours are not mechanically determined by either internal or external factors and who cannot attain fulfilment if they restrict their activity to the pursuit of their own individual interests.
- The purpose of an enterprise is not restricted to producing profits for their owners nor can the objective of maximising profit be the supreme standard of decision. Organisations are members of larger societies and must contribute to their common good. The activities of organisations must also be compatible with - and contribute to - the full human development of those who work in them.
- Organisations are not mere production units. First and foremost they must be human communities where all have an opportunity to participate and contribute responsibly to the common good of the organisation and that of society.
- Organisations are not justified in creating and marketing products or services by the mere fact that a demand for them exists or can be created. The value of the organisation's activity ultimately depends on its serving authentic human needs and values.
- Organisations must respect the dignity of all the human persons (employees, customers, suppliers...) with whom they relate in the exercise of their activity. A person's dignity is not respected when one chooses to harm him or her, even if this is done as a means to attain some desirable objective.

1.4 Overview of the Programme

Mechanical engineering is the application of the principles of engineering physics (namely of motion, energy, and force), mathematics, materials science and engineering problem-solving techniques to the design, analysis, manufacture, operation and maintenance of mechanical systems while ensuring competitive costing, safety, reliability and efficiency of such systems. The mechanical engineering discipline employs such contemporary design tools such as computer-aided design (CAD), computer-aided manufacturing (CAM), and product life cycle management tools to design and analyse a wide variety of systems.

This curriculum is designed in line with contemporary global trends in Mechanical Engineering education; emphasizing the development of mathematical models of materials, mass, momentum and energy balances leading to the description of conservation laws of nature. These lead to several important constitutive models and multiphysics covering such special fields as:

1. Linear, nonlinear, and applied Mechanics (involving the analysis of the behaviour of solid bodies subjected to external loads, stresses and/or vibrations and using the information in the design and manufacture/construction of such bodies)
2. Fluid Mechanics (involving the analysis of the behaviour of liquids and gases and employing the knowledge in the design and development of machinery and systems that can and/or do influence that behaviour – pumps, fans, turbines, piping systems, *et cetera*)
3. Thermal Engineering [including Thermodynamics and Heat Transfer] (involving the analysis of the conversion of thermal energy into work and/or other forms of energy and thermal energy transport and employing this knowledge in the design and development of energy conversion devices and systems, e.g., power plants, engines, heating, ventilation & air conditioning (HVAC) systems, etc.)
4. Mechanical Design and Manufacturing Engineering (covering the full range of mechanical-based products and systems); arising from the above engineering sciences synthesized together into modern software solutions of the resulting complex equations that, added to 3D Solid models, simulation analysis and optimization produce useful design tools
5. Industrial Engineering and Management Sciences

1.5 Philosophy of the Programme

The Mechanical Engineering program at Pan-Atlantic University aims to produce graduates with high academic standards and practical skills for self-employment and industry. The program provides a strong foundation in engineering principles, preparing students for careers in engineering, academia, and entrepreneurship. Emphasis is placed on problem-solving, critical thinking, and ethical professional conduct. Students are trained in design, manufacturing, mechatronics, materials, fluid mechanics, thermodynamics, and computer-aided engineering tools. The goal is to develop professionals who uphold high intellectual, ethical, and professional values, fostering creativity, social responsibility, and a spirit of enterprise.

1.6 **Objectives of the Programme**

The objectives of the undergraduate Mechanical Engineering programme are to prepare its graduates to:

1. actively engage in engineering practice or in other fields, such as education, science, business, public policy, politics or governance for sustainable development;
2. retain intellectual curiosity that will motivate them to pursue meaningful lifelong learning via graduate education in engineering or related fields, participation in professional development and/or industrial training courses, and/or obtain engineering certification;
3. develop successful careers as mechanical engineers and apply their mechanical engineering education to address the full range of technical and societal problems with professional engineering competence, creativity, imagination, confidence and responsibility;
4. occupy positions of increasing responsibility and/or assignments and aspire to positions of leadership within their profession for enhanced community participation and qualitative service delivery; and
5. exhibit the highest ethical and professional standards, and, as agents of positive change, communicate the importance and excitement of Mechanical Engineering.

1.7 Unique Features of the Programme

Some unique features of the programme include:

1. stimulating intellect and encouraging students towards developing ingenuity and originality in problem solving;
2. encouraging students to maintain intellectual curiosity that will motivate them to pursue meaningful lifelong learning; and
3. equipping students with the relevant intellectual capacity, contemporary software proficiency, communication, entrepreneurial and
4. other relevant soft skills like teamwork, flexibility, adaptability and interpersonal knack to engage effectively in engineering practice, business and in leadership roles.

1.8 Employability Skills

Graduates of this programme may find jobs in diverse sectors as:

1. in the automobile, aerospace, biomedical, building and construction, food and beverages, manufacturing, oil and gas, power, petrochemical and process, railway and telecommunication industries, and as
2. industrial systems engineers, product designers, managers, researchers, applied mathematicians, and, of course, performing a multitude of other traditional Mechanical Engineering duties.

The curriculum is designed to:

1. equip graduates of the Mechanical Engineering programme with the intellectual capacity (to apply the principles of engineering physics, mathematics, materials science and engineering problem-solving techniques) and relevant contemporary skills;
2. offer students skills that are highly sought after and highly remunerated in industry;

3. prepare graduates to undertake the challenge of working on a wide range of projects, with the prospect of working with a broad spectrum of other professionals; and
4. develop successful careers as mechanical engineers and apply their mechanical engineering education to address the full range of technical and societal problems with professional engineering competence, creativity, imagination, confidence and responsibility.

1.9 21st Century Skills

The programme emphasises such contemporary skills as:

1. developing ingenuity and originality in critical thinking/ problem solving/decision making;
2. creativity and innovation;
3. information literacy;
4. intellectual curiosity that will motivate them to pursue meaningful lifelong learning;
5. contemporary software proficiency;
6. effective communication skills;
7. entrepreneurial capability;
8. collaboration (teamwork and work ethic);
9. Flexibility and adaptability; and
10. Learning to learn/metacognition.

1.10 Admission and Matriculation Requirements

Prospective students would need to satisfy the following general requirements:

(a) Admissions shall be through the Joint Admissions and Matriculations Board (JAMB);

(b) For admission to 100-Level through the Unified Tertiary Matriculation Examination (UTME/Indirect Entry), candidates should:

   i. Obtain at least five (5) credit level passes at Senior Secondary School Certificate Examination (SSSCE) or equivalent in relevant subjects including English Language, Mathematics, Physics, Chemistry, and other acceptable science subjects (Further Mathematics and Technical Drawing provide an advantage) at not more than two sittings;
   ii. Score preferably a minimum of 220 points in UTME. The minimum point required is subject to review by the University from time to time.
   iii. Pass the Post-UTME interview organized by the university.

(c) For admission into 200-Level (Direct Entry), candidates should (in addition to 5 SSCE credits in relevant subjects including English Language and Mathematics in not more than two sittings):
Pass Mathematics, Physics, and Chemistry at GCE ‘A’ level or equivalent. Holders of a National Diploma at a minimum of Upper Credit level are eligible for

consideration for admission into the 200 level. They are also required to pass the interview organized by the university.

(d) *Inter-University Transfer Mode*
Students can transfer into 200-Level courses provided they have the relevant qualifications and pass the interview organized by the Pan-Atlantic University (PAU). PAU is to satisfy itself that the grades obtained by such candidates from their previous institution are acceptable.

1.11 The Semester Course System

The undergraduate programmes will run on a Semester Course basis. There shall ordinarily be two semesters in an academic year, except the University Council through Senate shall provide otherwise.

(i) Instruction in the programme shall be by courses.
(ii) There shall be five levels of courses in line with the years of study. Level or year 1 courses are 100, 101, etc., and Level 2 or year 2 courses are 200, 201, etc.
(iii) Students will be required to complete their registration for the courses within the period stipulated by the PAU Senate. Amendment of this registration will be allowed through the addition or deletion of courses but it must take place within the time stipulated by the Senate.
(iv) Failure to register for the courses for a given semester means that the student will be deemed absent for the entire semester.

1.12 Examination and Grading System

Students will be evaluated through a combination of Laboratory Experiments, Continuous Assessment Tests (30%), Class participation (5%), End-of-Semester Examinations (65%). For the purely practical/workshop courses, Continuous Assessment will carry 100 marks.

To be eligible to sit for any examinations, students will be expected to attend a minimum of 80% of the lectures of any course registered for. The School reserves the right to prevent any defaulting student from sitting for the relevant examination.

All courses registered for will be taken into consideration during the computation of results. Students will not be credited for courses which they did not register for, even if they are inadvertently allowed to take the examinations and pass them. Failure to take the examination in a course for which one has registered will attract a score of 0.0, which will have the consequent effect of lowering the student's Grade Point Average.

(i) Special examinations to enable a student to graduate may in exceptional circumstances be held by order of the Senate.

(ii) Grades will be awarded based on the scores of the students as follows:

Percent score	Grade point	Letter Grade
70 – 100	5.0	A
60 – 69.9	4.0	B
50 – 59.9	3.0	C
45 – 49.9	2.0	D
40 – 44.9	1.0	E
0 – 39.9	0	F

The following qualifications shall be applied to the grades:

A	Excellent
B	**Very Good**
C	Good
D	Fair
E	Pass
F	Fail

(iii) To obtain the Cumulative Grade Point Average (CGPA) of the student, the grade point assigned to the mark obtained in each course is multiplied by the units of that course. The total from all the courses is added up to give the total weighted grade point. This total is then divided by the total number of units taken by the student to give the grade point average.

(iv) For the purpose of calculating a student's CGPA, grades obtained in ALL registered courses, whether passed or failed, must be included in the computation.

1.13 Retention and Progression

To remain in the School, students will be required to ensure that their CGPA does not fall below a certain minimum standard. A student must pass all the specified courses, and obtain a minimum CGPA of 1.5 at the end of every semester. Any student who does not meet this requirement will be placed on probation. If after one semester on probation, the CGPA remains below 1.5, the student shall be asked to withdraw. A student on probation should register for a maximum of 18 credit units.

1.14 Period of Study and Requirements for the Award of a Degree

The normal period of study for a degree shall be ten (10) semesters.

The determination of the class of degree shall be based on the weighted grade points of all the courses taken. The award of the degree shall be dependent on the student having obtained a Cumulative Grade Point Average of at least 1.5 in addition to fulfilling other minimum requirements for an honours degree.

The following classes of degree are approved for the CGPA indicated:

Class of Degree	**Cumulative GPA**
First Class	**4.50 - 5.00**
Second Class (*Upper Division*)	**3.50 – 4.49**
Second Class (*Lower Division*	**2.50 – 3.49**
Third Class	**1.50 – 2.49**
Pass	**1.00 – 1.49**
Fail	**Less than 1.0**

1.15 Graduation Requirements

To qualify for the award of a degree from Pan-Atlantic University:

1. Candidates admitted through the UTME mode shall have registered for a minimum of 150 and a maximum of 190 units of courses during the 5 – year engineering degree programme. Such candidates shall have spent a minimum of ten academic semesters.

2. Candidates admitted through the Direct entry mode shall have registered for a minimum of 120 and a maximum of 155 units of courses during a 4 – year engineering degree programme. Such candidates shall have spent a minimum of eight academic semesters.
3. The minimum and maximum credit load per semester is 15 and 24 credit units respectively.
4. A student shall have completed and passed all the Courses registered for, including all compulsory courses and such elective /optional courses as may be specified by the university/faculty or department; obtained a minimum Cumulative Grade Point Average (CGPA) specified by the university but not less than 1.00.
5. A student shall also have earned the 13 credit units of the Students Industrial Work Experience Scheme (SIWES), eight credit units of University General Study courses, and four credit units of Entrepreneurship courses.

For the purpose of calculating a student's cumulative grade point average (CGPA) in order to determine the class of Degree to be awarded, grades obtained in ALL the courses registered, whether compulsory or optional and whether passed or failed must be included in the computation. Even when a student repeats the same course once or more before passing it or substitutes another course for a failed optional course, grades scored at each and all attempts shall be included in the computation of the GPA.

Pre-requisite courses must be taken and passed before a particular course at a higher level.

Furthermore, if a student fails to graduate at the end of the normal academic session, he or she would not be allowed to exceed the total allowable semesters as approved by the Senate from time to time.

Graduation Requirement is 177 Units. All courses registered must be passed.

Table 5: Global Course Structure

Level	GST/ENT	Basic Science	Discipline GET	Programme (MEE/PAU-MEE)	Electives	SIWES	Total Units
100	6	27	3	2	-	-	38
200	6	-	33	0	-	3	42
300	4	-	18	20		4	46
400	-	-	5	15	6	6	32
500	-	-	7	8	16	-	31
Total	**16**	**27**	**66**	**45**	**22**	**13***	**189**
Required	**16**	**27**	**66**	**45**	**10**	**13***	**177**

*All 13 SIWES units credited in the 2^{nd} Semester of 400-Level

2.0 CURRICULUM FOR B.Eng. DEGREE IN MECHANICAL ENGINEERING IN AGREEMENT WITH THE NUC CCMAS (2023)

NOTE the following legend for the list of courses below:
C = Compulsory Course – A course that every student must compulsorily take and pass in any particular programme at a particular level of study.

E = Elective Course – A course that students take within or outside the faculty (school). Students may graduate without passing the course provided the minimum credit unit for the course had been attained.

R = Required Course – A course that you take at a level of study and must be passed before graduation

LH = Lecture Hours per semester
PH = Practical Hours per semester

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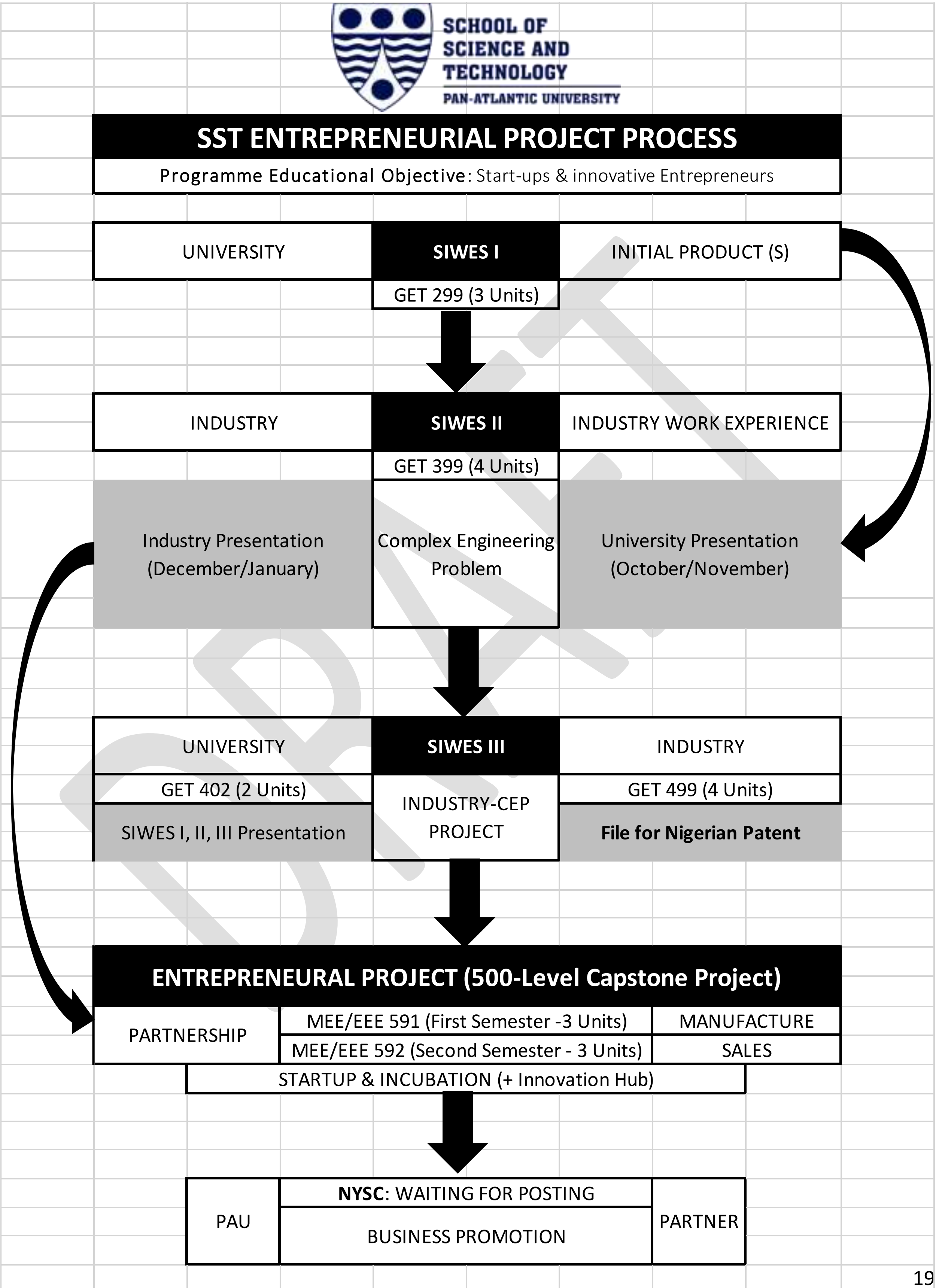
Mechanical Engineering Programme Outline 2023-2027

100 Level	**38**
GET	**3**
GET 100 Remedial Technical Drawing	0
GET 101 Engineer in Society	1
GET 102 Engineering Graphics and Solid Modelling I	2
GST	**6**
GST 111 Communication in English	2
GST 112 Nigerian People and Culture	2
MEE 192 Introduction to Christian Theology	2
MEE	**2**
MEE 101 Introduction to Mechanical Engineering	2
Science	**27**
CHM 101 General Chemistry I	
CHM 102 General Chemistry II	3
CHM 107 General Practical Chemistry I	1
CHM 108 General Practical Chemistry II	1
MTH 102 Elementary Mathematics II	2
MTH 103 Elementary Mathematics III (Vectors, Geometry and Dynamics)	2
PAU-MEE 112 Probability for Engineers	3
PHY 101 General Physics I (Mechanics)	2
PHY 102 General Physics II (Behaviour of Matter)	2
PHY 103 General Physics III (Electricity and Magnetism	2
PHY 104 General Physics IV (Vibration, Waves, and Optics)	2
PHY 107 General Practical Physics I	1
PHY 108 General Physics Practical II	1
MTH 101 Elementary Mathematics I	2
200 Level	**42**
GET	**33**
GET 201 Applied Electricity I	3
GET 202 Engineering Materials	3
GET 203 Engineering Graphics and Solid Modelling II	2
GET 204 Students Workshop Practice	2
GET 205 Fundamentals of Fluid Mechanics	3
GET 206 Fundamentals of Thermodynamics	3
GET 207 Applied Mechanics I	3
GET 208 Strength of Materials	3
GET 209 Engineering Mathematics I	3
GET 210 Engineering Mathematics II	3
GET 211 Computing and Software Engineering	3
PAU-MEE 202 Applied Electricity II	2

GST	**6**
ENT 211 Entrepreneurship and Innovation	2
GST 212 Philosophy, Logic, and Human Existence	2
PAU-MEE 202 The Nature of Human Beings	2
SIWES	**3**
GET 299 SIWES I (Project-based with Engineering Design)	3
300 Level	**46**
GET	**18**
GET 301 Engineering Mathematics III	3
GET 302 Engineering Mathematics IV	3
GET 304 Technical Writing and Communication (including Seminar Presentation kills)	3
GET 305 Engineering Statistics and Data Analytics.	3
GET 306 Renewable Energy Systems and Technology	3
GET 307 Introduction to Artificial Intelligence, Machine Learning and Convergent Technologies	3
GST	**4**
ENT 312 Venture Creation	2
PAU-MEE 309 Professional and Personal Skills	2
MEE	**20**
MEE 306 Computer-Aided Design and Manufacture	1
PAU-MCE 302 Introduction to Robotics	2
PAU-MEE 307 Theory of Machines I	2
PAU-MEE 310 Fluid Mechanics II	2
PAU-MEE 312 Engineering Metallurgy	2
PAU-MEE 313 Manufacturing and Engineering Technology	2
PAU-MEE 315 Control Systems Engineering	3
PAU-MEE 322 Metrology	2
PAU-MEE 331 Engineering Graphics and Solid Modelling III	2
PAU-MEE-306 Thermodynamics II	2
SIWES	**4**
GET 399 SIWES II (Project-based with Engineering Design)	4
400 Level	**32**
GET	**5**
PAU-MEE 401 Professional Ethics for Engineers	2
PAU-MEE 402 Engineering Economics	3
MEE	**13**
MEE 401 Mechanical (Machine) Engineering Design II	2
MEE 402 Theory (Mechanics) of Machines I	2
MEE 403 Applied (Engineering) Thermodynamics I	2
MEE 404 Applied Fluid Mechanics	2
MEE 405 Heat and Mass Transfer	3

MEE 407 Advanced Mechanics of Materials	2
SIWES	**8**
GET 402 Engineering Project I	2
GET 404 Engineering Valuation and Appraisal	2
GET 499 SIWES III (Project-based with Engineering Design)	4
ELECTIVE	**6**
PAU-IPE 422 Production and Inventory Systems Design	2
PAU-MCE 404 Computer Vision and Image Processing	2
PAU-MEE 409 Corrosion Engineering and Protections	2
500 Level	**31**
GET	**7**
GET 501 Engineering (Project) Management	3
GET 502 Engineering Law	2
PAU-MEE 510 Engineering Management	2
MEE	**8**
MEE 501 Applied Design	2
MEE 591 B.Eng. Project I	3
MEE 592 B.Eng. Project II	3
ELECTIVE	**16**
PAU-MEE 503 Applied Thermodynamics II	2
PAU-MEE 504 Mechanical (Machine) Design Engineering III	2
PAU-MEE 507 Theory of Elasticity and Plasticity	2
PAU-MEE 511 Tribology	2
PAU-MEE 512 Turbomachinery	2
PAU-MEE 518 Industrial Automation and Control	2
PAU-MEE 521 Design of Mechatronics Engineering and Robotics Systems	2
PAU-MEE 522 Automotive System Design	2
Grand Total	**189**
LESS ELECTIVES 12 out of 22	**-12**
REQUIRED FOR GRADUATION	**177**


SCHOOL OF SCIENCE AND TECHNOLOGY
PAN-ATLANTIC UNIVERSITY
SST ENTREPRENEURIAL PROJECT PROCESS
Programme Educational Objective: Start-ups & innovative Entrepreneurs
UNIVERSITY
SIWES I
INITIAL PRODUCT (S)
GET 299 (3 Units)
INDUSTRY
SIWES II
INDUSTRY WORK EXPERIENCE
GET 399 (4 Units)
Industry Presentation (December/January)
Complex Engineering Problem
University Presentation (October/November)
UNIVERSITY
SIWES III
INDUSTRY
GET 402 (2 Units)
INDUSTRY-CEP PROJECT
GET 499 (4 Units)
SIWES I, II, III Presentation
File for Nigerian Patent
ENTREPRENEURAL PROJECT (500-Level Capstone Project)
PARTNERSHIP
MEE/EEE 591 (First Semester -3 Units)
MEE/EEE 592 (Second Semester - 3 Units)
MANUFACTURE
SALES
STARTUP & INCUBATION (+ Innovation Hub)
PAU
NYSC: WAITING FOR POSTING
BUSINESS PROMOTION
PARTNER

Mechanical Engineering Programme Outline 2023

Course Structure at 100-Level Mechanical Engineering Degree Programme

Course Code	Course Title	Units	Status	LH	PH
First Semester					
GET 100	Remedial Technical Drawing	0	E		45
GET 101	Engineer in Society	1	C	15	
MEE 101	Introduction to Mechanical Engineering	2	C	30	
GST 111	Communication in English	2	C	30	
CHM 101	General Chemistry I	2	C	30	
CHM 107	General Practical Chemistry I	1	C		45
MTH 101	Elementary Mathematics I	2	C	30	
PHY 101	General Physics I (Mechanics)	2	C	30	
PHY 102	General Physics II (Behaviour of Matter)	2	C	30	
PHY 107	General Practical Physics I	1	C		45
MEE 192	Introduction to Christian Theology	2	C	30	
	Sub Total	**17**			
Second Semester					
GST 112	Nigerian People and Culture	2	C	30	
GET 102	Engineering Graphics and Solid Modelling I	2	C	15	45
CHM 102	General Chemistry II	2	C	30	
CHM 108	General Practical Chemistry II	1	C		45
MTH 102	Elementary Mathematics II	2	C	30	
MTH 103	Elementary Mathematics III (Vectors, Geometry and Dynamics)	2	C	30	
PHY 108	General Physics Practical II	1	C		45
PHY 103	General Physics III (Electricity and Magnetism	2	C	30	
PHY 104	General Physics IV (Vibration, Waves, and Optics)	2	C	30	
PAU-MEE 112	Probability for Engineers	3	C	30	
	Sub Total	**19**			
	TOTAL UNITS	**36**			

Course Structure at 200-Level Mechanical Engineering Degree Programme

Course Code	Course Title	Units	Status	LH	PH
First Semester					
GET 201	Applied Electricity I	3	C	45	-
GET 205	Fundamentals of Fluid Mechanics	3	C	45	-
GET 209	Engineering Mathematics I	3	C	45	-
GET 211	Computing and Software Engineering	3	C	30	45
GET 203	Engineering Graphics and Solid Modelling II	2	C	15	45
GET 207	Applied Mechanics I	3	C	30	45
PAU-MEE 292	The Nature of Human Beings	2	C	30	
ENT 211	Entrepreneurship and Innovation	2	C	30	-
		21			
Second Semester					
GET 202	Engineering Materials	3	C	45	-
GET 204	Students Workshop Practice	2	C	15	45
GET 208	Strength of Materials	3	C	45	-
GET 210	Engineering Mathematics II	3	C	45	-
GET 206	Fundamentals of Thermodynamics	3	C	45	-
PAU-MEE 202	Applied Electricity II	2	C	15	45
GST 212	Philosophy, Logic, and Human Existence	2	C	30	-
	TOTAL UNITS	**18**			

SCHOOL OF SCIENCE AND TECHNOLOGY
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Course structure at 300-Level Mechanical Engineering

Course Code	Course Title	Units	Status	LH	PH
First Semester					
GET 301	Engineering Mathematics III	3	C	45	-
GET 305	Engineering Statistics and Data Analytics.	3	C	45	-
GET 306	Renewable Energy Systems and Technology	3	C	30	45
PAU-MEE 313	Manufacturing and Engineering Technology	2	C	15	45
PAU-MEE 307	Theory of Machines I	2	C	15	45
PAU-MEE 315	Control Systems Engineering	3	C	30	45
PAU-MEE 331	Engineering Graphics and Solid Modelling III	2	C	15	45
PAU-MCE 302	Introduction to Robotics	2	C	15	45
	Sub Total	**20**			
Second Semester					
GET 302	Engineering Mathematics IV	3	E	45	-
GET 304	Technical Writing and Communication (including Seminar Presentation Skills)	3	C	45	-
GET 307	Introduction to Artificial Intelligence, Machine Learning and Convergent Technologies	3	C	45	-
MEE 306	Computer-Aided Design and Manufacture	1	E		45
PAU-MEE-306	Thermodynamics II	2	C	15	45
PAU-MEE 310	Fluid Mechanics II	2	C	15	45
PAU-MEE 312	Engineering Metallurgy	2	C	15	45
PAU-MEE 322	Metrology	2	C	15	45
ENT 312	Venture Creation	2	C	15	45
PAU-MEE 309	Professional and Personal Skills	2	C	30	
	Sub Total	22			
	TOTAL UNITS	**42**			

Course structure at 400-Level Mechanical Engineering

Course Code	Course Title	Units	Status	LH	PH
MEE 401	Mechanical (Machine) Engineering Design II	2	C	30	-
MEE 403	Applied (Engineering) Thermodynamics I	2	C	30	-
MEE 405	Heat and Mass Transfer	3	C	45	-
MEE 407	Advanced Mechanics of Materials	2	C	30	-
PAU-MEE 409	Corrosion Engineering and Protections	2	E	30	
PAU-MEE 401	Professional Ethics for Engineers	2	C	30	
	TOTAL UNITS	**13**			
Second Semester					
MEE 402	Theory (Mechanics) of Machines I	2	C	30	-
MEE 404	Applied Fluid Mechanics	2	C	30	-
PAU-MEE 402	Engineering Economics	3	C	45	
PAU-MCE 404	Computer Vision and Image Processing	2	E	30	
GET 402	Engineering Project I	2	C		90
GET 404	Engineering Valuation and Appraisal	2	C	30	
PAU-IPE 422	Production and Inventory Systems Design	2	E	30	
	TOTAL UNITS	**15**			

SIWES Courses

Course Code	Course Title	Units	Status	LH/PH
GET 299	SIWES I (University)	3	C	9 weeks
GET 399	SIWES II (Industry)	4	C	12 weeks
GET 499	SIWES III (Industry)	4	C	12weeks
Total		**11***		

* All credited in the 2nd Semester of 400-level

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Course structure at 500-Level Mechanical Engineering

Course Code	Course Description Semester I	Units	Status	LH	PH
First Semester					
GET 501	Engineering (Project) Management	3	C	45	-
MEE 501	Applied Design	2	C	15	45
PAU-MEE 507	Theory of Elasticity and Plasticity	2	E	45	
PAU-MEE 503	Applied Thermodynamics II	2	E	30	
PAU-MEE 511	Tribology	2	E	30	
PAU-MEE 521	Design of Mechatronics Engineering and Robotics Systems	2	E	30	
MEE 591	B.Eng Project I	3	C		135
	Sub Total	16			
Second Semester					
GET 502	Engineering Law	2	C	30	-
PAU-MEE 504	Mechanical (Machine) Design Engineering III	2	**E**	30	
PAU-MEE 510	Engineering Management	2	E	30	
PAU-MEE 512	Turbomachinery	2	**E**	30	
PAU-MEE 518	Industrial Automation and Control	2	E	15	45
PAU-MEE 522	Automotive System Design	2	E	30	
MEE 592	B.Eng. Project II	3	C	-	135
	Sub Total	15			
	TOTAL UNITS	**31**			

COURSE CONTENT AND LEARNING OUTCOMES

100 Level

GST 111: Communication in English (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students should be able to:
1. identify possible sound patterns in English Language;
2. list notable language skills;
3. classify word formation processes;
4. construct simple and fairly complex sentences in English;
5. apply logical and critical reasoning skills for meaningful presentations;
6. demonstrate an appreciable level of the art of public speaking and listening; and
7. write simple and technical reports.

Course Contents

Sounds and sound patterns in English Language (vowels and consonants, phonetics and phonology); English word classes (lexical and grammatical words, definitions, forms, functions, usages, collocations); major word formation processes; the sentence in English (types: structural and functional); grammar and usage (tense, concord and modality). Reading and types of reading, comprehension skills, 3RsQ. Logical and critical thinking; reasoning methods (logic and syllogism, inductive and deductive argument, analogy, generalisation and explanations). Ethical considerations, copyright rules and infringements. Writing activities (pre-writing (brainstorming and outlining), writing (paragraphing, punctuation and expression), post- writing (editing and proofreading). Types of writing (summary, essays, letter, curriculum vitae, report writing, note-making). etc. Mechanics of writing. Information and Communication Technology in modern language learning. Language skills for effective communication. The art of public speaking.

GST 112: Nigerian Peoples and Cultures (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. analyse the historical foundation of Nigerian cultures and arts in pre-colonial times;
2. identify and list the major linguistic groups in Nigeria;
3. explain the gradual evolution of Nigeria as a political entity;
4. analyse the concepts of trade and economic self-reliance of Nigerian peoples in relation to national development;
5. enumerate the challenges of the Nigerian state regarding nation building;
6. analyse the role of the judiciary in upholding fundamental human rights
7. identify the acceptable norms and values of the major ethnic groups in Nigeria; and
8. list possible solutions to identifiable Nigerian environmental, moral and value problems.

Course Contents
Nigerian history, culture and art up to 1800 (Yoruba, Hausa and Igbo peoples and cultures; peoples and cultures of the minority ethnic groups). Nigeria under colonial rule (advent of colonial rule in Nigeria; colonial administration of Nigeria). Evolution of Nigeria as a political unit (amalgamation of Nigeria in 1914; formation of political parties in Nigeria; nationalist movement and struggle for independence). Nigeria and challenges of nation building (military intervention in Nigerian politics; Nigerian Civil War). Concepts of trade and economics of self-reliance (indigenous trade and market system; indigenous apprenticeship system among Nigerian peoples; trade, skill acquisition and self-reliance). Social justice and national development (definition and classification of law); Judiciary and fundamental rights. Individuals, norms and values (basic Nigerian norms and values, patterns of citizenship acquisition; citizenship and civic responsibilities; indigenous languages, usage and development; negative attitudes and conducts [Cultism, kidnapping and other related social vices]). Re-orientation, moral and national values (The 3Rs – Reconstruction, Rehabilitation and Re-orientation; re-orientation strategies: Operation Feed the Nation

(OFN), Green Revolution, Austerity Measures, War Against Indiscipline and Corruption (WAIC), Mass Mobilization for Self-Reliance, Social Justice and Economic Recovery (MAMSER), National Orientation Agency (NOA). Current socio-political and cultural developments in Nigeria.

GET 100 Remedial Technical Drawing (1 Unit, E, PH 45)

Course Contents (Remedial course for student without Technical Drawing Background)

Introduction of Engineering Drawing as means of communication. Drawing paper format. Use of drawing instruments. Type of lines and their use in Engineering Drawing. Circles and tangents. Plane geometry. Circles to satisfied conditions involving other circles, lines and points. Conic sections, various methods of their construction. Cycloid, epicycloids, and hypocycloids, involute. Archimedes spiral. Helix (cylindrical and conical) single and multi-start threads. Coiling of compression and tension springs. Loci- Paths of points on moving link work. The theory of projection. Perspective (briefly), parallel projections (oblique – general, cavalier, cabinet). (Orthographic – Multi-view, two views, three views, auxiliary views). (Axonometric – Isometric, Diametric, Trimetric). Multiview representation. 1st and 3rd angle projections. Isometric drawings. Oblique drawings. Freehand sketching.

GET 101: Engineer in Society (1 Unit C: LH 15)

Learning Outcomes

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

1. differentiate between science, engineering and technology, and relate them to innovation;
2. distinguish between the different cadres of engineering – engineers, technologists, technicians and craftsmen and their respective roles and competencies;
3. identify and distinguish between the relevant professional bodies in engineering;
4. categorise the goals of global development or sustainable development goals (SDGs); and
5. identify and evaluate safety and risk in engineering practice.

Course Contents
History, evolution and philosophy of science. engineering and technology. The engineering profession – engineering family (engineers, technologists, technicians and craftsmen), professional bodies and societies. Engineers' code of conduct and ethics, and engineering literacy. Sustainable development goals (SDGs), innovation, infrastructures and nation building - economy, politics, business. Safety and risk analysis in engineering practice. Engineering competency skills – curriculum overview, technical, soft and digital skills. Guest seminars and invited lectures from different engineering professional associations.

GET 102: Engineering Graphics and Solid Modelling I (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. have a good grasp of design thinking and be obsessed with the determination to apply such to solving simple everyday and also complex problems;
2. recognise the fundamental concepts of engineering drawing and graphics;
3. show skills to represent the world of engineering objects in actionable solid models, and put such models in a form where they can be inputs for simulation and analyses;
4. analyse such models for strength and cost;
5. prepare the objects for modern production and manufacturing techniques of additive and subtractive manufacturing;
6. recognise that engineering is multidisciplinary in the sense that mechanical, electrical and other parts of physical structures are modelled in context as opposed to the analytical nature of the courses they take; and
7. analyse and master the basics of mechanical and thermal loads in engineering systems.

Course Contents
Introduction to design thinking and engineering graphics. First and third angle orthogonal projections. Isometric projections; sectioning, conventional practices, conic sections and development. Freehand and guided sketching – pictorial and orthographic. Visualisation and solid modelling in design, prototyping and product-making. User interfaces in concrete terms. Design, drawing, animation, rendering and simulation workspaces. Sketching of 3D objects. Viewports and sectioning to shop drawings in orthographic projections and perspectives. Automated viewports. Sheet metal and surface modelling. Material selection and rendering. This course will use latest professional design tools such as fusion 360, solid works, solid edge or equivalent.

CHM 101: General Chemistry I (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. define atom, molecules and chemical reactions;
2. discuss the modern electronic theory of atoms;
3. write electronic configurations of elements on the periodic table;
4. rationalise the trends of atomic radii, ionisation energies, electronegativity of the elements, based on their position in the periodic table;
5. identify and balance oxidation–reduction equation and solve redox titration problems;
6. draw shapes of simple molecules and hybridised orbitals;
7. identify the characteristics of acids, bases and salts, and solve problems based on their quantitative relationship;

8. apply the principles of equilibrium to aqueous systems using LeChatelier's principle to predict the effect of concentration, pressure and temperature changes on equilibrium mixtures;
9. analyse and perform calculations with the thermodynamic functions, enthalpy, entropy and free energy; and
10. determine rates of reactions and its dependence on concentration, time and temperature.

Course Contents
Atoms, molecules, elements and compounds, and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridisation and shapes of simple molecules. Valence forces; Structure of solids. Chemical equations and stoichiometry; chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (2 Units C: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. state the importance and development of organic chemistry;
2. define fullerenes and its applications;
3. discuss electronic theory;
4. determine the qualitative and quantitative of structures in organic chemistry;
5. state rules guiding nomenclature and functional group classes of organic chemistry;
6. determine the rate of reaction to predict mechanisms of reaction;
7. identify classes of organic functional group with brief description of their chemistry;
8. discuss comparative chemistry of group 1A, IIA and IVA elements; and
9. describe basic properties of transition metals.

Course Contents
Historical survey of the development and importance of organic chemistry; fullerenes as fourth allotrope of carbon, uses as nanotubules, nanostructures, nanochemistry. Electronic theory in organic chemistry. Isolation and purification of organic compounds; determination of structures of organic compounds including qualitative and quantitative analysis in organic chemistry; nomenclature and functional group classes of organic compounds. Introductory reaction mechanism and kinetics. Stereochemistry. The chemistry of alkanes, alkenes, alkynes, alcohols, ethers, amines, alkyl halides, nitriles, aldehydes, ketones, carboxylic acids and derivatives. The chemistry of selected metals and non-metals. Comparative chemistry of group IA, IIA and IVA elements. Introduction to transition metal chemistry.

CHM 107: General Practical Chemistry I (1 Unit C: PH 45)

Learning Outcomes

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

1. state the general laboratory rules and safety procedures;
2. collect scientific data and correct carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. state the differences between primary and secondary standards;
5. perform redox titration;
6. record observations and measurements in the laboratory notebooks; and
7. analyse the data to arrive at scientific conclusions.

Course Contents

Laboratory experiments designed to reflect topics presented in courses CHM 101 and CHM 102. These include acid-base titrations, qualitative analysis, redox reactions, gravimetric analysis, data analysis and presentation.

CHM 108: General Practical Chemistry II (1 Unit C: PH 45)

Learning Outcomes

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

1. state the general laboratory rules and safety procedures;
2. collect scientific data and correctly carry out chemical experiments;
3. identify the basic glassware and equipment in the laboratory;
4. identify and carry out preliminary tests which include ignition, boiling point, melting point, test on known and unknown organic compounds;
5. carry out solubility tests on known and unknown organic compounds;
6. carry out elemental tests on known and unknown compounds; and
7. carry out functional group/confirmatory test on known and unknown compounds which could be acidic/basic/ neutral organic compounds.

Course Contents

Continuation of CHM 107. Additional laboratory experiments to include functional group analysis, quantitative analysis using volumetric methods.

MTH 101: Elementary Mathematics I (Algebra and Trigonometry) (2 Units C: LH 30)

Learning Outcomes

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

1. define and explain set, subset, union, intersection, complements, and demonstrate the use of Venn diagrams;
2. solve quadratic equations;
3. solve trigonometric functions;
4. identify various types of numbers; and
5. solve some problems using binomial theorem.

Course Contents

Elementary set theory, subsets, union, intersection, complements, Venn diagrams. Real numbers, integers, rational and irrational numbers. Mathematical induction, real sequences and series, theory of quadratic equations, binomial theorem, complex numbers, algebra of complex numbers, the argand diagram. De-Moiré's theorem, nth roots of unity. Circular measure, trigonometric functions of angles of any magnitude, addition and factor formulae.

MTH 102: Elementary Mathematics II (Calculus) (2 Units C: LH 30)

Learning Outcomes

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

1. identify the types of rules in differentiation and integration;
2. recognise and understand the meaning of function of a real variable, graphs, limits and continuity;
3. solve some applications of definite integrals in areas and volumes;
4. solve function of a real variable, plot relevant graphs, identify limits and idea of continuity;
5. identify the derivative as limit of rate of change;
6. identify techniques of differentiation and perform extreme curve sketching;
7. identify integration as an inverse of differentiation;
8. identify methods of integration and definite integrals; and
9. perform integration application to areas, volumes.

Course Contents

Functions of a real variable, graphs, limits and idea of continuity. The derivative, as limit of rate of change. Techniques of differentiation, maxima and minima. Extreme curve sketching, integration, definite integrals, reduction formulae, application to areas, volumes (including approximate integration: Trapezium and Simpson's rule).

MTH 103: Elementary Mathematics III (Vectors, Geometry and Dynamics) (2 Units C: LH 30)

Learning Outcomes

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

1. solve some vectors in addition and multiplication;
2. calculate force and momentum; and
3. solve differentiation and integration of vectors.

Course Contents (Pre-requisite –MTH 101)

Geometric representation of vectors in 1-3 dimensions, components, direction cosines. Addition, scalar, multiplication of vectors, linear independence. Scalar and vector products of two vectors. Differentiation and integration of vectors with respect to a scalar variable. Two-dimensional co-ordinate geometry. Straight lines, circles, parabola, ellipse, hyperbola. Tangents, normals. Kinematics of a particle. Components of velocity and acceleration of a particle moving in a plane. Force, momentum, laws of motion under gravity, projectiles and resisted vertical motion. Elastic string and simple pendulum. Impulse, impact of two smooth spheres and a sphere on a smooth surface.

PHY 101: General Physics I (Mechanics) (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. identify and deduce the physical quantities and their units;
2. differentiate between vectors and scalars;
3. describe and evaluate motion of systems on the basis of the fundamental laws of mechanics;
4. apply Newton's laws to describe and solve simple problems of motion;
5. evaluate work, energy, velocity, momentum, acceleration, and torque of moving or rotating objects;
6. explain and apply the principles of conservation of energy, linear and angular momentum;
7. describe the laws governing motion under gravity; and
8. explain motion under gravity and quantitatively determine behaviour of objects moving under gravity.

Course Contents
Space and time; units and dimension, vectors and scalars, differentiation of vectors: displacement, velocity and acceleration; kinematics; Newton's laws of motion (inertial frames, impulse, force and action at a distance, momentum conservation); relative motion; application of Newtonian mechanics; equations of motion; conservation principles in physics, conservative forces, conservation of linear momentum, kinetic energy and work, potential energy, system of particles, centre of mass; rotational motion; torque, vector product, moment, rotation of coordinate axes and angular momentum. Polar coordinates; conservation of angular momentum; circular motion; moments of inertia, gyroscopes and precession; gravitation: Newton's law of gravitation, Kepler's laws of planetary motion, gravitational potential energy, escape velocity, satellites motion and orbits.

PHY 102: General Physics II (Behaviour of Matter) (2 Units C: LH 30)

Learning Outcomes
On completion, the students should be able to:
1. explain the concepts of heat and temperature and relate the temperature scales;
2. define, derive and apply the fundamental thermodynamic relations to thermal systems;
3. describe and explain the first and second laws of thermodynamics, and the concept of entropy;
4. state the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;

5. deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
6. describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents

Heat and temperature, temperature scales; gas laws; general gas equation; thermal conductivity; first Law of thermodynamics; heat, work and internal energy, reversibility; thermodynamic processes; adiabatic, isothermal, isobaric; second law of thermodynamics; heat engines and entropy, Zero's law of thermodynamics; kinetic theory of gases; molecular collisions and mean free path; elasticity; Hooke's law, Young's shear and bulk moduli; hydrostatics; pressure, buoyancy, Archimedes' principles; Bernoullis equation and incompressible fluid flow; surface tension; adhesion, cohesion, viscosity, capillarity, drops and bubbles.

PHY 107: General Practical Physics I (1 Unit C: PH 45)

Learning Outcomes

On completion, the student should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs; and
5. draw conclusions from numerical and graphical analysis of data.

Course Contents

This introductory course emphasizes quantitative measurements. Experimental techniques. The treatment of measurement errors. Graphical analysis. The experiments include studies of meters, the oscilloscope, mechanical systems, electrical and mechanical resonant systems, light, heat, viscosity, etc. (covered in PHY 101, 102, 103 and PHY 104). However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis, and deduction.

PHY 108: General Practical Physics II (1 Unit C: PH 45)

Learning Outcomes

On completion, the student should be able to:

1. conduct measurements of some physical quantities;
2. make observations of events, collect and tabulate data;
3. identify and evaluate some common experimental errors;
4. plot and analyse graphs;
5. draw conclusions from numerical and graphical analysis of data; and
6. prepare and present practical reports.

Course Contents

This practical course is a continuation of PHY 107 and is intended to be taught during the second semester of the 100 level to cover the practical aspect of the theoretical courses that have been covered with emphasis on quantitative measurements, the treatment of measurement errors, and graphical analysis. However, emphasis should be placed on the basic physical techniques for observation, measurements, data collection, analysis and deduction.

MEE 101: Introduction to Mechanical Engineering (1 Units C: LH 15)

Learning Outcomes:
At the end of this course, the students should be able to:
1. differentiate between science, engineering and technology, and relate them to innovation;
2. identify the various branches of mechanical engineering discipline and their applications to the solution of societal problems;
3. demonstrate appreciation of the problem of climate change; and
4. demonstrate appreciation of the role of energy systems to environmental sustainability.

Course Contents
Historical development of the mechanical engineering discipline. Philosophy and scope of contemporary mechanical engineering course programme. Overview of mechanical engineering special fields: applied (solid) mechanics, fluid and thermal engineering (thermodynamics and heat transfer). Industrial/production engineering and engineering management sciences. The linkage between mechanical engineering and other engineering disciplines and the sciences. The concept of innovation. Illustrations of a wide variety applications of mechanical engineering. The role of mechanical engineers in the society and human development. Professional ethical responsibility. Climate change, renewable energy and environmental sustainability.

PAU-MEE 102 General Physics III (Electricity, Magnetism and Modern Physics) (2 Units, Core, LH=30)

Learning Outcomes
On completion of the course, students should be able to:
1. describe the various field types emanating from different geometric arrangement of stationary charges
2. apply the equation $dq = \lambda dl$ to calculate electrostatic properties of simple charge distributions
3. describe the magnetic field of a long wire
4. determine the magnetic properties of simple current distributions such as straight wire, circular loop, and solenoid
5. apply Faraday's first and second laws to calculate change in flux linkages
6. State Gauss's law, Faraday's law, and Ampere-Maxwell's laws in integral forms

7. Solve for electric voltage, current, resistance, electric power and energy, and difference between conventional and electron current flow for simple DC circuits
8. differentiate among resistors, capacitors, and Inductors in terms of their voltages and currents

Course contents

Forces in nature. Electrostatics (electric charge and its properties, methods of charging). Coulomb's law and superposition. Electric field and potential. Gauss's law. Capacitance. Electric dipoles. Energy in electric fields. Conductors and insulators. DC circuits (current, voltage and resistance). Ohm's law. Resistor combinations. Analysis of DC circuits. Magnetic fields. Lorentz force. Biot-Savart and Ampère's laws. Magnetic dipoles. Dielectrics. Energy in magnetic fields. Electromotive force. Electromagnetic induction. Self and mutual inductances. Faraday and Lenz's laws. Step up and step-down transformers. Maxwell's equations. Electromagnetic oscillations and waves. AC voltages and currents applied to inductors, capacitors, and resistance.

PAU-MEE 104 General Physics IV (Vibration, Waves and Optics) (2 Units, Core, LH=30)

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

1. Describe the principles of polarization, diffraction and interference;
2. Discuss the motion of a mass on a spring and state the categories of waves
3. Explain transmission, reflection and refraction of light
4. Explain reflection of a pulse, longitudinal waves, and standing waves on a string
5. Explain reflection and refraction in mirrors and lenses

Course contents
Simple harmonic motion (SHM). Energy in a vibrating system. Damped SHM. Resonance and transients. Coupled SHM. Q values and power response curves. Normal modes. Waves (types and properties of waves as applied to sound). Transverse and longitudinal waves (superposition, interference, diffraction, dispersion, polarization). Waves at interfaces (energy and power of waves). The wave equation. 2-D and 3-D wave equations. Wave energy and power. Phase and group velocities. Echo and beats. The Doppler-effect. Propagation of sound in gases, solids and liquids and their properties.

Optics: Nature and propagation of light. Reflection and refraction. Internal reflection. Scattering of light. Reflection and refraction at plane and spherical surfaces. Thin lenses and optical instruments. Wave nature of light. Dispersion. Huygens's principle (interference and diffraction).

PAU-MEE 112 Probability for Engineers (3 Units, Core, LH=45)

Learning outcomes

On completion of the course, the students should be able to:
1. Construct the probability of a sample space that consists of tossing a coin and/or rolling a die;
2. Use Pascal's triangle, Binomial expansion, Permutation, Combinations, Binomial theorem and the Binomial probability distribution to determine probability distributions;
3. State the five properties of mathematical expectations;
4. Solve probability problems involving joint, conditional and marginal distributions;
5. Use Bayes' theorem to solve problems of conditional probability.

Course content

Introduction to probability and its axioms. Mutually exclusive and independent events. Addition and multiplication rules of probability. Conditional probability and independence, Bayes' theorem. Random variables, mathematical expectations, and moments of random variables. Laws of large numbers. Chebyshev's inequality. Some special probability distributions: Bernoulli, binomial, geometric, negative binomial, Poisson, hypergeometric, normal and Weibull distributions.

PAU-MEE 103 Introduction to Christian Theology (2 Units, Core, LH=30)

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

1. Discuss at least 3 philosophical arguments about the existence of God;
2. Narrate a brief history of the Christian religion and the origins of the Bible;
3. Explain the relationship between science and faith using at least three concrete examples;
4. Explain three modern theories about the relationship between creation and evolution;
5. Analyze human actions to determine their morality based on the three criteria of action, circumstance, and intention;
6. List and explain the Ten Commandments and their implications;
7. Explain the Christian view of contemporary sexual issues like homosexuality, pornography and cohabitation;
8. Explain the ethics of handling the truth: detraction and keeping professional secrets;
9. Explain the ethics behind gambling; and
10. Explain the ethics behind contemporary issues relating to human life and drug use.

Course contents
The Existence of God. Divine Revelation. Creation and Evolution. Jesus Christ: both man and God. Eschatology. Human Freedom and Natural Law. Moral Conscience. Factors that

determine the Morality of Human Acts. Personal Sin and Responsibility. Influence of the Passions in Human Actions. The Virtues. Introduction to the Ten Commandments. Contemporary human Life issues. Contemporary sexual issues. The morality of Gambling. Contemporary issues regarding handling the truth. Christian Prayer.

200 Level

GST 212: Philosophy, Logic and Human Existence (2 Units C: LH 30)

Learning Outcomes
At the end of the course, students should be able to:
1. know the basic features of philosophy as an academic discipline;
2. identify the main branches of philosophy & the centrality of logic in philosophical discourse;
3. know the elementary rules of reasoning;
4. distinguish between valid and invalid arguments;
5. think critically and assess arguments in texts, conversations and day-to-day discussions;
6. critically asses the rationality or otherwise of human conduct under different existential conditions;
7. develop the capacity to extrapolate and deploy expertise in logic to other areas of knowledge, and
8. guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents
Scope of philosophy; notions, meanings, branches and problems of philosophy. Logic as an indispensable tool of philosophy. Elements of syllogism, symbolic logic— the first nine rules of inference. Informal fallacies, laws of thought, nature of arguments. Valid and invalid arguments, logic of form and logic of content — deduction, induction and inferences. Creative and critical thinking. Impact of philosophy on human existence. Philosophy and politics, philosophy and human conduct, philosophy and religion, philosophy and human values, philosophy and character molding.

ENT 211: Entrepreneurship and Innovation (2 Units C: LH 30)

Learning Outcomes
At the end of this course, students should be able to:
1. explain the concepts and theories of entrepreneurship, intrapreneurship, opportunity seeking, new value creation and risk-taking;
2. state the characteristics of an entrepreneur;
3. analyse the importance of micro and small businesses in wealth creation, employment generation and financial independence;
4. engage in entrepreneurial thinking;
5. identify key elements in innovation;

6. describe the stages in enterprise formation, partnership and networking, including business planning;
7. describe contemporary entrepreneurial issues in Nigeria, Africa and the rest of the world; and
8. state the basic principles of e-commerce.

Course Contents

The concept of entrepreneurship (entrepreneurship, intrapreneurship/corporate entrepreneurship); theories, rationale and relevance of entrepreneurship (Schumpeterian and other perspectives, risk-taking, necessity and opportunity-based entrepreneurship, and creative destruction); characteristics of entrepreneurs (opportunity seeker, risk-taker, natural and nurtured, problem solver and change agent, innovator and creative thinker); entrepreneurial thinking (critical thinking, reflective thinking and creative thinking). Innovation (The concept of innovation, dimensions of innovation, change and innovation, knowledge and innovation). Enterprise formation, partnership and networking (basics of business plan, forms of business ownership, business registration and alliance formation, and joint ventures). Contemporary entrepreneurship issues (knowledge, skills and technology, intellectual property, virtual office and networking). Entrepreneurship in Nigeria (biography of inspirational entrepreneurs, youth and women entrepreneurship, entrepreneurship support institutions, youth enterprise networks and environmental and cultural barriers to entrepreneurship). Basic principles of e-commerce.

GET 201: Applied Electricity I (3 Units C: LH 30; PH 45)

Learning Outcomes

Students will be able to:

1. discuss the fundamental concepts of electricity and electrical d.c. circuits;
2. state, explain and apply the basic d.c. circuit theorems;
3. explain the basic a.c. circuit theory and
4. apply to solution of simple circuits.

Course contents

Fundamental concepts: Electric fields, charges, magnetic fields. current, B-H curves Kirchhoff's laws, superposition. Thevenin, Norton theorems, Reciprocity, RL, RC, RLC circuits. DC, AC bridges, Resistance, Capacitance, Inductance measurement, Transducers, Single phase circuits, Complex j - notation, AC circuits, impedance, admittance, susceptance.

GET 202: Engineering Materials (3 Units C: LH 45)

Learning Outcomes

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

1. demonstrate the role of atoms and molecules (aggregates of atoms) in the building of solid/condensed matter known as engineering materials, the electrons quantum numbers

and how the electrons are arranged in different atomic elements, and explain the role of electronic configuration and valence electrons in bonding;

2. define metals, alloys and metalloids, demonstrate mental picture of the solid mineral resources development as a relay race among four 'athletes': geologist, mining engineer, mineral processing technologist, process metallurgical engineer, and classify metallurgical engineering into 3Ps: process, physical and production;
3. explain the relationship between structure and properties of materials, characteristics, components and compositions of phase diagrams and phase transformations of solid solutions;
4. define ceramics, glass and constituents of glasses and understand application of ceramics in mining, building, art and craft industries;
5. define and classify polymers as a class of engineering materials and polymeric materials, demonstrate polymerisation reactions, their types and mechanism, and applications of polymers;
6. define properties, types and application of composite materials and fibres (synthetic and natural);
7. define and classify nanomaterials, demonstrate applications of nanomaterials, concept, design and classification of fracture mechanics, corrosion classification, including the five principal ways of controlling corrosion and metal finishing processes such as sherardising, galvanising and anodising; and
8. identify factors affecting the performance and service life of engineering materials/metals and metallography of metals/materials (materials anatomy), which enables metallurgical and materials engineers to prescribe appropriate solutions to test metals/materials fitness in service through structure-property-application relationships.

Course Contents

Basic material science; atomic structure, atomic bonding and crystal structures. Engineering materials situating metals and alloys; metals and alloys, classifications of metals, metal extraction processes using iron and steel (ferrous) and aluminium (nonferrous) as examples, phase diagrams/iron carbon diagrams, and mechanical workings of metals. Selection and applications of metals and alloys for specific applications in oil, aerospace, construction, manufacturing and transportation industries, among others. Ceramics (including glass); definition, properties, structure and classifications of ceramics. Bioactive and glass – ceramics. Toughing mechanism for ceramics. Polymers; definition of polymers as engineering materials, chemistry of polymeric materials, polymer crystallisation, polymer degradation and aging. Thermoplastic and thermosetting polymers and concepts of copolymers and homopolymers. Composites; definition, classification, characterisation, properties and composite. Applications of composites. Nanomaterials; definition, classification and applications of nanomaterials as emerging technology. Processing of nanomaterials including mechanical grinding, wet chemical synthesis, gas phase synthesis, sputtered plasma processing, microwave plasma processing and laser ablation. Integrity assessment of engineering materials; effect of engineering design, engineering materials processing, selection, manufacturing and assembling on the performance and service life of engineering materials. Metallography and fractography of materials. Mechanical testing (destructive testing) of materials such as compressive test, tensile test, hardness test, impact test, endurance limit and fatigue test. Non-destructive test (NDT) such as dye penetrant, x-ray and eddy current.

GET 204: Students Workshop Practice (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify various basic hands and machine tools, analogue and digital measurement devices and instruments, and acquire skills in their effective use and maintenance;
2. practically apply basic engineering technologies, including metrology, casting, metal forming and joining, materials removal, machine tooling (classification, cutting tool action, cutting forces, non-cutting production) and CNC machining technology;
3. master workshop and industrial safety practices, accident prevention and ergonomics;
4. physically recognise different electrical & electronic components like resistances, inductances, capacitances, diodes, transistors and their ratings;
5. connect electric circuits, understand different wiring schemes, and check ratings of common household electrical appliances and their basic maintenance; and
6. determine household and industrial energy consumption, and understand practical energy conservation measures.

Course Contents
The course comprises general, mechanical and electrical components: supervised hands-on experience in safe usage of tools and machines for selected tasks; Use of measuring instruments (calipers, micrometers, gauges, sine bar, wood planners, saws, sanders, and pattern making). Machine shop: lathe work shaping, milling, grinding, reaming, metal spinning. Hand tools, gas and arc welding, cutting, brazing and soldering. Foundry practice.Industrial safety and accident prevention, ergonomics, metrology. Casting processes. Metal forming processes: hot-working and cold-working processes (forging, press-tool work, spinning, etc.). Metal joining processes(welding, brazing and soldering). Heat treatment. Material removal processes. machine tools and classification. Simple theory of metal cutting. Tool action and cutting forces. Introduction to CNC machines.
Supervised identification, use and care of various electrical and electronic components such as resistors, inductors, capacitors, diodes and transistors. Exposure to different electric circuits, wiring schemes, analogue and digital electrical and electronic measurements. Household and industrial energy consumption measurements. Practical energy conservation principles.

GET 205: Fundamentals of Fluid Mechanics (3 Units C: LH 45)

Learning Outcomes
At the end of this course, the students should be able to :
1. explain the properties of fluids;

2. determine forces in static fluids and fluids in motion;
3. determine whether a floating body will be stable;
4. determine the effect of various instruments, (valves, orifices, bends and elbows) on fluid flow in pipes;
5. measure flow parameters with venturi meters, orifice meters, weirs;
6. perform calculations based on principles of mass, momentum and energy conservation;
7. perform dimensional analysis and simple fluid modelling problems; and
8. specify the type and capacity of pumps and turbines for engineering applications.

Course Contents

Fluid properties, hydrostatics, fluid dynamics using principles of mass, momentum and energy conservation from a control volume approach. Flow measurements in pipes, dimensional analysis, and similitude, 2-dimensional flows. Hydropower systems.

GET 206: Fundamentals of Engineering Thermodynamics (3 Units C: LH 45)

Learning Outcomes

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

1. describe basic concepts of thermodynamics, quantitative relations of Zeroth, first, second and third laws;
2. define and explain system (surrounding, closed and open system), control volume and control mass, extensive and intensive properties;
3. calculate absolute and gage pressure, and absolute temperature, calculate changes in kinetic, potential, enthalpy and internal energy;
4. evaluate the properties of pure substances i.e. evaluate the state of the pure substances such as compressed liquid, saturated liquid-vapour mixture and superheated vapour using property diagrams and tables; arrange the ideal and real gas equations of state,
5. formulate the first law of thermodynamics for a closed system i.e. organize the change in energy in the closed systems via heat and work transfer;
6. distinguish heat transfer by conduction, convection and radiation, and calculate the amount of heat energy transferred;
7. calculate the changes in moving boundary work, spring work, electrical work and shaft work in closed systems;
8. apply the first law of thermodynamics for closed systems and construct conservation of mass and energy equations;
9. formulate the first law of thermodynamics to the open systems i.e. describe steady-flow open system, apply the first law of thermodynamics to the nozzles, diffusers, turbines, compressors, throttling valves, mixing chambers, heat exchangers, pipe and duct flow;
10. construct energy and mass balance for unsteady-flow processes;
11. evaluate thermodynamic applications using second law of thermodynamics;
12. calculate thermal efficiency and coefficient of performance for heat engine, refrigerators and heat pumps; and
13. restate perpetual-motion machines, reversible and irreversible processes.

Course Contents
Basic concepts, definitions and laws (quantitative relations of Zeroth, first, second and third laws of thermodynamics). Properties of pure substances: the two-property rule (P-V-T behaviour of pure substances and perfect gases); state diagrams. The principle of corresponding state; compressibility relations; reduced pressure; reduced volume; temperature; pseudo-critical constants. The ideal gas: specific heat, polytropic processes. Ideal gas cycles; Carnot; thermodynamic cycles, turbines, steam and gas, refrigeration. The first law of thermodynamics – heat and work, applications to open and closed systems. The steady flow energy equation (Bernoulli's equation) and application. Second law of thermodynamics, heat cycles and efficiencies.

GET 208: Strength of Materials (3 Units C: LH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. recognise a structural system that is stable and in equilibrium;
2. determine the stress-strain relation for single and composite members based on Hooke's law;
3. estimate the stresses and strains in single and composite members due to temperature changes;
4. evaluate the distribution of shear forces and bending moments in beams with distributed and concentrated loads;
5. determine bending stresses and their use in identifying slopes and deflections in beams;
6. use Mohr's circle to evaluate the normal and shear stresses in a multi-dimensional stress system and transformation of these stresses into strains;
7. evaluate the stresses and strains due to torsion on circular members; and
8. determine the buckling loads of columns under various fixity conditions at the ends.

Course Contents
Consideration of equilibrium; composite members, stress-strain relation. Generalised Hooke's law. Stresses and strains due to loading and temperature changes. Torsion of circular members. Shear force, bending moments and bending stresses in beams with symmetrical and combined loadings. Stress and strain transformation equations and Mohr's circle. Elastic buckling of columns.

GET 209: Engineering Mathematics I (3 Units C: LH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. solve qualitative problems based on vector and matrix analyses such as linear independence and dependence of vectors, rank etc;

2. describe the concepts of limit theory and nth order differential equations and their applications to physical phenomena;
3. solve the problems of differentiation of functions of two variables and know about the maximization and minimization of functions of several variables;
4. describe the applications of double and triple integration in finding the area and volume of engineering solids, and explain the qualitative applications of Gauss, Stoke's and Green's theorem;
5. explain ordinary differential equations and applications, and develop a mathematical model of linear differential equations, as well as appreciate the necessary and sufficient conditions for total differential equations; and
6. analyse basic engineering models through partial differential equations such as wave equation, heat conduction equation, etc., as well as fourier series, initial conditions and its applications to different engineering processes

Course Contents

Limits, continuity, differentiation, introduction to linear first order differential equations, partial and total derivatives, composite functions, matrices and determinants, vector algebra, vector calculus, directional derivatives.

GET 210: Engineering Mathematics II (3 Units C: LH 45)

Learning Outcomes

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

1. describe physical systems using ordinary differential equations (ODEs);
2. explain the practical importance of solving ODEs, solution methods, and analytically solve a wide range of ODEs, including linear constant coefficient types;
3. numerically solve differential equations using MATLAB and other emerging applications;
4. perform calculus operations on vector-valued functions, including derivatives, integrals, curvature, displacement, velocity, acceleration, and torsion, as well as on functions of several variables, including directional derivatives and multiple integrals;
5. solve problems using the fundamental theorem of line integrals, Green's theorem, the divergence theorem, and Stokes' theorem, and perform operations with complex numbers;
6. apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions of complex variables, as well as the theory of conformal mapping to solve problems from various fields of engineering; and
7. evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula.

Course Contents

Introduction to ordinary differential equations (ODEs); theory, applications, methods of solution; second order differential equations. Advanced topics in calculus (vectors and vector-valued function, line integral, multiple integral and their applications). Elementary complex analysis including functions of complex variables, limits and continuity. Derivatives, differentiation rules and differentiation of integrals. Cauchy-Riemann equation, harmonic functions, basic theory of conformal mapping, transformation and mapping and its applications to engineering problems. Special functions.

GET 211: Computing and Software Engineering (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of the course, the students should be able to:
1. describe and apply computing, software engineering knowledge, best practices, and standards appropriate for complex engineering software systems;
2. develop competence in designing, evaluating, and adapting software processes and software development tools to meet the needs of an advanced development project through practical object-oriented programming exposure taught in concrete terms with a specific modern language – preferable selected from Python, Java or C++;
3. use widely available libraries to prepare them for machine learning, graphics and design simulations;
4. develop skills in eliciting user needs and designing an effective software solution;
5. recognise human, security, social, and entrepreneurial issues and responsibilities relevant to engineering software and the digitalisation of services; and
6. acquire capabilities that can further be developed to make them productively employable by means of short Internet courses in specific areas;

Course Contents
Introduction to computers and computing; computer organisation – data processing, memory, registers and addressing schemes; Boolean algebra; floating-point arithmetic; representation of non-numeric information; problem-solving and algorithm development; coding (solution design using flowcharts and pseudo codes). Data models and data structures; computer software and operating system; computer operators and operators precedence; components of computer programs; introduction to object oriented, structured and visual programming; use of MATLAB in engineering applications. ICT fundamentals, Internet of Things (IoT). Elements of software engineering.

GET 299: Students Industrial Work Experience I (3 Units C: 9 weeks)

Learning Outcomes
SIWES I should provide opportunity for the students to:
1. acquire industrial workplace perceptions, ethics, health and safety consciousness, inter-personal skills and technical capabilities needed to give them a sound engineering foundation;
2. learn and practise basic engineering techniques and processes applicable to their specialisations;
3. build machines, devices, structures or facilities relevant to their specific engineering programmes and applications; and

4. acquire competence in technical documentation (log-book) and presentation (report) of their practical experiences.

Course Contents
Practical experience in a workshop or industrial production facility, construction site or special centres in the university environment, considered suitable for relevant practical/industrial working experience but not necessarily limited to the student's major. The students are exposed to hands-on activities on workshop safety and ethics, maintenance of tools, equipment and machines, welding, fabrication and foundry equipment, production of simple devices; electrical circuits, wiring and installation. (8-10 weeks during the long vacation following 200 level).

NOTE: Each programme to indicate additional details of programme-specific activities for their students.

PAU-MEE 202 Applied Electricity II (2 Units, Core, LH=15 PH=45)

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

1. Use computational tools and packages in the design of electric power systems, electronic, and digital equipment, and systems.
2. Solve common, technical problems in the design of electronics and electrical circuits including electric power systems and seek specialist advice as needed for more complicated problems.
3. Identify the process of innovation and the main factors of entrepreneurship and creative thinking and apply methods of product development.
4. Apply project management methods to the planning of projects;
5. Analyse projects, using current best-practice methods; and
6. Calculate using a spreadsheet the cost estimate for a design solution, and understand the uncertainties associated with the cost estimation process.

Course contents

Power factor, Power in AC circuit, Resonance in RLC series and parallel circuit, Three Phase Circuits: Voltages of three balanced phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams. DC Machines: Construction, Basic concepts of winding (Lap and wave); DC generator: Principle of operation, EMF equation, characteristics (open circuit, load) DC motors: Principle of operation, Torque Equation, Speed Torque Characteristics (shunt and series machine); Single Phase Transformer: Constructional parts, Types of transformers, Emf equation, No Load no load and on load operation, phasor diagram and equivalent circuit, losses of a transformer, regulation and efficiency calculation; Three Phase Induction Motor: Types, Construction, production of rotating field, principle of operation, Slip and Frequency, rotor emf and current, Equivalent circuit and phasor diagram, Torque Slip characteristics torque-speed characteristics; General Structure of Electrical Power System: Power generation to distribution through overhead lines and underground cables with single line diagram, Earthing of Electrical Equipment, Electrical Wiring Practice.

PAU-MEE 203 Engineering Graphics and Solid Modelling II (2 Units, Core, LH=15 PH=45)

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

1. Use projections to prepare at least two (2) detailed working drawings of objects and designs.
2. Use parametric design to produce an BSI or DIN complaint design in the optimal specification of materials and systems to meet needs;
3. Analyse at least three (3) designs using strength and material minimization approaches.
4. Identify the need for the theoretical perspectives that create the basis for the analyses that are possible in design and optimisation and recognize the practical link to excite their creativity and ability to innovate.
5. Translate to working shop floor drawings for multi-physical, multidisciplinary design.

Course contents
Projection of lines, auxiliary views, and mixed projection. Preparation of detailed working production drawing; semi-detailed drawings, conventional presentation methods. Solid, surface, and shell modeling. Faces, bodies, and surface intersections. Component-based design. Component assembly and motion constraints. Constrained motions and animation. Introduction to electronics modeling. Electronics board layout preparation, Component libraries, and Schematic design. Parametric modeling and adaptive design. Simulation for material optimization. Designing for manufacturing. Additive and subtractive manufacturing. Production for 3-D printing, Laser cutting, and CNC machinery. Arrangement of engineering components to form a working plant (Assembly Drawing of a Plant).

PAU-MEE 207 Applied Mechanics I (3 Units, Core, LH=30 PH=45)

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

1. Resolve forces into components and determine the resultant of multiple forces acting on a particle.
2. Analyze forces, moments, and couples applied to at least three (3) engineering structures

3. Determine the equilibrium at least two (2) simple structures and machine parts.
4. Apply equilibrium to at least two (2) simple structures and machine parts.
5. Describe and evaluate the friction phenomenon in at least four (4) machine components.
6. Apply the first and second moments of the area, centroids.
7. Apply kinematics of particles and rigid bodies in plane motion.
8. Evaluate the kinetics of particles using Newton's second law.
9. Analyze the kinetics of particles using energy and momentum methods.
10. Evaluate the dependent motion of particles.

Course contents
Forces, moments, and couples. Equilibrium of simple structures and machines parts. Rigid Bodies: equivalent systems of Forces. Equilibrium in two- and three-dimensions. Friction. Wedges and screws. Square-threaded screws. Belt friction. First and second moments of area; centroids. Kinematics of particles and rigid bodies in plane motion. Rectilinear motion of particles. The curvilinear motion of particles. Position, Velocity, and Acceleration. The projectile of a particle. Newton's Second Law of Motion. Linear Momentum of a particle and its rate of change.

PAU-MEE 202 The Nature of Human Beings (2 Units, Core, LH=30)

Learning Outcomes

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

1. Explain the basic concepts in philosophical anthropology.
2. Compare the nature of human beings with the nature of lower animals.
3. Explain the operations of the human intellect and will.
4. Explain human dignity, its foundation, and its practical consequences of human dignity in socio-political, economic, and cultural practices as well as in technology development.
5. Demonstrate knowledge of human virtues and their development in the human person.
6. Discuss the phenomenon of human death, the immortality of the soul, and how the idea of death shapes one's sense of meaning and value of one's life and that of others.

Course contents
Introduction and conceptual clarifications. Human beings as higher animals. Human emotions and emotional Intelligence. The rationality of human beings – intelligence and will. The unity of the human person. Human sexuality. The nature of Human Freedom. Freedom and truth. Freedom and Evil. Human beings as social beings. Expanded view of the social environment – virtual world and meta-verse. Human beings as working beings – the objective and subjective dimensions of human work. Human development – the virtues. The

dignity of human beings and its practical consequences. Human fulfillment. Existence and the meaning of Life. The phenomenon of Human death.

300 Level

GST 312: Peace and Conflict Resolution (2 Units C: LH 30)

Learning Outcomes
At the end of this Course, students should be able to:
1. analyse the concepts of peace, conflict and security;
2. list major forms, types and root causes of conflict and violence;
3. differentiate between conflict and terrorism;
4. enumerate security and peace building strategies; and
5. describe the roles of international organisations, media and traditional institutions in peace building.

Course Contents
The concepts of peace, conflict and security in a multi-ethnic nation. Types and theories of conflicts: ethnic, religious, economic, geo-political Conflicts; structural conflict theory, realist theory of conflict, frustration-aggression conflict theory; root causes of conflict and violence in Africa: indigene and settlers phenomenon, boundaries/boarder disputes, political disputes, ethnic disputes and rivalries, economic inequalities, social disputes, nationalist movements and agitations; selected conflict case studies – Tiv-Junkun, ZangoKartaf, chieftaincy and land disputes, etc. Peace building, management of conflicts and security: Peace & Human Development. Approaches to Peace & Conflict Management (religious, government, community leaders, etc.). Elements of peace studies and conflict resolution: Conflict dynamics assessment Scales: Constructive & Destructive. Justice and Legal framework: Concepts of Social Justice; The Nigeria Legal System. Insurgency and terrorism. Peace mediation and peace keeping. Peace and Security Council (international, national and local levels). Agents of conflict resolution – Conventions, Treaties Community Policing: Evolution and Imperatives. Alternative Dispute Resolution (ADR) (dialogue,. arbitration, negotiation, collaboration, etc). The roles of international organizations in conflict resolution ((a) The United Nations, UN and its conflict resolution organs. (b) The African Union & Peace Security Council (c) ECOWAS in peace keeping). The media and traditional institutions in peace building. Managing post-conflict situations/crises: Refugees. Internally Displaced Persons (IDPs);the role of NGOs in post-conflict situations/crises.

ENT 312: Venture Creation (2 Units C: LH 15; PH 45)

Learning Outcomes
At the end of this course, students, through case study and practical approaches, should be able to:
1. describe the key steps in venture creation;

2. spot opportunities in problems and in high potential sectors, regardless of geographical location;
3. state how original products, ideas and concepts are developed;
4. develop a business concept for further incubation or pitching for funding;
5. identify key sources of entrepreneurial finance;
6. implement the requirements for establishing and managing micro and small enterprises;
7. conduct entrepreneurial marketing and e-commerce;
8. apply a wide variety of emerging technological solutions to entrepreneurship; and
9. appreciate why ventures fail due to lack of planning and poor implementation.

Course Contents

Opportunity identification (sources of business opportunities in Nigeria, environmental scanning, demand and supply gap/unmet needs/market gaps/market research, unutilised resources, social and climate conditions and technology adoption gap). New business development (business planning, market research). Entrepreneurial finance (venture capital, equity finance, micro-finance, personal savings, small business investment organizations and business plan competition). Entrepreneurial marketing and e-commerce (principles of marketing, customer acquisition & retention, B2B, C2C and B2C models of e-commerce, First Mover Advantage, E-commerce business models and successful e-commerce companies). Small business management/family business: Leadership & Management, basic book keeping, nature of family business and family business growth model. Negotiation and business communication (strategy and tactics of negotiation/bargaining, traditional and modern business communication methods). Opportunity discovery demonstrations (business idea generation presentations, business idea contest, brainstorming sessions, idea pitching). Technological solutions (The concept of market/customer solution, customer solution and emerging technologies, business applications of new technologies - artificial intelligence (AI), virtual/mixed reality (VR), Internet of things (IoTs), blockchain, cloud computing, renewable energy, etc. Digital business and e-commerce strategies).

GET 301: Engineering Mathematics III (3 Units C: LH 45)

Learning Outcomes

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

1. demonstrate a clear understanding of the course content, that is, possess a breadth of knowledge in the area covered;
2. possess an in-depth knowledge upon which a solid foundation can be built in order to demonstrate a depth of understanding in advanced mathematical topics;
3. develop simple algorithms and use computational proficiency;
4. write simple proofs for theorems and their applications; and
5. communicate the acquired mathematical knowledge effectively in speech, writing and collaborative groups.

Course Contents

Linear Algebra. Tensor algebra and analysis, Elements of Matrices, Determinants, Inverses of Matrices, bases representation of tensors. The Euclidean point space and vector spaces. Theory of Linear Equations. Eigen Values and Eigen Vectors. Analytical Geometry. Basic transformations: identity, spherical, Projection and Coordinate Transformation as tensors, Traces, Determinants and other scalar invariants. Equivalent stresses and strains as examples of scalar invariant. Applications to design, analyses and optimization. Elgenvalues, Elgeanvectors of tensors. Solid Geometry. Polar, cylindrical and spherical coordinates. Elements of functions of several variables. Surface Variables. Ordinary Integrals. Evaluation of Double Integrals, Triple Integrals, Line Integrals and Surface Integrals. Derivation and Integrals of Vectors. The gradient of scalar and fiels. Flux of Vectors. The curl of a vector field, Gauss, Greens and Stoke's theorems and applications: Determinations and applications to field equations in linear abd nonlinear mechanics. Singular Valued Functions. Multivalued Functions. Analytical Functions. Cauchy Riemann's Equations. Singularities and Zeroes. Contour Integration including the use of Cauchy's Integral Theorems. Bilinear transformation.

GET 302: Engineering Mathematics IV (3 Units E: LH 45)

Learning Outcomes

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

1. solve second order differential equations;
2. solve partial differential equations;
3. solve linear integral equations;
4. relate integral transforms to solution of differential and integral equations;
5. explain and apply interpolation formulas; and
6. apply Runge-Kutta and other similar methods in solving ODE and PDEs.

Course Contents

Series solution of second order linear differential equations with variable coefficients. Bessel and Legendre equations. Equations with variable coefficients. Sturn-Louville boundary value problems. Solutions of equations in two and three dimensions by separation of variables. Eigen value problems. Use of operations in the solution of partial differential equations and Linear integral equations. Integral transforms and their inverse including Fourier, Laplace, Mellin and Handel Transforms. Convolution integrals and Hilbert Transforms. Calculus of finite differences. Interpolation formulae. Finite difference equations. RungeKutta and other methods in the solutions of ODE and PDEs. Numerical integration and differentiation.

GET 304: Technical Writing and Communication (3 Units C: LH 45)

Learning Outcomes

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

1. demonstrate the concept of clear writing, common pitfalls and unambiguous language in engineering communication, including technical reporting for different applications and emotional comportment;
2. demonstrate the skills of language flexibility, formatting, logic, data presentation styles, referencing, use of available aids, intellectual property rights, their protection, and problems in engineering communication and presentation; and
3. demonstrate good interpersonal communication skills through hands-on and constant practice on real-life communication issues for engineers in different sociocultural milieu for engineering designs, structural failure scenarios and presentation of reports.

Course Contents

A brief review of common pitfalls in writing. Principles of clear writing (punctuations and capitalization). Figures of speech. Units of grammar. Tenses and verb agreement. Active and passive sentences Lexis and structure Fog Index concept. Skills for communication and communication algorithm. Types and goals of communication; Interpersonal communication; features and the Finger Model or A,B,C,D,E of good interpersonal communication (accuracy of technical terms, brevity of expression, clarity of purpose, directness of focus and effectiveness of the report). Language and organisation of reports. Technical report writing skills(steps, problems in writing, distinguishing technical and other reports, significance, format and styles of writing technical reports). Different formats for communication; styles of correspondences – business report and proposal, business letter, memorandum, e-mails, etc. Proposals for projects and research; format, major steps and tips of grant-oriented proposals. Research reports(competency, major steps, components and formats of research reports and publishable communication). Sources and handling of data, tables, figures, equations and references in a report. Presentation skills; overview, tips, organisation, use of visual aids and practising of presentation. Intellectual property rights in research reports. Case studies of major engineering designs, proposals and industrial failures with professional presentation of reports.

GET 305: Engineering Statistics and Data Analytics (3 Units C: LH 45)

Learning Outcomes

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

1. work with data from the point of view of knowledge convergence, machine learning, and intelligence augmentation, which significantly raises their standard for engineering analysis (the approach forces them to learn statistics in an actionable way that helps them to see the holistic importance of data analytics in modern engineering and technology);
2. anticipate the future with Artificial Intelligence while fulfilling the basic requirements of conventional engineering statistical programming consistent with their future careers;
3. perform, with proficiency, statistical inference tasks with language or programming toolboxes such as R, Python, Mathematica or MATLAB, and Design Expert to summarise analysis and interpretation of industry engineering data, and make appropriate conclusions based on such experimental and/or real-life industrial data;

4. construct appropriate graphical displays of data and highlight the roles of such displays in data analysis, particularly the use of statistical software packages;
5. plan and execute experimental programmes to determine the performance of programme-relevant industrial engineering systems, and evaluate the accuracy of the measurements undertaken; and
6. demonstrate mastery of data analytics and statistical concepts by communicating the results of experimental and industry-case investigations, critically reasoned scientific and professional analysis through written and oral presentation.

Course Contents
Descriptive statistics, frequency distribution, populations and sample, central tendency, variance data sampling, mean, median, mode, mean deviation, percentiles, etc. Probability. Binomial, poison hyper-geometric, normal distributions, etc. Statistical inference intervals, test hypothesis and significance. Regression and correlation. Introduction to big data analytics and cloud computing applications. Introduction to the R language; R as a calculator; Vectors, matrices, factors, data frames and other R collections. Iteration and looping control structures. Conditionals and other controls. Designing, using and extending functions. The Apply Family. Statistical modelling and inference in R.

GET 307: Introduction to Artificial Intelligence, Machine Learning and Convergent Technologies (3 Units C: LH 45)

Learning Outcomes
At the completion of the course, the students are expected to be able:
1. explain the meaning, purpose, scope, stages, applications and effects of artificial intelligence;
2. explain the fundamental concepts of machine learning, deep learning and convergent technologies;
3. demonstrate the difference between supervised, semi-supervised and unsupervised learning;
4. demonstrate proficiency in machine learning workflow and how to implement the steps effectively;
5. explain natural languages, knowledge representation, expert systems and pattern recognition;
6. describe distributed systems, data and information security and intelligent web technologies;
7. explain the concept of big data analytics, purpose of studying it, issues that can arise with a data set and the importance of properly preparing data prior to a machine learning exercise; and
8. explain the concepts, characteristics, models and benefits, key security and compliance challenges of cloud computing.

Course Contents

Concepts of human and artificial intelligence; artificial/computational intelligence paradigms; search, logic and learning algorithms. Machine learning and nature-inspired algorithms – examples, their variants and applications to solving engineering problems; understanding natural languages; knowledge representation, knowledge elicitation, mathematical and logic foundations of AI; expert systems, automated reasoning and pattern recognition; distributed systems; data and information security; intelligent web technologies; convergent technologies – definition, significance and engineering applications. Neural networks and deep learning. Introduction to python AI libraries.

GET 399: Students Industrial Work Experience II (4 Units C: 12 weeks)

Learning Outcomes
At the end of the SIWES, students should be able to:
1. demonstrate proficiency in at least any three softwares in their chosen career choices;
2. demonstrate proficiency in some animation videos (some of which are free on YouTube) in their chosen careers;
3. carry out outdoor hands-on construction activities to sharpen their skills in their chosen careers;
4. demonstrate proficiency in generating data from laboratory analysis and develop empirical models;
5. demonstrate proficiency in how to write engineering reports from lab work;
6. fill logbooks of all experience gained in their chosen careers; and
7. write a general report at the end of the training.

The experience is to be graded and the students must pass all the modules of the attachment and shall form part of CGPA.

Course Contents
On-the-job experience in industry chosen for practical working experience but not necessarily limited to the student's major (Students are to proceed on three months of work experience i.e. 12 weeks during the long vacation following 300 level). Students are engaged in the more advanced workshops, indoor software design training similar to what they will use in the industry and outdoor construction activities to sharpen their skills. The use of relevant animation videos that mimic industrial scenarios is encouraged. Students are to write a report at the end of the training. As much as possible, students should be assisted and encouraged to secure 3 months placement in the industry. Examples of outline of activities and experiences to which students are expected to be exposed to earn prescribed credits include:

Section A: Welding and fabrication processes, automobile repairs, · lathe machine operations: machining and turning of simple machine elements, such as screw threads, bolts, gears, etc. Simple milling machine operations, machine tool maintenance and trouble-shooting, andwooden furniture making processes.

Section B: Mechanical design with computer graphics and CAD modelling and drafting. Introduction to Solidworks: software capabilities, design methodologies and applications. Basics part modelling: sketching with SolidWorks, building 3D components, using extruded Bose base · Basic assembly modelling, and solidWorks drawing drafting. Top-down assembly technique exploded view, exploded line sketch. Introduction to PDMS 3D design software; autoCAD mechanical, SPSS.

A comprehensive case study design project. The student should be introduced to the concept of product/component design and innovation and then be given a comprehensive design project.

Examples of projects should include the following:

a. design of machine components;
b. product design and innovation;
c. part modelling and drafting in solidworks; and
d. technical report writing.

MEE 301: Computer-Aided Design and Manufacture (3 Units C: LH 30; PH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. visualise and apply basic drafting fundamentals;
2. prepare and edit engineering drawings;
3. explain the concepts and underlying theory of modelling and the usage of models in different engineering applications;
4. compare the different types of modelling techniques and explain the central role solid models play in the successful completion of CAD/CAM-based product development;
5. produce CAD drawings (create accurate and precise geometry of complex engineering systems and use the geometric models in different engineering applications);
6. use and assess commercial CAD/CAM tools efficiently, effectively and intelligently in selected engineering applications;
7. take active role in product design and development process as well as protptyping;
8. model 3D part and assemblies using SolidWorks program (or alternative CAD software);
9. analyse the part design using one of the computational methods (e.g. stress analysis) - calculate part features using math skills;
10. demonstrate proficiency in the concepts of computer-aided manufacturing and a number of applied associated processes; and
11. explain the basic concepts of CNC programming and machining.

Course Contents
Introduction to computer aided design (CAD). Basic data structuring technique. Computer graphics. Geometric transformation techniques. Mathematical bases for surface modeling:

curves, surfaces and solids. Principles of solid modeling and application. CAD software. Introduction to CAM: Relation between production volume and flexibility. Various manufacturing systems – batch, mass, group, cellular and flexible manufacturing systems. Type of automation and benefits of soft or flexible automation. Automation in material handling and assembly. CNC machines: Introduction, classification, design and control features including interpolations. Numerical control and NC part-programming. Introduction to Robotics: Definitions, motivation, historical development. Basic structure, classification, workspace, drives, controls, sensors, grippers, specifications. Manual CNC programming (milling and turning). Basic and advanced CAD/CAM for CNC (milling and turning). Group project assignment.

PAU-MEE 306 Thermodynamics II (2 Units, Core, LH=15 PH=45)

Learning Outcomes

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

1. Evaluate the properties of pure substances i.e., evaluate the state of the pure substances such as compressed liquid, saturated liquid-vapour mixture and superheated vapour using property diagrams and tables;
2. Evaluate thermodynamic applications using second law of thermodynamics and apply its working principles to Internal Combustion Engines
3. Calculate thermal efficiency and coefficient of performance for heat engine, refrigerators, and heat pumps; and restate perpetual-motion machines, reversible and irreversible processes in the laboratory.
4. Apply reciprocating air compressors and other positive displacement compressors, Gas and vapour power cycles in typical workplace.
5. Analyse and apply refrigeration cycles, vapour compression units, principles of absorption refrigeration in everyday life
6. Compare and Contrast heat transfer by conduction, convection, and radiation, and calculate the amount of heat energy transferred; construct energy and mass balance for unsteady-flow processes; in everyday life
7. Testing of various heat engine plants using international standard procedures
8. Apply an integrated simulation and Computer-aided engineering platform to thermos-fluid design and analysis using simulation software such as ANSYS Fluent and Workbench

Course contents

Ideal air cycles. Introduction of Internal Combustion Engines; Reciprocating air compressors and other positive displacement compressors. Gas and vapour power cycles, refrigeration cycles, vapour compression units, principles of absorption refrigeration. Testing of various heat engine plants.

PAU-MEE 307 Theory of Machines I (2 Units, Core, LH=15 PH=45)

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

1. Illustrate at least 10 simple mechanisms and their analysis.
2. Outline 4 cases using vector diagrams, simple Harmonic motion and applications.
3. re-assess the Newton's Laws of motion, relative motion of machines and their units on the example of at least 4 basic mechanisms.
4. Demonstrate the force analysis of at least 10 mechanisms.
5. Evaluate the friction effect relative to 4 mechanisms and 2 machines.
6. Analyse at least 5 machines and their possible applications.
7. Analyse the theory of structures and its relationship to machines and mechanisms using 2 case studies.
8. Outline the dynamics of linear systems and the concept of balancing using al least 2 examples.
9. Analyse the gear systems and gear trains using the example of at least 1 spur gear drive, 1 helical gear,1 bevel gear drive, 1worm gear and 1 planetary gear system.
10. Evaluate the significance of the rigid body in Theory of Machines using 2 applications.
11. Explain tribology with at least 3 examples of machines.

Course contents
Simple mechanisms and their analysis. Vector diagrams. Simple harmonic motion. Newton's Laws of motion. Force analysis of mechanism. friction effect. analysis and applications. Theory of Structures. Dynamics of linear systems. Balancing. Gear systems and Gear trains. Rigid body. Introduction to tribology.

PAU-MEE 310 Fluid Mechanics II (2 Units, Core, LH=15 PH=45)

Learning Outcomes

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

1. Outline the properties of fluids and their domain of application using at least 2 cases.
2. Analyse the concept of hydrostatics and their areas of application using 2 examples.
3. Generate fluid motion and momentum equation and their areas of application in engineering and science.
4. Analyse Boundary Layer flow and Flow measurements using at least 1 example each.
5. evaluate fluid operated machines and Rotodynamic machines and their areas of application based on at least 1 example each.
6. Develop a sound knowledge of Fluid Power transmission using the example of a pump or compressor.
7. Select pumps, and their characteristic- 3 examples.
8. Design 3 different types of pumps

Course Contents

Properties of fluids. Hydrostatics. Fluid motion. Momentum equation; Boundary Layer flow. Flow measurements. Fluid operated machines. Rotodynamic machines. Fluid Power transmission. Pumps. Pump design.

PAU-MEE 312 Engineering Metallurgy 2 Units, Core, LH=15 PH=45)

Learning Outcomes

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

1. Discuss using practical illustrations chemical metallurgy as an important value addition process to mineral resources and the gateway to metallurgical engineering.
2. Explain with illustrations the principles and applications pyrometallurgy, hydrometallurgy, electrometallurgy, and refining processes.
3. Describe the principle using charts the applications of Ellingham, Pourbaix and McCabe Thiele Diagrams.
4. Explain at least five (5) recent advances in chemical metallurgy.

Course contents

Introduction to the electric structure of atom and matter. Solid State Crystallography. Relationship between structure and composition and mechanical and thermal properties of materials, alloys, plastics, ceramics, and natural products. Heat treatment: Annealing, Normalizing, Tempering and Hardening. Metallic corrosion and protection. Manufacture and structure of high polymers. Thermoplastic and thermosetting resins

PAU-MEE 313 Manufacturing and Engineering Technology (2 Units, Core, LH=15 PH=45)

Learning Outcomes

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

1. Describe at least 3 fundamentals of manufacturing and engineering technology.
2. Describe the various types of manufacturing processes and their uses.
3. Compare the working principles of at least 3 machine tools used in engineering technology.
4. Analyse the operations and capabilities of machine tools including application of CAE, CAD and CAM designs in manufacturing process.
5. Evaluate the principles of maintenance management, work study and safety precautions in a manufacturing industry.

Course contents

Fundamentals of manufacturing and engineering technology. Plant organization, administration and management. Production planning and control in workshops. Casting, welding and metal forming manufacturing processes. Processing of ceramics, plastics, composite materials and powder metallurgy. Working principles of lathe, milling, planer, shaper and drilling machines amongst others. Machine tools operations, classifications, and machining processes. Applications of CNC machines in CAE, CAD, and CAM designs. Types of chips and methods of metal cutting. Classifications and properties of cutting tools. Analysis of force of a single point tool and cutting tool ratio. Cutting speed, feed, and depth of machining. Cutting tool life, materials, and properties. Machining of gears and threads in a workshop. Maintenance management, work study, job evaluation, wages and incentives. Inventory control and financial budgeting. Industrial safety procedures.

PAU-MCE 302 Introduction to Robotics (2 Units, Core, LH=30)

Senate-approved relevance

Pan-Atlantic University is located near the Lagos Free Zone. The Lagos Free Zone (LFZ) is envisioned to become the preferred industrial hub and investment destination in West Africa. Several Companies such as the Dangote refinery, Africa's biggest oil refinery and the world's biggest single-train facility, as well as several other manufacturing enterprises are already springing up in the LFZ. Training of engineers with strong capacity for robotics for community manufacturing is in line with Pan-Atlantic strategic positioning statement for her School of Science and Technology to becoming Nigeria's research hub for smart and scalable inventions for transforming the manufacturing industry.

Overview

Robots increase speed for manufacturing processes. The speed and dependability of robots ultimately reduces cycle time and maximises throughput. For small and medium scale community manufacturing outfits, the need for cost-effective implementation and sustainability are critical for remaining competitive.

This course provides object-oriented theory and practice for the development and application of robot technology in small and medium enterprises (SME) but very cost-effective production processes in a manufacturing community such as the upcoming manufacturing clusters in the Lagos Free Zone.

Objectives

The objectives of the course are to:

1. Describe robotic systems used in manufacturing.
2. Teach the application of Free and Open-Source Software (FOSS) to design robot manufacturing system.
3. Describe Robot Operating System (ROS) programming for ROS robot simulation hardware prototyping.
4. Perform troubleshooting procedures for robotic systems.
5. Analyse robot system using kinematics of serial and parallel Robots.
6. Demonstrate robots path planning procedure.
7. Explain actuators and drive systems for manufacturing robots.
8. Describe the characteristics of sensors for image processing and analysis of vision systems.
9. Teach cost minimisation methods in robot development in a development economy.
10. Teach the Nigeria laws for Free Zones.

Learning Outcomes

On completion of the course, students should be able to:
1. List at least four (4) robot system used in manufacturing as defined by global robotics organisations.
2. Install and use Free and Open-Source Software (FOSS) to design at least three systems for manufacturing.
3. Apply Robot Operating System (ROS) programming for hardware prototyping.
4. Troubleshoot faulty robotic system.
5. Analyse at least two (2) robot systems using kinematics of serial and parallel Robots principles.
6. Perform path planning of two robotics systems and motion control.
7. Describe ten (10) actuators and drive systems for manufacturing robots.
8. Describe the characteristics of at least seven (7) types of sensors used for image processing and analysis of vision systems.
9. State at least five (5) cost minimisation methods in robot development for SMEs.
10. List at least five (5) Nigeria laws for Free Zones.

Course contents

Robot Fundamentals. Free and Open-Source Software (FOSS). Introduction to Robot Operating System (ROS) programming. ROS Robot Simulation. ROS Robot hardware Prototyping. Trouble shooting and best practices. Kinematics of Serial and parallel Robots. Differential motion and velocities. Path planning of robotics systems and motion control. Actuators and Drive systems. Sensors. Image processing and analysis of vision systems. Fuzzy logic controls. Cost minimisation procedures in robot development. Robot project management. Basic Artificial Intelligence for Robotics design. Solar systems for robot drive and control. Understanding laws to operate in Nigeria Free Zones.

Minimum Academic Standards
Computer teaching laboratory with Ubuntu Linux operating system and ROS software with at least one computer to 5 students. One Robot-arm running with FOSS and ROS Software.

PAU-MEE 315 Control Systems Engineering (3 Units, Core, LH=30, PH=45)

Learning Outcomes
On completion of the course, students should be able to:
1. Develop at least one mathematical model of the physical systems.
2. Analyse the response and stability for two (2) closed and open loop systems.
4. Design at least three (3) kinds of compensator.
5. Differentiate alternate representations of dynamic systems (time domain, frequency domain, state space).
6. Define at least two (2) feedback and feed-forward control architecture and discuss the importance of performance, robustness, and stability in control design.
7. Interpret at least five (5) block diagram representations of control systems and design PID controllers based on empirical tuning rules.
8. Compute stability of linear systems using the Routh array test and use this to generate control design constraints.
9. Design using Evans root locus techniques in control design for real world systems.
10. Compute gain and phase margins using Bode diagrams and Nyquist plots and understand their implications in terms of robust stability.
11. Design at least two (2) Lead-Lag compensators based on frequency data for an open-loop linear System.
12. Analyse the stability of systems using root locus and frequency response methods.

Course contents
Concept of Control Engineering. Open and Close Loop Systems. Control System Classification. Basic Terminologies in Control System. Control System Design. History of Automatic Control. Systems Mathematical Modeling. Differential Equations of Physical Systems. Through and Across Variables. First-Order ODE Models. Linear Approximations of Physical Systems. Laplace Transform. Transfer Functions. Block Diagram Fundamentals and Reduction Techniques. Superposition of Multiple Inputs. Signal-Flow Graphs. Conversion of Block Diagrams into Signal Flow Graphs. Mason's Rule. Mechanical Measurements. Transducer and Sensors. Controllers. Basics of PID Control. PID Controller Structure.

PAU-MEE 322 Metrology (2 Units, Core, LH=15 PH=45)

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

1. Explain at least two (2) geometrical features of measurement, explain in detail how these features are measured, and identify the equipment and tools used in measuring them.
2. Differentiate between accuracy and precision using one engineering system.

3. Identify at least five (5) sources of errors in measurement.
4. Explain using charts how to care for the metrological instrument.
5. Measure force, torque, and strain using analog and digital measuring instruments.
6. Differentiate between linear and angular metrology using examples.
7. List at least six (6) tools and equipment used for both linear and angular metrology.
8. Explain the use of autocollimators in optical and mechanical engineering machine installations.
9. Describe profilometers and list areas of applications using diagrams.
10. List at least five (5) types of comparators, their uses, and the merit and demerit of each.

Course contents

Theory and practice of high precision. Need of inspection. Precision and accuracy in metrology. Errors in Measurement. Mechanical measurements under strict control conditions. General care of the metrological instrument. Linear & angular measurement. Measurement of Force, Torque, and Strain. Super micrometry and comparator profilometry. Collimator application in calibration and measurement tasks in optical and mechanical engineering machine installations, etc. Tolerances and quality, fits clearance, transition, and interference fit.

PAU-MEE 331 Engineering Graphics and Solid Modelling III (2 Units, Core, LH=15 PH=45)

Learning Outcomes

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

1. Discuss basic drawing principles using AutoCAD.
2. Draw using AutoCAD to produce 2D and 3D drawings
3. Demonstrate a mastery of Descriptive Geometry.
4. Explain using charts the limits and fits and master how they are represented in engineering drawing.
5. Demonstrate a good knowledge of Geometric tolerances and its standard illustration on conventional drawings.
6. Understand how to indicate Welding drawings and Design in standard in at least three (3) welding practice scenarios.
7. Apply the standard convention in drawings when Redesigning components using welded joints.
8. Draw harder examples of exploded assembly drawings using a complete gear box in exploded assembly drawings to demonstrate mastery of the AUTOCAD application.
9. Practice the arrangements of at least three (3) engineering components to form a working plant (Assembly drawing of a plant showing the layout of units and sub-assemblies).
10. Demonstrate out the requisite revisions in three scenarios.

Course contents

Introduction to AutoCAD. Using AutoCAD to produce 2D and 3D drawings. Descriptive Geometry. Limits and fits. Geometric tolerances, Welding drawings and Design. Redesigning of casts components using welded joints. Harder examples on exploded assembly drawings (e.g., a complete gear box in exploded assembly drawings). Arrangements of engineering components to form a working plant (Assembly drawing of a plant). Revision.

PAU-MEE 309 Professional and Personal Skills (2 Units, Core, LH=30)

Learning Outcomes

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

1. Describe at least five elements of professionalism and their manifestations within their chosen career paths.
2. Write a personal CV and professional profile.
3. Identify at least five ways in which their chosen career can be of service to communities.
4. Identify at least three ways in which students can serve the university community.
5. Identify at least three personal strengths, and at least strengths and five weaknesses associated with each of the four classical types of temperaments.
6. Describe five elements of good interpersonal communications.
7. Discuss at least three differences between assertiveness and aggression.
8. Describe at least five tips for financial responsibility and making good personal budgets.
9. Describe appropriate actions and responses to at least four common medical emergencies.
10. Describe two types of good leadership and describe at least five guidelines for good teamwork.

Course contents
Professionalism. Job search: interviews, writing applications, CVs, resumes and professional profiles. Professional work as service to the community. Social responsibility. Self-knowledge. Self-esteem & assertiveness. Open-mindedness. Emotional intelligence. Temperaments, character development and personality. Interpersonal communications. Public speaking. Time management. Social etiquette. Cultivating optimal health: metal and physical. Personal budgets and financial responsibility. Leadership. Teamwork.

400 Level

GET 499: Students Industrial Work Experience III (8 Units C: 24 weeks)

Learning Outcomes
Students on Industrial Work Experience Scheme (SIWES) are expected to:
1. be exposed and prepared for the Industrial work situation they are likely to meet after graduation, by developing their occupational competencies;

2. bridge the existing gap between theory and practice of programmes through exposure to real-life situations, including machines and equipment handling, professional work methods and ethics, human relations, key performance assessment methods, and ways of safeguarding the work environment – human and materials;
3. experience/simulate the transition phase of students from school to the world of work and the environment seamlessly,and expose them to contacts for eventual job placements after graduation;
4. be motivated to identify the industrial and practice engineering challenges of their place of engagement and the larger society and creatively device impactful solutions to them; and
5. exploit the opportunity to improve and utilise their acquired critical thinking and innate creativity skills, during the program and SIWES Seminar presentation respectively.

Course Contents
On-the-job experience in industry chosen for practical working experience but not necessarily limited to the student's major (24 weeks from the end of the first semester at 400-Level to the beginning of the first semester of the following session. Thus, the second semester at 400-Level is spent in industry). Each student is expected to work in a programme related industry, research institute or regulatory agencies etc, for a period of 6 months under the guidance of an appropriate personnel in the establishment but supervised by an academic staff of the Department. On completion of the training, the student submits the completed Log book on the experience at the establishment., Also, there will be a comprehensive report covering the whole of the student's industrial training experiences (GET 299, GET 399 and GET 499), on which a seminar will be presented to the Department for overall assessment.

MEE 401: Mechanical (Machine) Engineering Design II (3 Units C: LH 45)

Leaning Outcomes
At the end of this course, the students should be able to:
1. demonstrate proficiency in the principles of design;
2. demonstrate proficiency in the selection of materials for design;
3. carry out simple stress analysis; and
4. demonstrate proficiency in principles of coupling, clutches and brakes.

Course Contents
Journal bearings. Application of Hertz stress theory. Fluid couplings. Lubrication mechanics: hydrodynamic theory applied to tapered wedge and journal bearings and hydrostatic lubrication applied to journal bearings. Gears and power transmission systems. Elements of fluid power system design. Design of cylinders, pipes and pipe joints, tubes, plates and flywheel. Seals, packaging, gaskets and shields. Failure analysis; various types of joints, design of machine elements; system design, design of gear systems; material selection in design; design; design and production matching; optimisation in design D

MEE 402 Theory (Mechanics) of Machines II (2 Units E: LH 30)

Leaning Outcomes
At the end of this course, the students should be able to:
1. identify the forces acting on a mechanism and the resolution of the forces;
2. demonstrate understanding of the performance of various mechanisms and principal machine elements as regards their kinematics and dynamics;
3. identify the types of motion and their applications;
4. identify forces on shaft and bearing due to single revolving mass;
5. demonstrate procedure for balancing several masses in different transverse planes;
6. prepare professional quality solutions and presentations to effectively communicate the results of analysis and design;
7. translate ideas and imaginations into conceptual designs using the tools of conventional engineering drawings and computer aided designs; and
8. use the knowledge of the course to solve real life problems related to production processes and to develop machines.

Course Contents
Force analysis of mechanisms, fluctuation of kinetic energy and inertial effects. Complete static and dynamic analysis. Flexible shaft couplings: belt, rope and chain drives. The flywheel and mechanical governors. Brakes and dynamometers. Balancing of multi-cylinder engines. Balancing of machinery. Vibration of machinery; free and forced vibration, damping, natural frequencies and critical speeds. Transverse vibrations of beams, whirling of shafts and torsional vibrations.

MEE 403: Applied Engineering Thermodynamics (2 Units E: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. apply the knowledge of mathematics, science and engineering fundamentals to model the energy conversion phenomenon;
2. identify fuel types, availability, utilisation and its conversion to energy, understand fuel chemistry, combustion analysis, develop combustion equations and conduct exhaust and flue gas analysis in the laboratory;
3. identify enthalpy changes, determine heating values of fuels, steam generators;
4. identify type of boilers, fuels and combustion controls in boilers and power plant efficiency;
5. perform air standard cycle analysis, refrigeration and heat pump cycles and demonstrate their various application in internal combustion engines/refrigeration systems;
6. demonstrate proficiency in energy analysis, fuel combustion and thermal systems design; and
7. provide solution to thermodynamic problems in HVAC systems, power plant, engines or renewable energy technology.

Course Contents
Multistage reciprocating compressors. Rotary compressors – centrifugal and axial-flow; stagnation properties. Simple gas turbine plant. The steam power plant. Combustion of fuels; chemistry of common hydrocarbon fuels, combustion with deficiency or excess air. Thermo-chemistry: Hess' Law of Heat Summation; heats of combustion and reaction; ideal adiabatic flame temperature. Reciprocating internal combustion engines. General thermodynamics relations. Kinetic theory of gas. Mixture of gases, psychometry, air-conditioning and cooling towers. Introduction to heat transfer.

MEE 404: Applied Fluid Mechanics (2 Units E: LH 30)

Learning Outcomes
At the end of this course, the students should be able to:
1. identify the various types of fluids and flows;
2. carry out simple calculations on floating and submerged surfaces;
3. explain the concept of fluid machinery for prototype development;
4. explain concepts of boundary layer;
5. explain and derive the Navier–Stokes for conservation of momentum and conservation of mass for Newtonian fluids;
6. describe machines that transfer energy between a rotors and a fluids;
7. identify pump types performed by simple pump selection, including both turbines and compressors; and
8. perform simple CDD grid processing, calculations and result processing.

Course Contents
Unsteady flow; oscillation in U-tube; surge tank; water hammer. Open-channel flows. Introductory concepts of boundary layer and re-circulating flows, mathematical derivation of Navier-stokes equations and its application. Dimensional analysis and similitude. Introduction to turbo machinery; characteristic curve for axial-flow and centrifugal pumps, fans, blowers, impulse and reaction turbines. Pump selection and application. Pipeline systems (Series and Parallel). Open channel flow. Overview of computational fluid dynamics (CFD)

MEE 405: Heat and Mass Transfer II (3 Units E: LH 45)

Learning Outcomes
At the end of this course, the students should be able to:
1. explain the principle of heat by diffusion under steady or unsteady conditions;
2. explain continuity and momentum equations and their roles in convection heat transfer analysis;
3. recognise convection heat transfer in laminar and turbulent flows;
4. determine heat transfer coefficients in internal and external flows;
5. identify dimensionless groups in convection heat transfer;
6. identify combined modes of heat transfer;

7. perform simple heat exchanger analysis and design;
8. demonstrate an understanding of heat and mass transfer modes and models;
9. demonstrate understanding of the different types of interface reactions;
10. explain comparison of Fick's and Fourier's laws and similarities between conduction and mass transfer in stationary systems; and
11. apply principles of heat and mass transfer phenomena to selected processes.

Course Contents

Convection heat transfer: Newton's law of cooling. Energy equation of convection. Continuity and momentum equations and their roles in convection heat transfer analysis. Convection heat transfer in laminar and turbulent flows. Internal and external flows. Heat transfer coefficients. Dimensional analysis and dimensionless groups in convection heat transfer. Convection heat transfer correlations. Heat exchanger analysis and design. Combined modes of heat transfer.

Mass transfer: Mechanisms of mass transfer. Fick's law of mass diffusion. General diffusion law. Rate equations. Comparison of Fick's and Fourier's laws. Equations of mass transfer in stationary systems. Similarities between conduction and mass transfer in stationary systems. Mass transfer coefficient. Electrical analogy of mass transfer. Equimolal counter diffusion. Drying and humidification of solids and gases. Types of dryers. Evaporation. Mass transfer correlations in convective systems.

MEE 406: Advanced Mechanics of Materials (2 Units C:LH 30)

Learning Outcomes

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

1. explain the theory, concepts, principles and governing equations of solid mechanics;
2. demonstrate the ability to deconstruct complex problems to produce effective outcomes;
3. perform simple analysis on thick cylinders; compound cylinders, rotating disks and bending of flat plates;
4. perform simple analysis on beams on an elastic foundation;
5. explain two-dimensional theory of elasticity and apply to elastoplastic problems;
6. use analytical, experimental and computational tools needed to solve the idealised problem;
7. Use these solutions to guide a corresponding design, manufacture, or failure analysis;
8. explain the selection, design and stress analysis of composite materials;
9. analyse the stresses in simple structures as used in industry, and
10. use interpersonal understanding, teamwork and communication skills working on group assignments.

Course Contents

Thick cylinders; compound cylinders. Rotating disks. Bending of flat plates. Beams on an elastic foundation. Membrane stresses in shells of revolution. Two-dimensional theory of elasticity. Elastoplastic problems and limit theory.

PAU-MEE 401 Professional Ethics for Engineers (2 Units, Core, LH=30)

Learning Outcomes

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

1. List at least ten of the rules contained in the COREN Engineering Practitioners' Code of Conduct 2022.
2. Provide at least one justification for each of the more commonly accepted ethical principles (concern for others, rationality, fairness; effectiveness/dedication; role responsibility, life plan and no intentional infliction of harm).
3. Relate at least ten of the rules of the COREN Engineering Practitioners' Code of Conduct 2022 to the more commonly accepted ethical principles.
4. Analyse practical problems of engineering ethics by making use of the rules contained the COREN Engineering Practitioners' Code of Conduct 2022.
5. Explain the relationship between having internalised standards of professional ethics and being a more professional engineer.
6. Identify at least three practical ways in which their profession can be an avenue for rendering service to others.

Course contents

Professional ethics. Human fulfillment. Main ethical principles: rationality, concern for others, fairness, effectiveness/dedication, life plan, role responsibility, no intentional harm. Main duties of engineering firms by providing actual value to clients, stability of employment, protection from harm, job design and participation, payment of a living wage, privacy, fair hearing. Responsibilities in relation to the environment. Safety. Cost-benefit analysis. Life-cycle analysis. Environmental impact assessments. Duty of care. Professional competence. Obeying the law. Confidentiality, truthfulness, and appropriation of ideas. Duties to the profession. Duties to professional colleagues. Questionable payments. Fiduciary relationships/the duty of loyalty such as Accepting bribes, nepotism and cronyism, self-dealing, conflicts of interest. Whistleblowing.

GET 404 Engineering Valuation and Appraisal (2 Units, Core, LH=30)

Learning Outcomes

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

1. Explain at least one systematic valuation process, standards, and ethical values in engineering and environmental projects.
2. describe four (4) risks and uncertainties that affect evaluation outcomes and ways to deal with uncertainties and risks in analysis.
3. describe at least five (5) the challenges of multi-attributed decision-making and apply an appropriate model to a given project for effective decision making.

4. explain valuation principles/process in at least three (3) business domains such as real properties, personal properties, machinery and equipment, oil and gas, and mines and quarries.
5. develop at least one professional technical report (using valuation methods and practices) that show critical analysis of information gathered from reliable sources to a specified audience.

Course contents

Objectives of valuation work/ valuer's primary duty and responsibility. Valuer's obligation to his or her client, to other valuers, and to the society. Valuation methods and practices. Valuation reports. Expert witnessing. Ethics in valuation. Valuation standards. Price, cost, and value. Depreciation and obsolescence. Valuation terminology. Appraisal reporting and review. Real property valuation. Personal property valuation. Machinery and equipment valuation. Oil and gas valuation. Mines and quarries valuation.

PAU-MEE 402 Engineering Economics (3 Units, Core, LH=45)

Learning Outcomes

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

1. outline three (3) reasons to justify the nature and scope of economics
2. evaluate three (3) basic concepts of engineering economy.
3. differentiate between the interest formulae, discounted cash flow, present worth, equivalent annual growth, and rate of return comparisons.
4. contrast replacement analysis, breakdown analysis. cost-benefit analysis.
5. explain the minimum acceptable rate of return in three (3) engineering projects.
6. analyze three (3) approaches for judging the attractiveness of a proposed investment.

Course contents
The nature and scope of economics. Basic concepts of engineering economy. Interest formulae. Discounted cash flow, present worth, equivalent annual growth, and rate of return comparisons. Replacement analysis. Breakdown analysis. Cost-Benefit Analysis. The minimum acceptable rate of return. Judging the attractiveness of a proposed investment.
The economics of the management, operation, and growth and profitability of engineering firms. Macro-level engineering economic trends and issues. Engineering product markets and demand influences. The development, marketing, and financing of new engineering technologies and products. Benefit–cost ratio

PAU-MCE 404: Computer Vision and Image Processing (2 Units E: PH 30)

Learning Outcomes

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

1. explain the basic algorithms, tools and systems for the management, processing and analysis of digital images;
2. identify basic concepts, terminology, theories, models and methods in the field of computer vision;
3. describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition;
4. assess which methods to use for solving a given problem, and analyse the accuracy of the methods;
5. develop and apply computer vision techniques for solving practical problems;
6. choose appropriate image processing methods for image filtering, image restoration, image reconstruction, segmentation, classification and representation;l
7. acquire good and practical skills in computer vision; and
8. design and develop simple systems oriented to real-world computer vision applications such as those requiring segmentation and classification of objects in digital images.

Course Contents

Computer vision and image processing are important and fast evolving areas of Mechatronics and Robotics. Student will get familiar with both established and emergent methods, algorithms and architectures. The course will enable students to apply computer vision and image processing techniques to solving various real-world mechatronics and robotics problems, and develop skills for research in the fields. Image formation, image filtering, edge detection and segmentation, morphological processing, registration, object recognition, object detection and tracking 3D vision.

The topics may include but are not limited to:

1. Image formation and perception, image representation.
2. Image filtering: space- and frequency- domain filtering, linear and non-linear filters.
3. Morphological image processing.
4. Image geometric transformations, image registration.
5. Edge detection, image segmentation, active contours, and level set methods.
6. Object recognition, template matching, and classification.

7. Object detection and tracking: background modeling, kernel-based tracking, particle filters.
8. Camera models, stereo vision.

PAU-MEE 409 Corrosion Engineering and Protection (2 Units, Elective, LH=30)

Learning Outcomes

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

1. Explain in using every day examples details what corrosion is;
2. Discuss at least three (3) the socio-economic implications of corrosion and the need to prevent same in manufacturing processes, materials selection and surface finish.
3. Describe using the Pourbaix diagram and its application to corrosion prevention and control.
4. Develop the necessary skill on methods of corrosion control and prevention using inhibitors, surface coating and electroplating.

Course contents

Two view points on corrosion: extractive metallurgy in reverse and electrochemical degradation of materials which is within the purview of physical metallurgy and electrochemistry; socio-economic implications of corrosion and need to prevent it; emphasis on the thermodynamics and kinetics of electrochemical corrosion of metals and alloys; description of metallurgical factors, effect of applied stress corrosion, cracking corrosion fatigue and passivity; methods of corrosion control and prevention including alloy selection, inhibitors, anodic and cathodic protection, coating and electroplating.

500 level

GET 501: Engineering Project Management (3 Units C: LH 45)

Learning Outcomes

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

1. explain the basics of project management as it relates to the Engineering discipline;
2. demonstrate knowledge and understanding of engineering, management and financial principles and apply these to their own work, as a member and/or leader in a team, to manage projects and in multi-disciplinary environments;
3. conduct, manage and execute projects in multi-disciplinary areas;

4. possess the skills needed for project management; and
5. work within the budget when executing a project for proper management.

Course Contents

Project management fundamentals – definitions, project environment, nature and characteristics, development practice, management by objectives, and the centrality of engineering to projects, infrastructures, national and global development. The scope of project management – organisational, financial, planning and control, personnel management, labour and public relations, wages and salary administration and resource management. Identification of project stakeholders; beneficiaries and impacted persons – functions, roles, responsibilities. Project community relations, communication and change management. Project planning, control and timeliness;decision making, forecasting, scheduling, work breakdown structure (WBS), deliverables and timelines, logical frameworks (log frames), risk analysis, role of subject matter experts (SMEs), role conflicts; Gantt Chart, CPM and PERT. Optimisation, linear programming as an aid to decision making, transport and materials handling. Monitoring and Evaluation – key performance indices (KPIs); methods of economic and technical evaluation. Industrial psychology, ergonomics/human factors and environmental impact considerations in engineering project design and management. Project business case - financial, technical and sustainability considerations. Case studies, site visits and invited industry professional seminars. General principles of management and appraisal techniques. Breakthrough and control management theory; production and maintenance management. Training and manpower development. The manager and policy formulation, objective setting, planning, organising and controlling, motivation and appraisal of results.

GET 502: Engineering Law **(2 Units C: LH 30)**

Learning Outcomes

Students will be able to:
1. describe and explain the basic concept, sources and aspects of law;
2. describe and explain the major differences between the various categories of law, courts and legal jurisdictions;
3. describe and explain legal principles and their application in professional engineering design and management services and their professional liability implications; and
4. develop reasoned analysis of real-life or hypothetical engineering scenarios using the legal principles undertake critical analysis of reliable information to develop, and practically present technical reports for use in varying judicial/quasi-judicial settings including as an expert witness.

Course Contents

Common Law: its history, definition, nature and division. Legislation, codification interpretation. Equity: definition and its main spheres. Law of contracts for Engineers: Forms of contract and criteria for selecting contractors; offer, acceptance, communication termination of contract. Terms of Contracts; suppliers' duties – Damages and other Remedies. Termination/cancellation of contract Liquidation and Penalties; exemption clauses, safety and risk. Health and Safety. Duties of employers towards their employees. Duties imposed on employees. Fire precautions act. Design for safety. General principles of criminal law. Law of torts: definition, classification and liabilities. Patents: requirements, application, and infringement. Registered designs: application, requirements, types and infringement. Company law. Labour law and Industrial Law. Business registration.

MEE 503: Applied Design **(3 Units C: LH 45)**

Learning Outcomes

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

1. demonstrate proficiency in systematic scientific design methodology;
2. demonstrate creative application of the design process to engineering problems;
3. demonstrate proficiency in design for the manufacture of complete mechanical systems and devices;
4. undertake a group design project;
5. submit reports showing all calculations, justification for choice of design and instructions on detail design, manufacture, testing and use; and
6. demonstrate use and evaluation of a CAD/CAM software package in the actual manufacturing design project.

Course Contents

Scientific Design Methodology: creative application of the design process to engineering problems with emphasis on the manufacture of complete systems to accomplish overall objectives of minimum weight, high efficiency while satisfying the design constraints. An appreciation of the process of engineering design, and of systematic procedures and tools usable in the design process, with particular reference to mechanical systems and devices. Topics include systematic problem definition, search for possible solutions, statistical analysis of stress/strength interference, experiment planning techniques, optimum design for minimum weight and cost, and management of the design process. Design Project: Students will be required to conduct a design project under supervision, using the presented techniques, and taking at least to a workable layout drawing of a device. The design should involve simple mechanical systems (e.g. testing and assembling devices, heat drive, etc.) for a specified duty, analyse its operating conditions and after considering the design criteria, choose between potential solutions. Reports submitted by students should contain all calculations, a comparison of potential solutions, justification for the design finally chosen, and instructions on detail design, manufacture, testing and use. Use and evaluation of several

CAD/CAM software packages. Students will gain experience with CAD/CAM software while carrying out an actual manufacturing design project.

MEE 509: Project **(6 Units C:L H/PH 270)**

Learning Outcomes

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

1. identify an engineering research problem;
2. demonstrate proficiency in PowerPoint presentation in a seminar;
3. demonstrate a methodology for actualising aims and objectives of a research project;
4. partake in a group research project efficiently; and
5. submit report comprising a topic, abstract, problem statement, aims and objectives, methodology, experimentation and/or analysis, results and analysis, conclusion and recommendation.

Course Contents

Final-year projects are assigned at the beginning of each academic year. Each final year student chooses a project supervisor in consultation with the final-year project coordinator. The process is entirely interactive, but the coordinator ensures that there is an even distribution of students amongst the lecturers. The final topic is decided by the student and his supervisor, selected from the fields of mechanics of solids and fluids, materials science, machine design, heat power, heat transfer, production technology, industrial engineering and management. Each student presents at least two seminars as part of their final year project, usually at the beginning and ending of the second semester. Each student is required to submit a report of their findings and undergo an oral examination. All seminars are scored by a panel of lecturers.

PAU-MEE 503 Applied Thermodynamics II (2 Units, Elective, LH=30)

Learning Outcomes

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

1. Discuss general thermodynamics relation using Kinetic theory of gas.
2. Explain using everyday examples mixture of gases and psychometry.
3. Analyse at three (3) air-conditioning and cooling towers and heat transfer
4. Apply the knowledge of mathematics, science and engineering fundamentals to three (3) open system, closed systems and heat reservoirs.
5. Apply the knowledge of mathematics, science and engineering fundamentals to chemical equations and chemical equilibrium to three (3) engineering systems.
6. Categorize three (3) centrifugal and axial flow compressors used in industries.
7. Discuss using examples the concepts of Turbine theory, velocity diagrams, degree of reaction, impulse efficiency, reheat factor to engineering.

8. Evaluate the concepts of Combustion (engines) and product analysis and try to think beyond curriculum in alternative sources of energy in Nigeria.
9. Assess at least three (3) concepts learnt in fundamental laws of thermodynamics from which ideas are generated on how to sustain energy crisis and think beyond curriculum in the field of alternative and renewable sources of energy.

Course contents
General thermodynamics relations. Kinetic theory of gas. Mixture of gases, psychometry, air-conditioning and cooling towers. Introduction to Heat Transfer.

PAU-MEE 504 Mechanical (Machine) Design Engineering III (2 Units, Elective, LH=30)

Learning Outcomes

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

1. Apply the design process to at least 1 engineering problem with emphasis on the manufacture of complete systems.
2. Select for a simulated factory floor, relevant key parameters with emphasis of the effects on the system performance.
3. Evaluate the tradeoffs with at least 2 different design alternatives using economic analysis functions as well as direct performance measures- minimum weight and high efficiency.
4. Generate computer algorithms – minimum 2- for design using Fusion 360 and other CAD/CAM software packages to run a CNC machine.
5. Evaluate a product of an actual manufacturing project, using the concept of Flow Line Assembly, Just in time and flexible manufacturing systems-JIT & FMS-, Job Shop details - storage of raw material, work-in-process inventory as well as finished product,

Course contents

Creative application of the design process to engineering problems with emphasis of the manufacture of complete systems. General design objectives. Minimum weight and high efficiency satisfying the design constraints. Evaluation of several CAD/CAM software packages. CAD/CAM software. Design manufacturing design project. Compare software packages such as Fusion 360, CREO, and Inventor.

PAU-MEE 507 Theory of Elasticity and Plasticity (3 Units, Elective, LH=45)

Learning Outcomes

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

1. Apply the theory of Elasticity using two- and three- dimensional problems in Engineering.
2. Demonstrate the application of plane stress, plane strain, stress analysis, strain gauging, photoelasticity and holography in at least three (3) engineering scenarios.
3. Evaluate the stress concentration in round holes; Discs, wedges under three (3) types of loads such point loading, distributed loading, etc.
4. Analyse the theory of elasticity using approximate methods and Finite Element method.
5. Use modern tools (such as excel and MATLAB) to analyze equations and principles of elasticity of two-dimensional problems in Cartesian and polar coordinates.
6. Apply hyper elasticity to determine the response of elastomer-based objects and analyze the structural sections subjected to torsion.

Course contents

Application of Theory of Elasticity to two-dimensional problems in Engineering. Application of Theory of Elasticity to three-dimensional problems in Engineering Stress concentration in round holes; Discs, wedges under point loading, etc. Experimental stress analysis. Strain gauging. Photoelasticity. Holography. Approximate methods; Finite Element method. Computer applications. Graphical methods, Mechanical testing.

PAU-MEE 510 Engineering Management (2 Units, Elective, LH=30)

Learning Outcomes

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

1. Discuss at least three (3) important relevance of Management to Engineers.
2. Explain at least four (4) managerial functions, roles, and skills.
3. Interpret using practical examples the elements, principles, and management objectives of an organization.
4. Select four (4) most appropriate financial management method(s); Personnel management method(s); and Resource management method(s) in engineering situations.
5. Analyse at least three (3) principles and different methods of economic valuation, assets valuation and Depreciation accounting.
6. Describe the planning, directing and controlling of three (3) production operations
7. Apply using the concepts of work study, motion economy and ergonomics in the design of equipment and processes.
8. Demonstrate the ability to understand, analyze, and improve organizational practices using current technology, analysis, to address evolving business and customer needs in at least three (3) engineering outfits.
9. Identify at least four (4) ethical issues while assessing occupational environmental factors like heat stress, noise, and vibration and Respirable Suspended Particulate Matter (RSPM) level in the industry.

10. Analyze using the annual financial statements/report of an engineering enterprise.

Course contents

Elements of organization; management by objectives. Financial management, accounting methods, financial statements, cost planning and control, budget, and budgetary control. Depreciation accounting and valuation of assets. Personnel management, selection, recruitment and training, job evaluation and merit rating. Industrial Psychology. Resource management; contracts, interest formulae, rate of return. Methods of economic evaluation. Planning decision making; forecasting, scheduling. Production control. Gantt chart, CPM and PERT. Optimization linear, materials handling. Raw materials and equipment. Facility layout and location. Basic principles of work study. Principles of motion economy. Ergonomics in the design of equipment and process.

PAU-MEE 511 Tribology (2 Units, Elective, LH=30)

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

1. Evaluate theories of friction between metallic, non-metallic, dry, and lubricated surfaces using an example in each case.
2. Assess the properties and testing of materials and liquid lubricants with at least one assignment and one quiz results as proof of verification of the control.
3. Interpret the theory of self-acting and pressurized bearings, including Reynolds equation and solutions, dynamic loading, temperature, and pressure effects on viscosity on the basis of an existing design.
4. Analyse elasto-hydrodynamic lubrication, gears and rolling contact bearings using the example of a gear box, front and rear axles of an automobile and a machine tool spindle.
5. Design journal and thrust bearing using an automobile engine as an example.

Course contents
Theories of friction between metallic, non-metallic, dry and lubricated surfaces. Testing and properties of materials; Solid and liquid lubricants. Theory of self-acting and pressurized bearings, including Reynolds equation and solutions, dynamic loading, temperature, and pressure effects on viscosity. Elasto-hydrodynamic lubrication, gears and rolling contact bearings. Design of journal and thrust bearing.

PAU-MEE 512 Turbomachinery (2 Units, Elective, LH=30)

Learning Outcomes
On completion of the course, students should be able to:
1. Apply and the principle of moment of momentum for different three (3) turbomachines.

2. Determine energy transfer in turbomachines of different designs using at least two (2) models.
3. Evaluate for two examples flow through two-dimensional turbine and compressor cascade using the cascade theory of Mach number effects.
4. Interpret flow through centrifugal compressor and its performance using 2 examples.
5. Design axial flow turbomachine with radial equilibrium.
6. Illustrate at least six (6) practical cases of fan.
7. Assess flow through radial flow turbine and wind turbine for a sustainable environment based on a practical case.
8. Analyse using charts future turbomachinery concepts of a machine based on physical principles

Course contents

Introduction and Classification: Axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effects of Coriolis and Centrifugal forces, momentum and energy equation, Euler work, and illustrative examples. Gas Turbine Cycle: Brayton Cycle, regenerative cycle, reheat, inter-cooling, turboprop, turbojet and turbofan engine, thrust augmentation, and illustrative examples. Similarity Analysis: Similarity rules, specific speed, Cordier diagram and illustrative examples. Cascade Analysis: Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, compressor and turbine cascade, blade geometry, and illustrative examples.Axial Flow Compressor: Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, the effect of Mach number, performance and efficiency, three-dimensional flow, tip clearance, losses, compressor performance, and illustrative examples. Centrifugal Pump and Compressor: Theoretical analysis and design, the effect of circulation and Coriolis forces, reversal eddies, slip factor, head and efficiency, diffuser, introduction to the combustion system, and illustrative examples. Axial Flow Turbine: Two-dimensional pitch line design, stage loading capacity, degree of reaction, stage efficiency, turbine performance, blade cooling, and illustrative examples. Applied to Turbomachinery Flows: Governing equations, numerical methods, and test cases illustrating flow and heat transfer related to turbomachines.

PAU-MEE 518 Industrial Automation and Control (2 Units, Elective, LH=15 PH=45)

Learning Outcomes

On completion of the course, students should be able to:
1. Describe working of at least two (2) blocks of basic industrial automation systems.
2. Create automation programming for troubleshooting in at least three (3) programmable logic controllers.
3. Design connection of the peripherals to at least two (2) programmable logic controllers.
4. Explain the functioning of at least three (3) PLC functions using small PLC programs.

5. Demonstrate distributed control system of one SCADA system.
6. Explain core hardware relating to one programmable automation controllers.
7. Describe three (3) industrial motor drives for the Industrial Automation
8. Explain the automation and control systems of one industrial system in Nigeria.

Course contents
Introduction to industrial automation and control. Architecture of industrial automation systems measurement systems. Pressure and force measurement, temperature measurement, displacement, and speed measurement. Flow measurement including measurement of level, humidity and PH. Signal conditioning circuits, errors, and calibrations. Process control including introduction to process control such as PID, PID Controller Tuning, PID Controller. Implementation Programmable Logic Control including the software environment and programming of PLC. Sequence control and structured RLL programming. Programming of PLCs and Sequential Function Chart. CNC machines including introduction to CNC Machines, CNC machines interpolation, control, and drive. Actuators such as control valves, directional control valves, switches and gauges, Industrial hydraulic circuits. Pneumatic control components and pneumatic control systems. Electric machines drive including energy savings with variable speed drives. Step Motors including principles, construction and drives, DC motors drives, induction motor drives, BLDC Motor Drives. Industrial embedded and communication system including introduction to Real-time embedded systems, real-time operating systems. Networking of field devices via Fieldbus. Higher levels of industrial automation.

PAU-MEE 521 Design of Mechatronics Engineering and Robotics Systems (2 Units, Elective, LH=30)

Learning Outcomes

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

1. List at least four (4) robot system used in manufacturing as defined by global robotics organisations.
2. Install the Free and Open-Source Software (FOSS) to design at least three systems for manufacturing.
3. Apply Robot Operating System (ROS) programming for hardware prototyping.
4. Troubleshoot faulty robotic system.
5. Analyse at least two (2) robot systems using kinematics of serial and parallel Robots principles.
6. Perform path planning of two (2) robotics systems and motion control.
7. Describe ten (10) actuators and drive systems for manufacturing robots.
8. Describe the characteristics of at least seven (7) types of sensors used for image processing and analysis of vision systems.
9. State at least five (5) cost minimisation methods in robot development for SMEs.

Course contents

Robot Fundamentals. Free and Open-Source Software (FOSS). Introduction to Robot Operating System (ROS) programming. ROS Robot Simulation. ROS Robot hardware Prototyping. Trouble shooting and best practices. Kinematics of Serial and parallel Robots. Differential motion and velocities. Path planning of robotics systems and motion control. Actuators and Drive systems. Sensors. Image processing and analysis of vision systems. Fuzzy logic controls. Basic Artificial Intelligence for Robotics design. Integrated design process of mechatronics systems. Components of mechatronics systems, sensors, and actuators. Fundamental principal of operation for components, strengths and weaknesses, and operational characteristics.

PAU-MEE 522 Automobile System Design (2 Units, Elective, LH=30)

Learning Outcomes

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

1. Describe at least five (5) design of engine block designs.
2. Describe at least five (5) contemporary chassis designs.
3. Demonstrate using simulation five (5) types of steering system.
4. Explain at five (5) mechanical transmission system designs of automobiles.

Course contents

Auto engine design. Design of steering systems. Design of transmission systems. Overall process and workflow. Automotive design and styling. Ergonomic analyses and factors considered in establishing initial concept of passenger vehicles. Vehicle Architecture. Monocoque and Body on frame constructions. Types of suspension and factors in suspension configuration selection for vehicle. Modular platforms. Key characteristic of modular platforms and their benefits. System packaging design and importance of interfaces. Role of integration. Engineering bill of materials. Example of design of frame. Overview of performance domains and the systems.

SST • School of Science and Technology • Pan-Atlantic University
52 km Lekki-Epe Expressway, Ibeju-Lekki, Lagos, Nigeria