



IMO STATE UNIVERSITY, OWERRI

P. M. B 2000

FACULTY OF ENGINEERING

DEPARTMENT OF CHEMICAL ENGINEERING



CORE CURRICULUM AND MINIMUM ACADEMIC STANDARDS

AND

BENCHMARK MINIMUM ACADEMIC STANDARDS

FOR

UNDERGRADUATE PROGRAMME

AND

STUDENT HANDBOOK

SECOND EDITION

2024/2025

ACADEMIC SESSION

IMO STATE UNIVERSITY (IMSU), OWERRI

FACULTY OF ENGINEERING (FENG)

**DEPARTMENT
OF
CHEMICAL ENGINEERING
(CME)**

BACHELOR OF ENGINEERING (B. ENG.) DEGREE PROGRAMME

**COMBINED
CORE CURRICULUM AND MINIMUM ACADEMIC STANDARDS
(CCMAS)
AND
BENCHMARK MINIMUM ACADEMIC STANDARDS
(BMAS)**

STUDENT HANDBOOK

SECOND EDITION

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ACADEMIC SESSION

IMO STATE UNIVERSITY, OWERRI NIGERIA



FACULTY OF ENGINEERING

Department of Chemical Engineering (CME)

COMBINED

CCMAS AND BMAS CURRICULUM AND STUDENT HANDBOOK

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FORWARD

Chemical Engineering is one of the two programmes of the Faculty of Engineering, Imo State University, Owerri, established in the 2021/2022 academic year.

Having had a successful resource verification in 2021/2022 academic session, this Department commenced academic activities and will graduate her pioneer students in 2025/2026 academic session. From available statistical data, this Department is now being consistently subscribed for among its likes in state-owned Universities.

The Department is determined to commence Postgraduate programmes upon graduating students in undergraduate programme.

We are happy to publish this second edition (in 2024/2025 academic session) of the undergraduate Core Curriculum and Minimum Academic Standards (CCMAS) based student handbook which is also Outcome Based Education (OBE) compliant. We do hope that both students and lecturers alike in Chemical Engineering Department would find it a very handy source of necessary and useful information.

Students are therefore, advised and encouraged to own a copy of this handbook.

The Department shall welcome any thoughtful and relevant suggestion that will be incorporated into the future edition.

Head of Department

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LIST OF ACADEMIC STAFF

S/N	NAME OF STAFF	QUALIFICATION WITH DATE	RANK/DESIGNATION
1	Engr. Prof E. N. Ikezue	B. Sc. (1985), M. Sc.(1987), M.Sc.Maths (2004), Ph.D. (2016)	Professor
2	Engr. Dr. I. S. Ike	B. Eng. (2001), M. Eng. (2008), M.Sc Maths(2010), Ph.D. (2017)	Reader
3	Engr. Dr. O. C. Nkuzinna	B. Eng. (2005), M. Eng. (2011), Ph.D. (2024)	Senior Lecturer
4	Engr. Dr. Mrs. K. T. Ojiabor	B. Eng. (2005), M. Eng. (2011), Ph.D. (2021)	Senior Lecturer
5	Engr. Dr.T. O. Azeez	B. Eng. (2007), M. Eng.(2013), Ph.D. (2022)	Senior Lecturer
6	Engr. Dr. J. C. Offurum	B. Eng. (2001), M. Eng. (2007), Ph.D. (2017)	Senior Lecturer
7	Engr. Dr. Ayodeji T. Balogun	B.Eng. (2004) M. Eng. (2018) Ph.D.(2022) Sustainable Energy	Senior Lecturer
8	Engr. C. N. Eze	B. Eng. (2015), M. Eng. (2020)	Lecturer I
9	Engr. E. E. Amadi	B. Eng. (2013), M. Eng. (2019)	Lecturer I
10	Dr. T. U. Nwaneri	B. Eng. (2002), M. Eng. (2013), Ph.D. (2024)	Lecturer I

LIST OF TECHNICAL STAFF

S/N	NAME OF STAFF	QUALIFICATION WITH DATE	RANK/DESIGNATION
1	Engr. U. J. Ezemelue	B. Teh. (2004),	Chief Technologist
2	Engr. G. U. Owo	B. Eng. (2001), M	Asst. Chief Technologist
3	Engr. U. C. Philips	B. Eng. (2006),	Asst. Chief Technologist
4	Mrs. R. N. Dike	B. Eng. (2008)	Senior Technologist
5	Mrs. L. E. Mbonu	HND (2014)	Senior Technologist
6	Mrs. P. E. Nsofo	B. Eng. (2012)	Senior Technologist
7	Mr. C. E. Eze	HND (2021)	Lab. Technician

LIST OF ADMINISTRATIVE STAFF

S/N	NAME OF STAFF	QUALIFICATION WITH DATE	RANK/DESIGNATION
1	Mr. K. N. Unadibia	B. Eng. (2015)	Higher Executive Officer
2	Miss C. C. Enendubagu	HND (2012)	Secretary/ Clerk
3	Mr. V. C. Iwuoha	B. Eng. (2020),	Administrative Officer

LIST OF ASSOCIATE LECTURERS

S/N	NAME OF STAFF	DEPARTMENT	DESIGNATION	COURSES SERVICED
1	Engr. Prof. J. O. Onyeka	Civil Engineering	Professor	GET 207, GET 208
2	Engr. Prof B. C. Chukwudi	Mechanical Engineering	Professor	GET 202
3	Engr. Prof. A. U. Iwuoha		Professor	IMSU-GET 221
4	Engr. Prof. L. E. Obi	Civil Engineering	Professor	GET 101, GEN 493
5	Engr. Dr. H. E. Opara		Reader	GEN 591, GEN 592
6	Engr. Dr. I. A. Ezenugu	Electrical & Electronic Engineering	Senior Lecturer	GET, 211, GEN 481
7	Engr. C. S. Nwokonko		Lecturer I	IMSU-GET 222
8	Dr. A. W. Verla	Chemistry	Reader	CME 321, CME 326
9	Dr. C. C. Duru		Reader	CHM 101, CHM 102
10	Dr. B. I. Obi	Mathematics	Senior Lecturer	MTH 101, MTH 103
11	Dr. N. O. Onuoha		Lecturer I	MTH 102
12	Prof. T. C. Chineke Mr. N. C. Nwulu	Physics	Professor Lecturer I	PHY 101, PHY 102
13	Prof. V. C Nwulu	GST Unit	Professor	GST 111, GST 112
14	Dr. E. Ohaegbulem	Statistics	Senior Lecturer	STA 112

1.0 GENERAL INFORMATION ON THE INSTITUTION, FACULTY AND DEPARTMENT

1.1 History of Imo State University (IMSU), Owerri

Imo State University was established on 23 February 1981 through the passage of Law No.4 by the Imo State House of Assembly in Owerri the State capital. The law establishing the university was amended by Edict 27 of 1985, another edict in 1988 and by the passage of Law No.2 of 1992 relocating the university to its present site in Owerri. The university commenced academic activities at a temporary site located at the former Madonna High School, Ihitte. The decision to establish a State university arose when the absence of a federal university was greatly felt by the people of Imo State whose major industry is education. The State had so many qualified candidates who could not be admitted into the existing universities.

The Government of Imo State under Chief Sam Mbakwe established the Imo State University as a response to the yearnings of the people after completing due processes of approval from the Federal Government. The decision to establish the university was also informed by: the need to provide a relatively easy and effective mechanism for producing various cadres of manpower for the State; and the anxiety of both the Government and people of Imo State to join the select group of regions of Nigeria that could boast of having their 'own' university.

Imo State University was established as a liberal studies tertiary institution. The University was designed as a multi-campus structure with each college to be located in the Senatorial Zones of the then Imo State. Thus, the main campus was located at Etiti in the Okigwe Senatorial Zone while the Aba Campus in Aba Zone, housed the Colleges of Business and Legal Studies. The first set of about 400 students came into residence on 23 October 1981 and matriculated on 19th day of December of the same year.

Subsequently the multi-campus structure was phased out, because of a serious problem of inadequate space. Thus, the University was in 1986 relocated to a consolidated campus at Uturu (Okigwe). With the creation of Abia State in 1991 out of the former Imo State, the entire physical facilities and human resources of Imo State University were ceded to Abia State as the land housing the University belonged to the Uturu community in Isiukwuato Local Government and thus became the property of Abia State.

Consequently, the Imo State Government of Chief Evans Enwerem in April 1992 re-established the Imo State University in Owerri. Two options were considered by the Imo State Government in the re-establishment of the university at Owerri. The first option was to move at once, all the staff and students at the various stages of their programs in Uturu who wanted to remain in newly re-established Imo State University presently at Owerri. The second option was to rebuild the university at Owerri over a specified period of time. The second option was adopted after various consultations by government and a target period of 5 years within which to complete the re-establishment of the university at Owerri was considered. Professor T.O.C. Ndubuizu, Deputy Vice-Chancellor, University of Nigeria, Nsukka was then appointed the Vice-Chancellor with the onerous responsibility of relocating and re-establishing Imo state University at Owerri.

At Owerri, the Imo State University was temporarily accommodated within the campus of Alvan Ikoku College of Education from May to December 1992. The University later moved to its own premises of four buildings within the Federal University of Technology, Owerri, at the Lake Nwaebere Campus. With the translocation of the Federal University, Owerri to its permanent site at Ihiagwa near Owerri, the Lake Nwaebere Campus of that University was then acquired for Imo State

University Owerri. The first batch of students was allocated to the new Imo State University by the Joint Admissions and Matriculation Board (JAMB) in February 1993. The National Universities Commission also formally approved the reestablishment of the university in 1992 at the Lake Nwaebere Campus.

The academic programs of Imo State University were initially organized in colleges and schools. However, the unwieldy collegiate system was replaced by the new faculty structure at the beginning of the 2001/2002 academic session. This is in line with the law establishing the Imo State University. The transition gave rise to some faculties and many departments, with only the College of Medicine and Health Sciences retaining its original status. The University offered undergraduate, postgraduate and diploma programs in various disciplines. In addition to its regular full-time and part-time programs, the University catered for the educational needs of the various segments of the Nigerian public through its sandwich programs, Institute of Continuing Education Program (ICEP) and Outreach and Consultancy Services (OCS) programs.

The take-off students' population of the university was 420 in the 1992/93 session. The students' population has grown steadily and the number of students under taking various diploma and degree programs of the university through its Full-time, part-time, sandwich, ICEP and outreach programs grew to about 24,000 with an academic staff population of about 1,131 by 2007.

The University graduated its first batch of students in the 1996/97 session. In April 2002, the 4th Convocation ceremony of the relocated and now re-invigorated Imo State University took place during which 2,309 and 871 graduates were awarded various first degrees and postgraduate diplomas/degrees respectively.

The Imo State University is now one of the best universities in Nigeria with highly qualitative academic programs for the training and character formation of tomorrow's leaders. The result of the 1999/2000 accreditation exercise of the National Universities Commission confirmed the high rating and acceptance of the university by the Nigerian public. The university was ranked 1st among all State universities in Nigeria and the 10th overall among both State and Federal universities.

The law establishing the Imo State University was amended by Law NO.5 of 2004 signed into law by the Executive Governor of Imo State, Chief Achike Udenwa on 2nd November 2004. The new law provides for the restructuring of Imo State University Owerri. The law is cited as the Imo State University Owerri Law 2004.

1.2 Motto of Imo State University (IMSU), Owerri: *Excellence in Service*

1.3. Vision of the Imo State University (IMSU), Owerri: The Vision of IMSU are to:

- ***Become a World First Class University***
- ***Extend Higher Education to all Qualified***
- ***Promote Academic Pursuits to the Highest Possible Standard***
- ***Retain Community Services as One of the Cornerstones of Raison D'être***

1.4. Mission of Imo State University (IMSU), Owerri: The Mission of IMSU include the mandate to:

- ***Provide and Promote High Quality Education and Training.***
- ***Encourage First Class Learning, Research and Innovations.***
- ***Ensure The Publication and Dissemination of Results of Such Academic and Professional Contributions.***

- *Provide Appropriate Community Services to Imo People in Particular, Nigerians and Humanity in General Through the Creation of Industrial Harmony, Effective Partnerships with Governments, Organizations, Institutions, As Well as Individuals in Line with The Socio-Economic, Cultural and Political Needs of Our People.*

1.5 Philosophy and Aspiration of Imo State University (IMSU), Owerri:

- *To Encourage the Advancement of Learning in Imo State in Particular, Nigeria and Humanity in General and*
- *To Hold Out to All Persons, Without Distinction of Race, Creed or Sex the Opportunity of Acquiring Higher Education.*

1.6 Motto of Faculty of Engineering, Imo State University (IMSU), Owerri:

Functional Impacts On Our Internal and External Communities

1.7 Vision of Faculty of Engineering, Imo State University (IMSU), Owerri:

Delivery of functional impacts on the 21st Century challenges of our Internal and External Communities through Admission, Training, Research and Innovative Engineering products blended with Entrepreneurial skills to satisfy their needs.

1.8 Mission of Faculty of Engineering, Imo State University (IMSU), Owerri:

To admit qualified and interested students into our programmes, train them through our Programme Outcomes and thus produce functional / competent and entrepreneurially-skilled Graduates who are research-ready, highly innovative and can tackle complex engineering problems by the application of critical thinking for creative / workable results aimed at solving the problems.

1.9 Philosophy of Faculty of Engineering, Imo State University (IMSU), Owerri:

Admit, Train and Graduate Students into the 21st Century Global Economy who:

1. *can solve problems*
2. *are committed to on-going learning*
3. *are creative*
4. *have above-average communication skills*
5. *are in line with new technological developments*
6. *are flexible*
7. *can participate in management processes and decision-making and*
8. *can work interactively.*

1.10 History of the B. Eng. Programme in Chemical Engineering, IMSU, Owerri

Imo State University as earlier stated was established in the year 1981. Following the creation of Abia State out of the old Imo State, the University relocated to Owerri in 1992. The University operated a Faculty system and Faculty of Engineering and Environmental services was among the eight Faculties set up to pioneer the new (or recreated) Imo State University.

In June 2006, the Faculty of Engineering came into existence through the splitting of the Faculty of Engineering and Environmental Sciences into Faculty of Engineering and Faculty of Environmental sciences. The Faculty of Engineering took off with the following four Departments;

- ✓ Department of Agricultural Engineering

- ✓ Department of Civil Engineering
- ✓ Department of Electrical & Electronic Engineering
- ✓ Department of Mechanical Engineering

In the year 2020, the Senate of Imo State University (IMSU), Owerri thought it wise to mount Chemical Engineering programme and hence gave approval for the programme to commence. Sequel to this approval, National Universities Commission (NUC) came for resources verification in 2020/2021 academic session.

Following the successful resources verification exercise and recommendations by the NUC, Chemical Engineering programme in Imo State University (IMSU), Owerri commenced admission of students and indeed full academic exercise in 2021/2022 academic session.

By the above fact, the Department of CHEMICAL ENGINEERING (CME) offers a five – year intensive academic programme leading to the award of Bachelor of Engineering (B. Eng.) Degree in CHEMICAL ENGINEERING for candidates admitted through the Unified Tertiary Matriculation Examinations (UTME) mode and a four - year study programme for candidates admitted through Direct Entry (DE) for the award of the same B.Eng. Degree in CHEMICAL ENGINEERING.

1.11 Motto of Chemical Engineering (CME) Department, IMSU, Owerri:
Engineering Solutions for a Better World.

1.12 Vision of Chemical Engineering (CME) Department, IMSU, Owerri:
To be a world first class programme for the training and graduation of competent, innovative and skilled Chemical Engineers whose positive impact will be felt by the immediate and remote communities.

- 1.13 Mission of Chemical Engineering (CME) Department, IMSU, Owerri:**
- *To provide and promote high quality education and training to qualified and admitted students into Chemical Engineering programme.*
 - *To set standards for first class learning leading to outcome based education that can contribute immensely to the technological and economic development in the 21st Century.*
 - *To produce modern high-tech Chemical Engineers for the analysis and determination of solution to problems for both national and global development.*

1.14 Aim and Philosophy of Chemical Engineering (CME) Department, IMSU, Owerri
The aim is to produce graduates that meet the needs of today's process industries by providing a thorough understanding of the subject, having generic skills, technical competencies, and transferable skills required for the 21st Century knowledge-based and digital economy as well as attitudes fit for subsequent industrial revolutions

The Philosophy of the Department is to admit, train and produce Chemical Engineering graduates who are highly skilled, flexible, innovative and well-versed in practical applications of engineering science to provide solution to problems regarding the design, manufacture, operation, maintenance and optimization of chemical and process plants. To this end, the programme seek to equip graduates such that they will have strong foundations in both theory and practical applications, as well as an understanding of the ethical and social responsibilities of Engineers.

They will be prepared to take on challenging roles in the industry and government, making a positive impact on the world through their work.

1.15 Objectives of Chemical Engineering (CME) Department, IMSU, Owerri

The objectives of the Programme are, amongst others, to:

- 1. Apply knowledge of Science, Technology, Engineering and Mathematics (STEM) fundamentals to the solution of Chemical Engineering related problems.*
- 2. Design solutions for Chemical Engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, environmental and other ethical considerations.*
- 3. Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.*
- 4. Create, select and apply appropriate technique(s), resource(s) and modern Engineering and IT tool(s): including prediction and modeling, to complex Engineering activities, with an understanding of the limitation(s).*
- 5. Function effectively both as an individual and as a team member or leader in diverse and in multi-disciplinary settings.*
- 6. Communicate effectively on complex Engineering activities with the Engineering community and with the society at large.*
- 7. Apply the knowledge and understanding of Engineering and Management principles in managing multi-disciplinary projects.*
- 8. Create awareness and understanding of the moral, ethical, legal, and professional obligations needed to function as part of a professional enterprise while protecting human health and welfare and the environment in a global society.*
- 9. Develop entrepreneurial skills and knowledge, in addition to adequate training in human and organizational discipline with a spirit of self-reliance so that they can set up their own businesses.*

2.0 ACADEMIC REGULATIONS

2.1 Admission Requirements

Candidates are admitted into the Bachelor of Engineering (B. Eng.) programme of the Department of CHEMICAL ENGINEERING through any of the following:

1. Unified Tertiary Matriculation Examinations (UTME)
2. Direct Entry (DE)
3. Inter-University Transfer (IUT)

2.2 Unified Tertiary Matriculation Examinations (UTME) Entry Mode

Candidates who have passed Senior Secondary Certificate Examination (SSCE), West African Senior Secondary School Certificate Examinations (WASSCE), the National Examination Council (NECO) or General Certificate of Education (GCE) (Ordinary Level ["O" Level]) with a minimum of credit level may be admitted into the five-year program of the Department of CHEMICAL ENGINEERING provided they satisfy the Unified Tertiary Matriculation Examinations (UTME) cut-off score mark set by the Department

Applicants for admission by UTME entrance examinations must have passed in one or two sittings either

1. The West African Senior Secondary School Certificate Examinations with at least five credits in English Language, Mathematics, Physics, Chemistry and one other Science or Technical subject.
2. The General Certificate of Education Ordinary Level examinations with at least five credits in English Language, Mathematics, Physics, Chemistry and one other Science or Technical subject.
3. The National Examination Council examinations with at least five credits in English Language, Mathematics, Physics, Chemistry and one other Science or Technical subject.

2.3 Direct Entry (DE) Mode

Candidates for admission by Direct Entry must have passed:

1. The Higher School Certificate (HSC) examinations in Pure Mathematics, Physics and Chemistry and satisfy the requirements of 2.2.
2. The General Certificate of Education (Advanced Level [“A” Level]) in Pure Mathematics, Physics and Chemistry and satisfy the requirements of 2.2. Candidates with JUPEB may be considered for admission into 200 level.
3. National Diploma (ND) Certificate in CHEMICAL ENGINEERING not below Lower Credit and satisfy the requirements of 2.2 may be offered admission into 200 level.

Note: Holders of Higher National Diploma (HND) Certificate in CHEMICAL ENGINEERING could be considered for Direct Entry admission on their individual merits may be offered admission into 300 level.

2.4 Inter University Transfer (IUT) Mode

- i. Students studying CHEMICAL ENGINEERING in IMSU-Senate-recognized universities may transfer into 200 level provided they have the relevant “O” level qualifications and their programmes are adjudged to meet the standards of the department.
- ii. No candidate shall be admitted from another university unless the department is satisfied that the grades obtained by such candidates for courses in which they have had instructions on are acceptable.

3.0 STAFFING

3.1 Academic, Technical and Administrative Staff

The Department of CHEMICAL ENGINEERING, Imo State University, Owerri has qualified, experienced, focused and renowned academics as core lecturers. The ranking of these lecturers ranges from Professor to Lecturer II. There are other members of the academic staff from various Engineering Departments who are respected intellectuals that take some common courses and other GEN (BMAS) and GET (CCMAS) coded courses.

Almost all members of the academic staff of CME are members of Nigerian Society of Engineers and are registered or licensed to practice Engineering by the Council for the Regulation of Engineering in Nigeria (COREN). In line with the requirements of the regulating bodies (NUC and COREN), the staff student ratio is quite normal as it is below the benchmark of 1:15.

The student population is bound to increase with time and it is hoped that more full- time and adjunct academic staff as well as other cadre of staff will be employed to keep the academic staff-student ratio within the National Universities Commission (NUC) approved ratio of 1:15.

The Technical staff of the Department comprising of Technologists and Technicians are adequate. The ratio of Technologists to Lecturers which COREN has the benchmark to be 1:15 is satisfied.

Chemical Engineering Department has qualified and able administrative staff who handles the administrative jobs of the Department.

4.0 OUTCOME-BASED EDUCATION (OBE)

4.1 What Outcome Based Education Really is

By Outcome-Based Education, all learning activities must be geared towards what the outcomes of the teachings should be, what the learner should be able to do and at what standard and NOT what the teacher is going to teach.

It indeed, involves the ***restructuring of curriculum, assessment and reporting practices*** in education to ***reflect the achievement of high order learning and mastery*** rather than ***accumulation of course credits***.

To base a system on something imply defining, deciding, organizing, structuring, focusing and operating what the system does according to some consistent standard or principle.

4.2 Importance of Outcome-Based Education

The OBE has some inherent merits as stated below

- (i) It discourages traditional education approaches based on direct instruction of facts and standard methods.
- (ii) OBE helps to have a more direct and rational curriculum in terms of its responsiveness to the societal and national needs.
- (iii) OBE focuses on what students can do or the attributes they should develop after they are taught.
- (iv) OBE requires that the students demonstrate proficiency in knowledge, skills and professional attitude.
- (v) OBE enhances graduate employability in an ever growing and competitive world.
- (vi) OBE fosters universities community and stakeholder's relations.
- (vii) OBE enhances university's visibility and ranking.
- (viii) With OBE, Degrees will be well recognized in all Washington Accord Countries.
- (ix) COREN becomes a PROVISIONAL SIGNATORY of the Washington Accord.

4.3 What Exactly Outcomes Are

The meaning of Outcomes especially in regards to OBE are as enumerated below

- (a) Outcomes are ***clear learning results that we want students to demonstrate at the end of significant learning experiences.***
- (b) Outcomes ***are what learners can actually do with what they know and have learnt.*** (Tangible application of what has been learnt).
- (c) Outcomes are ***actions and performances*** that embody and reflect learner competence in ***using content, information, ideas, and tools successfully.***
- (d) Outcomes represent the ultimate result that is sought from the learning

4.4 Levels of Outcomes in OBE

There are indeed, different levels of Outcomes in OBE. They are as represented in figure 4.1

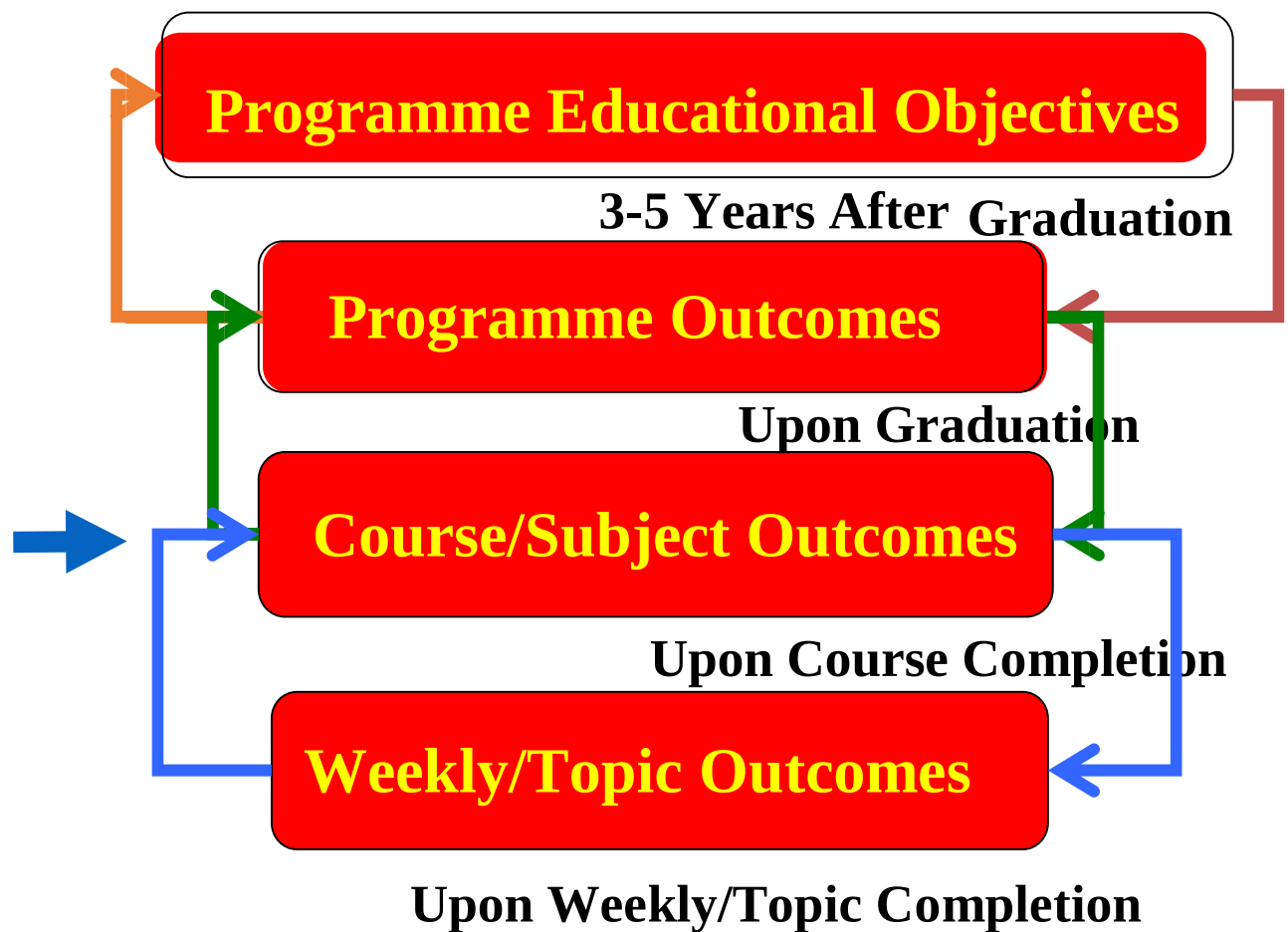


Figure 4.1: Different Levels of OBE Outcomes

4.4.1 Programme Educational Objectives (PEOs)

This is considered very important in OBE outcomes and scheme. PEOs as fondly termed or called refers to **What is expected of students a few years (say 3- 5 years) of their graduation (What the programme prepares graduates in their career and professional accomplishments).**

Programme Educational Objectives (PEOs) being a very important factor in OBE, regulation and standard demands that every Faculty and Department MUST develop their PEOs together with the stakeholders.

By this fundamental rule and regulation, the Faculty of Engineering PEOs and Chemical Engineering PEOs are developed and are as presented below.

4.4.1.1 Programme Educational Objectives (PEOs) of Faculty of Engineering

Displayed in table 4.1 is the Faculty of Engineering (FENG) PEOs

Table 4.1: Faculty of Engineering Programme Educational Objectives (PEOs)

PEO	ATTRIBUTE	DESCRIPTION
PEO 1	Preparation	Be established and recognized as a Valued Engineering Professional and an effective communicator in Industries, Academia, Research Institutions, Governments Ministries, Departments and Agencies (MDA) related to their branch of engineering study, as well as related Engineering Technologies.
PEO 2	Skill Acquisition and Collaboration	Practice their profession and apply scientific principles to the design, operation and maintenance of Engineering systems and devices in a collaborative team-oriented manner that embraces the multi-disciplinary and multi-cultural environment of present-day society.
PEO 3	Application	Engage in lifelong learning and professional development with proficient soft skills, creative, innovative and readily further develop entrepreneurial skills and technical competence, to be self-employed in Consultancy, Manufacturing or Service Industry.
PEO 4	Professionalism	Function as a socially, morally and legally responsible member of society with willingness to mentor fellow employees and understand the ethical, social and economic impacts of their work in a global framework.

4.4.1.2 Programme Educational Objectives (PEOs) of Chemical Engineering (CME)

Department

Listed below are the Programme Educational Objectives (PEOs) of the Department of Chemical Engineering (CME)

PEO	ATTRIBUTE	DESCRIPTION
PEO 1	Knowledge and Skill Justification	Demonstrate Excellent Engineering Knowledge and High Profile Skills to Design, Build, Operate, and Maintain Process Plants.
PEO 2	Collaboration and Communication	Engage in Teamwork to Enhance Interpersonal Skills and Professional Development.
PEO 3	Professionalism	Exhibit Professionalism in a Culturally Diverse Environment.
PEO 4	Lifelong Learning, Application and Productivity	Engage in Lifelong Learning with Skills in Research and Knowledge Acquisition Geared Towards Solving Societal Engineering Problems in a Sustainable Manner.
PEO 5	Application & Management	Demonstrate Technical, Managerial, and Financial Skills Necessary for Entrepreneurship.

4.4.2 Programme Outcomes (POs)

This simply refers to what is expected of the students to grab and offer in terms of knowledge, skill and attitude at the time of their graduation.

COREN in her wisdom carefully developed twelve (12) standard Programme Outcomes. They are as presented on table 4.2

Table 4.2: PROGRAMME OUTCOMES (POs)

PO	DESCRIPTION
PO 1	Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of <u>complex engineering problems</u> .
PO 2	Problem Analysis: Identify, formulate, research literature and analyse <u>complex engineering problems</u> reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
PO 3	Design/Development of Solutions: Proffer solutions for <u>complex engineering problems</u> and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.
PO 4	Investigation: Conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
PO 5	Modern Tool Usage:

	Create, select and apply appropriate techniques, resources and modern engineering and ICT tools, including prediction, modelling and optimization of <u>complex engineering activities</u> , with an understanding of the limitations.
PO 6	The Engineer and Society: Apply reasoning informed by contextual knowledge including Humanities and Social Sciences to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO 7	Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice, including adherence to the COREN Engineers Code of Conduct.
PO 9	Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
PO 10	Communication: Communicate effectively on developmental or 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, and give and receive clear instructions.
PO 11	Project Management: Demonstrate knowledge and understanding of engineering, management and financial principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
PO 12	Lifelong Learning: Recognize the need for, and have the preparations and ability to engage in independent and lifelong learning in the broadest context of technological and social changes.

5.0 REGISTRATION OF COURSES AND DURATION OF PROGRAMME

All students in the department must complete the following registration process.

5.1 Registration of Courses

Registration of courses for the first and second semesters normally starts at the beginning of the first semester of the academic year and lasts for two weeks from the date the registration exercise began.

Course registration is done in the students' department. The student registers his/her courses under the supervision of the academic adviser. Undergraduate students are required to ensure that the total credit units are not less than 15 units and not more than 27 units per semester.

The Head of Department signs for all the courses registered. In registering students, the Department of Chemical Engineering ensures that students re-register for all previously failed courses

in which the Programme requires a pass and meet the prescribed requirements for each course registered.

5.2 How to Register

1. Pay fees
2. Present fees clearance document to the faculty officer (FO) and collect a set of registration materials.
3. Thereafter report to the academic adviser who will plan the student's academic programmes of studies for the semester. The student completes all the registration materials and presents them to the Academic Staff Adviser and Head of Department (HOD) for signatures.

5.3 Early Registration

Students are expected to fulfill the conditions stated in section 5.2 within three weeks of resumption. Compliance with this attracts no form of penalty.

5.4 Late Registration

Students may be permitted late registration upon payment of late registration fee.

- i. Late registration shall not normally last beyond four weeks from the date lectures begin.
- ii. Students who have cogent reason for late registration must notify the registrar in writing in advance, copying the Head of Department.

5.5 Duration of the Programme

Chemical Engineering Programme is structured to be a five (year) programme for students who gained admission through the Unified Tertiary Matriculation Examinations (UTME). Direct Entry students with National Diploma (ND) are meant to spend four (4) years whereas Direct Entry students with Higher National Diploma (HND) are meant to graduate within three (3) years of their admission.

However, students who fail to graduate at his or her statutory time is give extra two (2) years to remedy whatever is his/her problem and thereafter the student's studentship will expire.

6.0 EXAMINATIONS

6.1 Background and Regulations.

Examinations are taken seriously in the department. As a science as well as an art, Engineering is only for those who have the aptitude. Effort is therefore made to ensure that only those who are prepared for the demands of the profession are allowed to move on at the end of 200level, students are screened and those who have accumulated more than four (4) carry-over courses or have a cumulative grade point average (CGPA) less than 2.0 are advised to repeat the 200level or withdraw from the department and the faculty.

Examinations may take the form of written papers, oral examinations, or any other form of examination approved by Senate. The continuous assessment of course work should be included in determining the results through assignments and/or periodic tests. It is expected that before students present themselves for examinations in any course, they have duly registered the course, have attended at least 75% of lectures and other exercises as may be assigned by the department.

6.2 Semester Examinations

All courses taught during a semester should be examined at the end of that semester and students shall be credited with the number of units assigned to the courses in which they have passed the requisite examinations.

6.3 Examination Time Table

The Registrar shall produce the final time table and circulate same to all departments normally not later than two weeks before the commencement of the examinations. Any suggested change shall be entertained only on the recommendation of a department through the Faculty to the Registrar who shall take such actions as deemed necessary.

6.4 Examination Invigilation

For invigilation of examinations, the following procedures and guidelines are used:

- a. The time allowed for written examination shall normally be on basis of not more than one-hour for each unit course. In any case, the time allowed for any one theory paper shall not exceed 3hours.
- b. The invigilation of examination within each department shall be the responsibility of the Departmental Academic Committee.
- c. There shall be at least two invigilators to every examination hall
- d. Invigilators must be at their respective examination halls not later than 20minutes before the start of the examination.
- e. Examination shall normally start at the time stated on the time-table.
- f. It is the duty of the invigilators under the leadership of the Chief Invigilator, to ensure that:
 - i. Every candidate admitted into the examination hall is in good standing as a student of Imo State University and has met the 75% attendance at lectures.
 - ii. Every candidate is reminded of the regulations governing the conduct of examinations
 - iii. The attendance register of the candidates is controlled during the examinations and that all students involved shall sign in.
 - iv. No student is allowed to enter the examination hall 30 minutes after the commencement of the examinations.
 - v. No student may leave the hall earlier than 30 minutes to the end of the examination.
 - vi. No student shall take examination papers out of the examination hall until the end of the examinations.
 - vii. Invigilators shall collect the scripts of each student before he or she leaves the examination hall and ensure that he/she signs out:

6.5 Examination Misconduct

Examination misconduct/malpractices are unfair practices or contravention of regulations of Imo State University examinations. These contraventions include but are not limited to students copying from each other, students bringing into the examination hall, papers and books, mobile phones, smart watches or any materials relevant to the examination paper, for cheating, all forms of communication between students: during examinations; causing any form of disturbance, not observing the time regulation of the examination, and disobeying the invigilators.

6.6 Procedure for Dealing with Examination Misconduct

- i. A student suspected or caught in a case of examination misconduct/malpractice should be allowed to complete the examination but he or she will be required to sign the invigilator's report or he or she may choose to write on his/her own. A student who refuses to sign the invigilator's report or to write his/her own will be guilty of an examination malpractice.
- ii. The chief invigilator shall submit a written report of the incident to the Head of Department and Dean, copying the Registrar within 24 hours (for the examination, taken from Monday to Thursday) after the examinations and 48 hours for examination taken on a Friday to Saturday.
- iii. The Head of Department and Dean shall pass on the report to the Registrar after the initial assessment within two weeks of the examination.
- iv. The Registrar shall refer the report to the Vice Chancellor not later than one week after the receipt of the report.
- v. The Vice Chancellor shall institute an investigation on the case. The investigation panel so initiated shall have the right to invite or request written or oral evidence from witnesses, the invigilator, the student(s) concerned and any other(s), relevant to the case.
- vi. The Vice Chancellor shall thereafter, take appropriate action and report to Senate.

6.7 Disciplinary Measures

Normally, the disciplinary action for all proven cases of examination misconduct/malpractice is expulsion from the University. However, all cases bordering on miscellaneous offences shall be referred to a court of law.

Whereas:

- a. Introduction of relevant notes in examination hall, students copying from each other, or previous access to examination papers etc shall attract expulsion from the University.
- b. Invigilation offences such as aiding and /or abetting, cheating, assaulting or attempting to assault the invigilator, causing any form of disturbance, not observing the time regulation of the examination, shall be punishable with one-year rustication.
- c. A student penalized under cases above, shall have the right to appeal to the Senate in the first instance and to the Council if not satisfied with the decision of the Senate on his appeal.

7.0 GRADING AND REVIEW OF EXAMINATION SCRIPTS

7.1 Grading System

A lecturer shall normally mark all the scripts for course(s) he/she taught or participated in teaching using a marking scheme and determine the grade to be awarded to each student. The scripts shall be submitted to the departmental committee of examiners for final vetting. The same provision shall apply to oral and practical examinations. The written examination at the end of a semester shall normally constitute 70% of the grade, while the remaining 30% comes from continuous assessment. However, for studio, laboratory, workshop and design courses, continuous assessment may account for up to 60% or 50% of the grade.

7.2 Review of Examination Scripts

- i. A student aggrieved by his or her grading shall in the first instance, petition the Registrar through the Head of Department and Dean for a review of his/ her examination script on a payment of a non-refundable fee to the bursary, stating in details the ground(s) for the application. The Registrar shall refer the petition to the faculty through the Dean.
- ii. On receipt of the petition, the Dean shall convene a meeting of the faculty board to consider the petition. If the board is satisfied that a prima facie case has been made, permission shall be sought from the Senate to set up a Review Panel comprising two internal Examiners not involved in the earlier marking, which shall independently review the script and report to the Dean. If the course is a final year course, the service of an external examiner specifically, appointed for the purpose shall be used. The result of the review shall be sent to senate for final determination along with the original score and the recommendation of the Faculty Board.
- iii. Where the faculty board decides ii, i a prima facie case has not been made, it shall state in detail the reason(s) for its decision and shall convey same to the Senate through the Vice Chancellor for disposal action.

8.0 RESULTS, AWARDS, GRADUATION AND CONVOCATION

8.1 Computation System

A candidate raw score in an examination usually expressed as a percentage are converted into grades which are weighted by being assigned point values. The following ranges of marks and their corresponding grades and points weighting are to be used.

RAW SCORE (%)	GRADE EQUIVALENT	GRADE INTERPRETATION	POINT WEIGHT
70 – 100	A	DISTINCTION	5
60 – 69	B	VERY GOOD	4
50 – 59	C	GOOD	3
45 – 49	D	SATISFACTORY	2
40 – 44	E	PASS	1
0 – 39	F	FAIL	0

“A”, “B”, “C”, and “D” “E” are PASS grades while “F” is a FAILURE grade. It is the responsibility of the Department/Faculty Board to determine how each lecturer within the department arrives at the grades. This must be in line with the laid down procedures.

8.2 Computation of Grade Point Average (GPA)

- i. All courses taken by a student shall be used in the computation of Cumulative Grade Point Average.
- ii. To compute the Grade Point Average (GPA) of a candidate, the total aggregate of the Grade point is divided by the number of semester units. A Grade Point is obtained by multiplying the point scored in examination with the number of semester units to that course e.g.

COURSES	CREDITS/UNITS	GRADE SCORE	GRADE POINTS
GST 111	2	B	$2 \times 4 = 08.00$
MTH 101	2	B	$2 \times 4 = 08.00$
PHY 101	2	A	$2 \times 5 = 10.00$
TCH 101	2	C	$2 \times 3 = 06.00$
CHM 101	2	D	$2 \times 2 = 04.00$
IMSU-PHY 103	2	A	$2 \times 5 = 10.00$
TOTAL	12		46.00

- iii. To compute the Cumulative Grade Point Average (CGPA) for a candidate at the end of the session, his total aggregate points for the two semesters are added and divided by the total number of semester units taken during the academic year, e.g

FIRST SEMESTER

COURSES	CREDITS/UNITS	GRADE SCORE	GRADE POINTS
GST 111	2	D	$2 \times 2 = 04.00$
MTH 101	2	B	$2 \times 4 = 08.00$
PHY 101	2	A	$2 \times 5 = 10.00$
TCH 101	2	D	$2 \times 2 = 04.00$
CHM 101	2	C	$2 \times 3 = 06.00$
IMSU-GET 121	1	C	$1 \times 3 = 03.00$
GET 101	1	A	$1 \times 5 = 05.00$
TOTAL	12		40

$$\text{GPA for First Semester} = 40 / 12 = 3.33$$

SECOND SEMESTER

COURSES	CREDITS/UNITS	GRADE SCORE	GRADE POINTS
GST 112	2	B	2×4= 08.00
MTH 102	2	C	2×3= 06.00
IMSU-STA 112	3	A	3×5= 15.00
CHM 102	2	B	2×4 = 08.00
IMSU-PHY 104	2	D	2×2 = 04.00
IMSU-CSD 102	1	C	1×3 = 03.00
PHY 102	2	A	2×5 = 10.00
TOTAL	14		54.00

GPA for Second Semester = $54/14 = 3.86$

Cumulative Grade Point Average = $40 + 54 / 12 + 14 = 94 / 26 = 3.62$

This cumulative Grade Point Average is for the two semesters in a session.

D. A CGPA of less than 1.00 at the end of any session shall lead to withdrawal from the University.

However, the candidate may be re-admitted into the university if he/she goes through the normal admission process as a fresh student.

8.3 Classification of Degrees

The Cumulative Grade Point Average that shall be used to classify degrees is as follows:

4.50 - 5.00 First Class (Honours)

3.50 - 4.49 Second Class (Honours) Upper Division

2.40 - 3.49 Second Class (Honours) Lower Division

1.50 - 2.39 Third Class

1.00 -1.49 Pass

0.09 - 0.99 Fail

8.4 Awards

A. For award of certificate of the Department of CHEMICAL ENGINEERING, a candidate must have satisfied the minimum requirements of the department for the award of that certificate. This shall include but not limited to a certain number of credit units and passing all the compulsory and required courses in the department.

B. Certificates for the award of Bachelor of Engineering shall be sealed with common seal of the University and signed by the Vice Chancellor and the Registrar. Certificates shall not be collected by proxy except with the approval of the Vice Chancellor.

C. No certificate of the Department shall be awarded to person(s) indebted to the University or concerning whom disciplinary proceedings are outstanding or in process, or found wanting in character or candidates whose admission credentials have not been verified and confirmed.

9.0 WITHDRAWALS AND DEFERMENT ADMISSIONS

9.1 Voluntary Withdrawals

A. Any student who wishes to withdraw from the University shall be required to give a written notification to the Registrar, through the Dean of the Faculty and Head of Department. He shall be required to complete withdrawal forms obtainable from the office of the Registrar.

B. The period of withdrawal shall not exceed one academic year and shall be subject to approval by Senate.

C. The student shall be required to pay a reactivation fee before re-admission.

D. In the case of voluntary withdrawal, the refund of fees paid in excess of the period stayed in the University will be made on pro-rata basis by the Bursar's office.

B. In order to be re-admitted a student who withdraws voluntarily from the University must apply to the Registrar for re-admission and receive official clearance.

9.2 Unauthorized withdrawal

In this case, such a student may not be considered for readmission until his unauthorized withdrawal has been dealt with on its individual merit by the Senate.

9.3 Withdrawal for Academic Reasons

A regular student who makes a Cumulative Grade Point Average of less than 1.00 shall be asked to withdraw from the University

9.4 Withdrawal for health Reasons

A student may withdraw or be asked to withdraw for health reasons certified by the Doctor of Health Services of the University. Such a student shall be re-admitted into the University on production of a valid medical report from an approved Medical Officer and certified by the University's Director of Medical Services.

9.5 Withdrawal for Disciplinary Reasons

A student may be asked to withdraw and be on suspension on the grounds of disciplinary action. Such a student may only be re-admitted by permission of the Vice Chancellor, provided the students submit a letter of future good behaviour written on his behalf by a personality acceptable to the University. If the student is caught again in the same act of indiscipline, he shall be asked to withdraw permanently from the University

9.6 Deferment of Admission (Freshmen)

Offers of provisional admission made to a candidate may be deferred for one session only if the candidate fulfills the following conditions:

a. He /she must first pay an acceptance fee to the University indicating acceptance of the admission.

b. He must apply to the Registrar for deferment within one month of commencement of lectures stating reasons for seeking deferment.

c. Obtain a form for deferment from the Registrar's office on payment of a fee to the bursary and present receipts of payment to the Registrar.

- d. The student must be register-able.
- e. He must matriculate either in person or notionally.
- f. He must pay a re-activation fee to the bursary before re-admission.
- g. List of re-admitted students shall be presented to Senate for ratification.

9.7 Deferment of Admission (Non Freshmen)

A student who has matriculated and is in 200 level and above may wish to defer his or her admission on health grounds or lack of funds to continue with his/her academic programme. Such deferment can be effective if the candidate fulfills the following conditions:

- a. He/she must as at the time deferment is sought, be up to date in the payment of his/her fees.
- b. He/she must apply to the Registrar through the Dean of the Faculty and the Head of Department of the programme for deferment stating reasons for seeking deferment.
- c. He/she must obtain University Senate approval following the presentation of his/her letter to the Registrar to the University Senate for discussion.

10.0 STUDENT INDUSTRIAL WORK EXPERIENCE SCHEME (SIWES) AND PROBLEM BASED LEARNING (PBL)

10.1 Aims and Objectives

Students Industrial Work Experience Scheme (SIWES) was set up as a skill training programme which should be done in the industry to complement the students' classroom instructions and laboratory/workshop/studio exercises. This is aimed at exposing the students and also to prepare them to face real life work situations after graduation. Its specific objectives are:

- i. To provide opportunities for students to acquire industrial experience and skill in their various disciplines.
- ii. To expose students to equipment, materials and machinery and the methods and techniques of handling them.
- iii. To prepare students for working condition after graduation.
- iv. To enhance the opportunity of students for post-graduation job placement.

10.2 Duration and Structure of SIWES Scheme

The SIWES programme is meant to be for a period of twelve months

The twelve (12) months training exercise is structured as follows:

- (a) Three (3) months at the end of 200 level examinations i.e. the long vacation at the end of their 200 level.
- (b) Three (3) months at the end of 300 level examinations i.e. the long vacation at the end of their 300 level.
- (c) Six (6) months in the second semester of their 400 level which includes the long vacation at the end of 400 level.

10.3 Administration

All students of CHEMICAL ENGINEERING are required to participate in SIWES programme. As stated in section 10.2, students shall go for three-month training at the end of the second and third year. The second semester of the fourth year including the long vacation is also devoted to industrial training. This means that during the five years' degree programme, students would have spent quality time working closely with SIWES staff of the University and their departments for serial documentation that precede and follow their industrial attachment. In the industry, students are enjoined to be regular or punctual and determined to participate and learn at their places of attachment and also obey the rules and regulations of the employer and keep proper records of the training activities in their log book.

SIWES is centrally coordinated in the Faculty of Engineering through a SIWES coordinator. This office liaises between the Faculty and the University Director of SIWES. The Department appoints a SIWES Representative for the Department to oversee SIWES matter as directed by the HOD. At the end of final period of attachment, each student writes a technical report which is submitted to the faculty SIWES coordinator.

10.4 SIWES Grading

On an appointed date, the student appears before a panel to defend his/her SIWES activities. Thereafter, the SIWES is graded as follows:

1. Technical Report	40%
2. Log Book	15%
3. Observation during visits	10%
4. Employer's Remarks	15%
5. Defense of SIWES	20%
Total	100%

Though the defense of the SIWES is scored only 20%, it is considered an essential aspect of the exercise and the student must defend his/her report to obtain a score.

Also, the panel could order student(s) to repeat the entire exercise, if in its opinion there is no evidence of effective participation. The SIWES defense itself is scored as follows

1. Presentation	5points
2. Evidence of effective participation	5points
3. Richness of experience	7points
4. Overall impression	3points
Total	20points

10.5 Problem Based Learning (PBL)

The PBL is designed to make the students learn by solving real life/world problem. In this programme, students function in teams or groups brainstorming, dividing tasks, developing solutions, and reflecting together. The lecturers and some stakeholders are facilitators and supervisors.

The 400 level students in Faculty of Engineering including same level in Chemical Engineering Department of IMSU do embark on Problem Based Learning in the second semester of their fourth (4th) year.

Also, the 300 level Engineering Students in IMSU including Chemical Engineering students are meant to carryout Problem Based Learning in the second semester of their third (3rd) year.

10.6 Job Opportunities

The CHEMICAL ENGINEERING graduate of Imo State University, Owerri, could find position of responsibility in every sphere of human endeavour.

Opportunities exist:

- In the manufacturing/production industries
- In the oil and gas industries as Design Analysts, Production and Quality Control Managers/Engineers.
- In the Engineering consultancy units as Project Consultants.
- In Teaching and Research
- In all, a Chemical Engineer, as a top executive in industry is a leader of people.

11.0 PROGRAMME STRUCTURE

11.1 Course Coding

The three-digit course coding system is adopted where the first digit indicates the level in which the course is offered; the second digit denotes the course stress area while the third indicates the semester in which the course is ordinarily offered. Odd numbers of the third digit indicate the first semester while even numbers signify the second semester. Any course offered by the department of CHEMICAL ENGINEERING is pre-fixed CME and those for all general Engineering are prefixed GEN in BMAS system and GET in CCMAS system.

11.2 Stress Area

The general courses, pre-fixed GEN- have as special stress area:

Fundamentals	- 0
Mechanics/ Strength of Material	-1
Laboratory	- 2
Agric. Engineering	- 3
Civil Engineering	- 4
Materials	- 5
Chemical Engineering	- 6
Electrical Engineering	- 7

Computer/Statistics - 8

Special Topics - 9

The courses offered by the Department for CHEMICAL ENGINEERING students Pre-Fixed CME have the following as the stress areas:

Basic Engineering and Analysis - 0

Chemical Engineering Design - 1

Manufacturing Technology and Processes - 2

Strength of Materials - 3

Mechanics of Machines - 4

Mechanics of Fluids - 5

Thermodynamics - 6

Heat and Mass Transfer Operations - 7

Engineering Management - 8

Engineering Laboratory Work, Seminar and Project - 9

11.3 CCMAS Course Listing

YEAR ONE: FIRST SEMESTER

S/ N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	CHM 101	General Chemistry I	2	C	30	-	NUC
2	GET 101	Engineer in Society	1	C	15	-	NUC
3	MTH 101	Elementary Mathematics I	2	C	30	-	NUC
4	PHY 101	General Physics I	2	C	30	-	NUC
5	TCH 101	Introduction to Chemical Engineering	2	C	30	-	NUC
6	IMSU-MTH103	Elementary Mathematics III (Vectors, Geometry and Dynamics)	2	C	30	-	COREN
7	IMSU-PHY 103	General Physics III	2	C	30	-	IMSU
8	IMSU-GET 105	Engineering Drawing	1	C	15	30	IMSU
9	IMSU-MTH 105	Elementary Mathematics V (Mechanics)	2	C	30	-	IMSU
10	CHM 107	General Practical Chemistry I	1	C	-	45	NUC
11	PHY 107	General Practical Physics I	1	C	-	45	NUC
12	IMSU-SGB 107	Basic Igbo	1	C	30	-	IMSU
13	GST 111	Communication in English	2	C	15	45	NUC
14	IMSU-GET 121	Workshop Practice I	1	C	15	30	IMSU
SEMESTER TOTAL			22				

YEAR ONE: SECOND SEMESTER

S/ N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	CHM 102	General Chemistry II	2	C	30	-	NUC
2	GET 102	Engineering Graphics and Solid Modelling I	2	C	15	45	NUC
3	MTH 102	Elementary Mathematics II	2	C	30	-	NUC
4	PHY 102	General Physics II	2	C	30	-	NUC
5	IMSU-CSD 102	Carrier Services Development	1	C	30		IMSU
6	IMSU-PHY104	General Physic IV (Vibration, Waves and Optics)	2	C	30	-	COREN
7	IMSU-MTH 104	Elementary Mathematics IV (Coordinate Geometry)	2	C	30	-	IMSU
8	CHM 108	General Practical Chemistry II	1	C	-	45	NUC
9	PHY 108	General Practical Physics II	1	C	-	45	NUC
10	IMSU-SGB 112	Readings and Practice in Igbo	1	C	30	-	IMSU
11	GST 112	Nigerian Peoples and Culture	2	C	30	-	NUC
12	IMSU-STA 112	Probability I	3	C	30	-	COREN
13	IMSU-GET 122	Workshop Practice II	1	C	15	30	IMSU
14	IMSU-CHM 114	Physical Chemistry	2	C	-	30	IMSU
SEMESTER TOTAL			24				
SESSIONAL TOTAL			46				

YEAR TWO: FIRST SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	IMSU-GET 201	Applied Electricity I	3	C	45	-	COREN
2	TCH 201	Chemical Engineering Fundamentals	3	C	45	-	NUC
3	IMSU-GET 203	Engineering Graphics and Solid Modeling II	3	C	15	45	COREN
4	GET 205	Fundamentals of Fluid Mechanics	3	C	45	-	NUC
5	IMSU-GET 207	Applied Mechanics	3	C	45	-	COREN
6	GET 209	Engineering Mathematics I	3	C	45	-	NUC
7	GET 211	Computing and Software Engineering	3	C	30	45	NUC
8	IMSU-GET 221	Engineering Laboratory I	1	C	30	45	IMSU
9	ENT 211	Entrepreneurship and Innovation	2	C	30	-	NUC
SEMESTER TOTAL			24				

YEAR TWO: SECOND SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	IMSU-GET 202	Engineering Materials	3	C	45	-	COREN
2	GET 204	Students Experience Workshop Practice	2	C	15	45	NUC
3	GET 206	Fundamentals of Thermodynamics	3	C	45	-	NUC
4	TCH 206	Statistics for Chemical Engineers	2	C	30		NUC
5	IMSU-GET 208	Strength of Materials	3	C	45	-	COREN
6	GET 210	Engineering Mathematics II	3	C	45	-	NUC
7	GST 212	Philosophy, Logic and Human Existence	2	C	30	-	NUC
8	IMSU-GET 222	Engineering Laboratory II	1	C	30	45	IMSU
9	IMSU-CME 224	Engineering Chemistry I (Physical Chemistry)	1	C	30	-	IMSU
10	GET 299	SIWES I: SIWEP	-	C	-	9wks	NUC
SEMESTER TOTAL			20				
SESSIONAL TOTAL			44				

YEAR THREE: FIRST SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	IMSU-GET 301	Engineering Mathematics III	2	C	30	-	IMSU
2	TCH 301	Transfer Processes I	2	C	15	45	NUC
3	IMSU-CME 303	Chemical Engineering Process Analysis	2	C	15	45	IMSU
4	TCH 305	Chemical Engineering Laboratories I	1	C	-	45	NUC
5	GET 307	Introduction to Artificial Intelligence, Machine Learning and Convergent Technologies	3	C	45	-	NUC
6	TCH 307	Biochemical Engineering	2	C	30	-	NUC
7	IMSU-CME 313	Separation Processes I	2	C	30	45	IMSU
8	IMSU-CME 333	Engineering Chemistry II (Organic & Analytical Chemistry)	2	C	30	-	IMSU
SEMESTER TOTAL			16				

YEAR THREE: SECOND SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	TCH 302	Chemical Engineering Thermodynamics	2	C	30	-	NUC
2	GET 304	Technical Writing and Communication	3	C	45	-	NUC
3	GET 306	Renewable Energy Systems and Technologies	3	C	30	45	NUC
4	IMSU-GET 308	Engineering Economics	3	C	45	-	COREN

5	TCH 308	Numerical Methods in Chemical Engineering	2	C	30	-	NUC
6	IMSU-CME 316	Chemical Engineering Laboratories II	1	C	-	45	IMSU
7	ENT 312	Venture and Creation	2	C	15	45	NUC
8	GST 312	Peace and Conflict Resolution	2	C	30	-	NUC
9	IMSU-PBL 300	Problem Based Learning I	2	C	-	90	COREN
10	GET 399	SIWES II	-	C	-	12 Wks	NUC
SEMESTER TOTAL			20				
SESSIONAL TOTAL			35				

YEAR FOUR: FIRST SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	TCH 401	Chemical Product Design	3	C	15	90	NUC
2	IMSU-CME 403	Chemical Reaction Engineering I & II	2	C	45	-	IMSU
3	IMSU-CME 405	Plant Design and Economics	2	C	45	-	IMSU
4	TCH 406	Process Modelling and Simulation	2	C	30	-	NUC
5	IMSU-CME 413	Chemical Engineering Laboratories III	1	C	-	45	IMSU
6	IMSU- CME 425	Separation Processes II	1	C	30	-	IMSU
7	IMSU-CME431	Fluid Particulate System	2	C	15	45	IMSU
8	IMSU-GET 481	Computer Aided Design	1	C	15	45	IMSU
9	IMSU-GET 493	Engineering Research Method	1	C	15	45	IMSU
SEMESTER TOTAL			15				

YEAR FOUR: SECOND SEMESTER

SIWES Courses

S/N	Course Code	Course Title	Units	Status	Duration
1	GET 299	SIWES I: SIWEP	3	C	9 Weeks
2	GET 399	SIWES II	4	C	12 Weeks
3	GET 499	SIWES III: Student Industrial Work Experience Scheme	8	C	24 Weeks
4	IMSU-PBL 400	Problem Based Learning II	2	C	8 Weeks
SEMESTER TOTAL			17		
SESSIONAL TOTAL			32		

YEAR FIVE: FIRST SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	GET 501	Engineering Project Management	3	C	45	-	NUC
2	TCH 501	Plant Design II	4	C	15	135	NUC
3	IMSU-CME 501	Process Optimization	2	C	15	45	IMSU
4	IMSU-CME 507	Process Control, Dynamics and Instrumentation	2	C	15	45	IMSU
5	IMSU-CME 511	Environmental Engineering	1	C	15	45	IMSU
6	IMSU-CME 513	Petrochemical Processes	2	C	15	45	IMSU
7	TCH 555	Chemical Engineering Research Project I	2	C	-	180	NUC
8	IMSU-CSD 401	Carrier Services Development	1	C	15	-	IMSU
SEMESTER TOTAL			17				

YEAR FIVE: SECOND SEMESTER

S/N	Course Code	Course Title	Units	Status	LH	PH	Remarks
1	GET 502	Engineering Law	2	C	30	-	NUC
2	IMSU-CME 512	Soap, Detergent and Food Processing Technologies	1	C	15	45	IMSU
3	IMSU-CME 514	Process Synthesis and Simulation	2	C	15	45	IMSU
4	IMSU-CME 516	Energy Conversion Engineering	2	C	45	-	IMSU
5	IMSU-CME 518	Petroleum Production Engineering	2	C	15	45	IMSU
6	IMSU-CME 522	Polymer Science and Technology	2	C	30	-	IMSU
7	IMSU-CME 524	Transfer Processes II	1	C	15	45	IMSU
8	IMSU-CME 544	Seminar	1	C	30	-	IMSU
9	TCH 555	Chemical Engineering Research Project II	2	C	-	180	NUC
SEMESTER TOTAL			15				
SESSIONAL TOTAL			32				

11.4 CCMAS Course Description

11.4.1 Serviced Courses

CHM 101: General Chemistry I

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Knowledge of SS1-SS3 Chemistry)

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.

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

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Knowledge of SS1-SS3 Mathematics)

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.

PHY 101: General Physics I (Mechanics)

(2 Units: C, LH 30)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Knowledge of SS1-SS3 Physics)

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.

CHM 102: General Chemistry II

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Knowledge of SS1-SS3 Chemistry)

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.

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

Course Learning Outcomes (CLOs)

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 every day 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

(Pre-requisite –Knowledge of the Use of Computer)

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.

MTH 102: Elementary Mathematics II (Calculus)**(2 Units C: LH 30)****Course Learning Outcomes (CLOs)**

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

1. Identify the types of rules in differentiation and integration;
2. Recognize 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

(Pre-requisite –Good Knowledge of Further Mathematics)

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).

PHY 102: General Physics II (Behaviour of Matter)**(2 Units C: LH 30)****Course Learning Outcomes (CLOs)**

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

(Pre-requisite –Good Knowledge of SS1-SS3 Physics)

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; Bernoulli's equation and incompressible fluid flow; surface tension; adhesion, cohesion, viscosity, capillarity, drops and bubbles.

Course Learning Outcomes (CLOs)

On completion, the students should be able to:

1. Have knowledge of origin of career services
2. Understand self-confidence and career development
3. Have knowledge of independence, responsibility and early career planning
4. Explain time management and productivity, personal branding and self - assessment
5. Establish the relationship between leadership and mentorship
6. Highlight various leadership styles/types

Course Contents

(Pre-requisite- Good Academic Standing)

Career conversations & connections, theories of career education, Self-confidence and Career Development: definition of self-confidence, qualities of self-confidence, types of self-confidence. Independence and responsibilities: meaning of independence and responsibility, manifestation of independence for freshers, signs of responsibility in fresher, challenges to independence and responsibility, students' independence at Tertiary institution. Eaerly Career Planning: steps in career planning, case studies in career planning. Time management and productivity: the 5Ps of time management strategies, time management techniques. Personal Branding and Self-assessment: strengths and weaknesses, importance of self-assessment, brandings and physical appearance. Interest Inventory: career interest inventory, types and essence of interest inventory. Career assessment and administration: definition, importance, purpose and types of career assessment, basic considerations for selecting career assessment tools. Cultural factors influencing career choices among students in Nigeria. Professionalism and Ethics of Teaching (Career Services); Leadership and Mentorship Skills for Students: characteristics of leadership, types of leadership style, leadership functions, traditional perspective on mentoring and mentorship style in higher institution. Technical and Computer Skills Relevant for Career Success: definition of computer skills, types of computer skills and the importance; Decision Making for Freshers.

IMSU-ICT 100: Information & Communication Technologies and Use of Library (1 Unit C: LH 30) XXX**Course Learning Outcomes (CLOs)**

On completion, the students should be able to:

1. Understand the basics of Computer and Computer appreciation
2. Have good knowledge of Computer, hardware, software and operating system
3. Understand what Computer virus is all about and its impacts to computers and the society
4. Understand the meaning, origin and types of libraries
5. Understand library resources and services
6. Understand the roles of ICT in library services and library ethics.

Course Contents:

(Pre-requisite – Good Academic Standing)

Computer Basics and Appreciation: Definition of Computer, Categories of computers and their uses, Various types of computer users, Methods of Data Processing, Basic characteristics of Computer, the importance of Computers, Benefits of using a computer, Advantages of Computer Disadvantages of Computer, Computer History and Development, Early Computing Machines Classification of Computers, Classification of Computers According to Size, Classification of Computers According to functions, Classification of computers according to their purpose.

Types of Computers, Generations of computers, Summary of *Computer Generations and Their Characteristics*. Interrelationship between Binary and Decimal Numbers. The Computer System, Units for measuring computer information or speed. Ways to take care of your computer. Computer Hardware: Peripherals, Parts of a Computer, Input and Output Devices, System unit

Central processing unit (CPU), Memory Unit, Primary Memory, Secondary Memory, Storage Medium, Functional Components of a Computer System.

Computer Software and Operating System: Computer Software, Types of computer Software, Word processors, spread sheets, Image Editors, Database management systems, Presentation applications, Desktop publishing software, operating system, Device Drivers Language Translators, Functions of an Operating System, Categories of an Operating System, Types of Operating Systems, Criteria for Package Acceptability, Modes of Software Acquisition, Operating System – Overview, Parts of Operating System, Elements of Graphical User Interface, Functions of An Operating System, Objectives of Operating System, Need for an Operating System (OS), Reasons for an Operating System. **Computer Virus:** Computer Virus Defined, Historical Backgrounds-Early Theoretical Development (1940-1970), The Emergence of Malicious Viruses (1980s), The Golden Age of Viruses (1990s), The New Age of Cyber Risks (2000s-Present), The Evolution of Viruses: Current Trends and Future, Focus, Current Trends, Future Predictions, Forms of Computer Virus Infection, Operational Mechanisms of Computer Worms and Viruses, Common Payload Activities: Concealment: Evading Detection, Common Concealment Techniques. Symptoms of a Computer Virus, Spread and Prevention Virus, Methods of Disguise, Prevention, Impact of Computer Viruses on individuals, Organizations, Governments and National Security, Healthcare, Economic, Environmental, Psychological and Social Impact. Positive Advancements Emanating from Computer Virus Attacks, Prevention and Protection Against Computer Viruses. **Meaning and Origin of Libraries:** Egyptian Library, Temple Libraries, Royal Libraries, Greek Library, Aristotle Library, The Alexandrian Library,

Library at Pergamum, Roman Libraries, Private Libraries, Public Libraries, Dark Ages, The Middle or Medieval Ages, Monastic Libraries, University Libraries, Renaissance, Modern Libraries, United States of America (USA), Great Britain, France, Germany, Africa. Types of libraries: Public Library, Objectives of and functions Public Libraries, School Library, Academic Library and its functions, National Library and its functions, National Library and its functions, Special Library and its characteristics. **Library Resources and Services:** Library, Human and Financial Resources. Physical Facilities, Information /Material Resources, Types of Information Resources in the Library, Parts of a Book, Library Services, Types of Library Services, Reference Services in the Library, Typical Components of a Reference Service, ICT Services in Libraries, Definition of Concepts, Key Roles of ICT in Library Services, Emerging Trends in Library Technology, Impact of ICT on Library Services, Reprographic Services in Library, Important Aspects of Reprographic Services in Libraries, Library

Orientation Services, Library Layout and Services: Library Policies and Procedures, Library Etiquette, Inter-library Loan, Online Research Tools, Importance of Library Orientation Programmes Interlibrary Cooperation Services. **Library Ethics: Rules and Regulations.**

IMSU-PHY 103: General Physics III (Behaviour of Matter) (2 Units C: LH 30)

Course Learning Outcomes (CLOs)

At the end of the course, 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. Describe and explain the first and second laws of thermodynamics, and the concept of entropy;
5. State the assumptions of the kinetic theory and apply techniques of describing macroscopic behaviour;
6. Deduce the formalism of thermodynamics and apply it to simple systems in thermal equilibrium; and
7. Describe and determine the effect of forces and deformation of materials and surfaces.

Course Contents

(Pre-requisite –PHY 101)

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). Bernoulli's equation and incompressible fluid flow. Surface tension (adhesion, cohesion, viscosity, capillarity, drops and bubbles).

IMSU-MTH 103: Elementary Mathematics III (Vectors, Geometry and Dynamics)

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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.

IMSU-MTH 104: Elementary Mathematics IV (Coordinate Geometry)

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

1. **Define and compute** the distance between two points using coordinate geometry.
2. **Determine** the coordinates of points that divide a line segment in a given ratio.
3. **Explain and calculate** the gradient of a line and apply it to solve related problems.
4. **Formulate** the equation of a straight line in intercept and perpendicular forms.
5. **Apply** coordinate geometry to determine the area of a triangle given its vertices.
6. **Evaluate** the angle between two lines using their gradients.
7. **Derive and explain** the equation of the bisector of an angle between two lines.
8. **State and interpret** the general equation of a circle in coordinate form.
9. **Construct** the equation of a circle passing through three non-collinear points.
10. **Derive and illustrate** the equations of the tangent and normal to a circle.

Course Contents

(Pre-requisite –MTH 101, MTH 105)

Define distance between two points. Explain coordinates of points dividing a line into a given ratio. Define gradient of a line. State equation of a line in intercept form. State equation of a line in perpendicular form. Explain area of a triangle in terms of the coordinates of its vertices. Explain angle between two lines. State and explain the equation of bisector of an angle. State the general equation of a circle. Illustrate the equation of a circle passing through three points. Illustrate the equation of tangent and normal to a circle.

IMSU-MTH 105: Elementary Mathematics V (Mechanics)

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

1. **Explain and apply** the concepts of impulse and momentum in solving particle dynamics problems.
2. **Analyze** situations involving conservation of linear momentum in both direct and oblique impacts of elastic bodies.
3. **Define and evaluate** work, power, and energy in mechanical systems.
4. **Apply** the principle of conservation of mechanical energy to practical problems.
5. **Examine** the general motion of a particle in two dimensions, including motion in horizontal and vertical circles.
6. **Model and analyze** simple harmonic motion and the motion of a particle attached to a light inelastic string.
7. **Describe and evaluate** the motion of a rigid body about a fixed axis.
8. **Compute** the moment of inertia of rigid bodies and explain its significance in rotational motion.

9. **Apply** the principles of conservation of energy and angular momentum to rigid body dynamics.
10. **Investigate** the dynamics of a compound pendulum using conservation laws.

Course Contents

(Pre-requisite – Good Academic Standing)

Impulse and momentum; Conservation of momentum; Work, power and energy. Principle of conservation mechanical energy; Direct and oblique impact of elastic bodies. General motion of a particle in two dimensions; Motion in a horizontal and vertical circles; Simple harmonic motion, motion of a particle attached to a light inelastic string. Motion of a rigid body about a fixed axis; Moment of inertia and diversion. Conservation of energy, compound pendulum, conservation of angular momentum.

IMSU-PHY 104: General Physics IV

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Describe and quantitatively analyze the behaviour of vibrating systems and wave energy
2. Explain five propagation and properties of waves in sound and light;
3. Identify and apply three wave equations
4. Explain three geometrical optics and principles of optical instruments.
5. Explain Simple harmonic motion (SHM)

Course Contents

(Pre-requisite –PHY 101, Good Academic Standing)

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).

IMSU-HPS 104: History and Philosophy of Science

(1 Unit C: LH 45) XXX

Course Learning Outcomes (CLOs):

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

1. Make sense of the processes of scientific knowledge, technological projects and medical strategies.
2. Create an awareness of the services of science to man and the effects of science on human society.
3. See how why these enterprises exert their powers and how they are trusted, contested and changed.
4. Establish the interrelationship between all disciplines.

5. Explain the nature of man, components of the universe in which he lives and how he obtains energy for his activities.

Course Contents:

(Pre-requisite- Good Academic Standing)

The nature of Philosophy and Philosophy's concern with other disciplines; What is science? And how it is different from Pseudo-Science; Principles and Assumptions of Science; Foundational Metaphysics and Epistemology of Science; The Methods and Features of Science; The problems with Science; The theories of Scientific Progress; Philosophy of the Social Science; Philosophy, Science and Development in Africa; Science, Technology and Inventions; Social implications of technological advancement; Man and his Origin; Man and his Environment; Man and his sources of Energy; Climate Change

CHM 107: General Practical Chemistry I**(1 Unit C: PH 45)****Course Learning Outcomes (CLOs)**

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. 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

(Pre-requisite –CHM 101, CHM 102)

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.

PHY 107: General Practical Physics I**(1 Unit C: PH 45)****Course Learning Outcomes (CLOs)**

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

(Pre-requisite –PHY 101, PHY 102, PHY 103)

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.

IMSU-SGB 107: Basic Igbo

(1 Unit C: LH 30)

Course Learning Outcome:

1. To engender students' communicative skills in Igbo.
2. To assist students to acquire the rules of Igbo grammar in their writing.
3. To develop students' interest in Igbo as a special, indigenous Nigerian language.
4. To encourage students' appreciation of basic literary works in Igbo.
5. Read and demonstrate good comprehension of texts in the language
6. Read and write two compositions in Igbo language with standard orthography.
7. Demonstrate understanding of word formation processes in the language
8. Demonstrate proper usage of Igbo language.
9. Identify the five dramatic elements in traditional drama in the language

Course Contents

(Pre-requisite –Good Knowledge of JS1-SS3 Igbo)

NHAZI QMXXM

Nqm; Wiik.	Isiqmxxm	Nd[niime Qmxxm
1.	Ndubata; Mkprrxab[d[	Ozi ekele; {kpqlite mmas[gbasara mmxta asxsx Igbo. {gxppta na ideppta Ab[[d[Igbo; Iwu Ndakqr[ta Xdaume: Nnupx Isi n'Iwu Ndakqr[ta Xdaume; Myirixdaume; Mgbochiume (Mkp[, Xdaqnx na Xdaimi); Mkprrxab[[d[Igbo na Mkprrxokwu; Mkprrxab[[d[Igbo na Ah[r[okwu. Qrxnka Ab[[d[na Mkprrxab[[d[.
2.	Nkejiasxsx: Aha na Nnqchiaha:	Nkenxxd[Aha: – Ahaaka na Ahaizugbe; – Ahaigwè na Ahauche. – Odide Nkejiasxsx Aha n'ah[r[okwu. Nkenxd[Nnqchiaha I: – Pesin na Ngx; – Nnqchimpesin;

		- Nnqchiaha na Ndakqr[ta Xdaume; - Nnqchiaha na ah[r[okwu; Nkenxxd[Nnqchiaha II: - Nnqchionye - Nnqchimpesin - Nnqchinke - Nnqchionwe Odide Nnqchiaha n'ah[r[okwu. Nnqchiaha na Xdaolu. Qrxnka Aha. Qrxnka Nnqchiaha.
3.	Nkejiasxsx Mbuxzq na Njikq:	Odide Mbuxzq n'ah[r[okwu. Nkenxxd[Njikq; Njikq n'ah[r[okwu; Nd[iche d[n'etiti Mbuxzq "na" nakwa Njikq "na". Nd[iche d[n'etiti Mbuxzq "na" nakwa Nnyemaka Ngwaa "na". Qrxnka Mbuxzq. Nkenxxd[Mbuxzq; Qmxmaatx Mbuxzq; Odide Njikq n'ah[r[okwu; Nd[iche d[n'etiti Njikq "na" nakwa Mbuxzq "na". Nd[iche d[n'etiti Njikq "na" nakwa Nnyemaka Ngwaa "na". Qrxnka Mbuxzq; Qrxnka Njikq.
4.	Nkejiasxsx Nkqwaaha na Nkwuwa:	Nkenxxd[Nkqwaaha: - Nkqwa - Nrxaka - Mkpokqta. Odide Nkqwaaha n'ah[r[okwu. Ejirimara Nkqwaaha. Nkenxxd[Nkwuwa:

		- Keoge - Keqd[d[- Keuchexda - Kensokwxnye - Kengwaa - Keugboro ugboro. Odide Nkwuwa n'ah[r[okwu. Qrxnka Nkqwaaha; Qrxnka Nkwuwa.
5.	Njxajxjx, Qnxqgxxg na Ntimkpu	Nkenxxd[Njxajxjx; Odide Njxajxjx n'ah[r[okwu. {kpqppta Qnxqgxxg: Otu ruo Ijeri; Mgbakq Qnxqgxxg: - Qnxego; - Qnxoge; - Qnxole; - Nqmba (Nqmba Nzuruoke, Nqmba na Nqmba Qnxmpekele. Nkenxd[Nqmba Qnxmpekele: - Nqmba Qnxmpe - Nqmba Qnxqgwa Nqmba Mweabxq na Nqmba Nsqabxq Ngxnke; Qnxafq; Ndubata Qnxqgxx Sqgm. Nkenxxd[Ntimkpu; Ntimkpu n'ime ah[r[okwu. Xdaolu n'ime Njxajxjx; Xdaolu n'ime Qnxqgxxg; Xdaolu n'ime Ntimkpu. Qrxnka Njxajxjx, Qnxqgxxg, Ntimkpu.
6.	Nnwale n'ime etiti semesta:	Mkpxrxab[[d[; Aha; Nnqchiaha; Mbuxzq; Njikq; Nkqwaaha; Nkwuwa; Njxajxjx; Qnxqgxxg; Ntimkpu;
7.	Nkejiokwu na Xdaolu:	Nkenxxd[Nkejiokwu;

		Mmebere Nkejiokwu; Nkejiokwu n’ime mkprxokwu; Nkejiokwu n’ime ah[r]okwu; Nkenxxd[Xdaolu; Xdaolu n’ime Nkejiokwu; Xdaolu n’ime Mkprxokwu; Xdaolu n’ime ah[r]okwu; Xdachi; Xdanusoro; Xdaolu n’ime Mfinitiivu. Qrxnka Nkejiokwu; Qrxnka Xdaolu.
8.	Nkejasxsx Ngwaa:	Isingwaa; Nsinangwaa: - Mfinitiivu - Enyemaaka Ngwaa; - Omekangwaa; - Jerqnd; - Omee. Xdaolu n’ime Ngwaa. Qrxnka Ngwaa.
9.	Mgbakwxnye:	Nganiiru; Nnqneetiti; Nsonaazu; Nsokwunye. Qrxnka Mgbakwxnye.
10.	Akaraedemede:	Kpqm; R[kqm ala maqbx kqma; R[kqm elu; Kpqr[kqm; Kpqmkpqm; Akara uhie; Zam; Akaramkpu; Akaraajxjx; Akara igbe; Akara nkepxta. Qrxnka Akaraedemede.
11.	Ah[r]okwu:	i) Ah[r]mfe - Ah[r] Otu Mkprxokwu;

		- Ah[r] Mkprrxokwu Olemole; - Ah[r]nkwusa; - Ah[r]njx; - Ah[r]ajxjx; - Ah[r]ntimiwu; - Ah[r]nchq; - Ah[r]ntimkpu. ii) Ah[r]ukwu iii) Ah[r]nha. Qrxnka Ah[r]okwu.
12.	Mkpqaha, Nkebiokwu na Nkebiah[r]:	i) Nkenxd[Mkpqaha. ii) Nkenxd[Nkebiokwu: - Nkebiokwu Keaha; - Nkebiokwu Kenkqwaaha; - Nkebiokwu Kejerqndx; - Nkebiokwu Kembuxzq; - Nkebiokwu Kengwaa; - Nkebiokwu Kemfinitiivu, dgz. iii) Nkenxd[Nkebiah[r]: - Nkebiah[r] Keaha; - Nkebiah[r] Kenkqwa; - Nkebiah[r] Kenkwuwa. Qrxnka Nkebiah[r]; Qrxnka Nkebiokwu; Qrxnka Mkpqaha.
13.	Mqf[m]:	Qmxmaatx Mqf[m]; Nkenxxd[Mqf[m]: - Nnqqrqonwe; - Ndabe: - Nganiiru; - Nnqneetiti; - Nsonaazx. Qrxnka Mqf[m].
14.	Qgxxg Igbo:	Ijiri nkenke agxmagx d[icheiche, wee gosipxta obibi ndx nd[Igbo, d[ka: - Ekele d[icheiche; - Nri d[icheiche; - Mmiri na Iyi d[icheiche; - {gba mbq; - Nzukq; - Uri na egwu Igbo; - Ndx qma.

15.	Mmxghar[na Ule:	- Ndephta; - Ngxphta; - Nch[kqta; - Ule.
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CHM 108: General Practical Chemistry II

(1 Unit C: PH 45)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –CHM 107)

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

PHY 108: General Practical Physics II

(1 Unit C: PH 45)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –PHY 107)

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.

GST 111: Communication in English

(2 Units C: LH 15; PH 45)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Sound academic standing)

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)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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.

IMSU-SGB 112: Readings and Practice in Igbo (1 Unit C: LH 30)

Course Learning Outcomes (CLOs):

1. To expose students to different styles of writing in Igbo.
2. To encourage students' hands-on practices in one or more areas of Igbo study including poetry, prose, drama, short story, an interview session in Igbo, to mention a few.
3. To encourage students' participation in enriching Igbo vocabulary through translating new forms and terminologies into Igbo.
4. To deepen students' interest in the use of Igbo for various communicative purposes.

Course Contents

(Pre-requisite –SGB 107)

NHAZI QMXMX

Nqm. Wiik	Isiqmxmx	Nhazi Qmxmx
1.	Ndubata:	Ntxleghar[Isiqmxmx SGB 107 na Simesta Mbx.
2.	Edemedede:	Edemedede: Akxkq, Leta, Okwunqha.
3.	Atxmatx Okwu na Asxsx Nka:	Atxmatx Okwu: – Ilu; – Xkabxilu; – As[niilu; – Akpaalaokwu. Asxsx Nka: – Myiri; – Mbxx; – Egbeokwu; – Kwunkwukwa; – Mmemadx; – dgz.
4.	Agxmagx Qd[naala:	Qmxmaatx nakwa [txle:

		- Akxkq Qd[naala; - Ejije Qd[naala; - Abx Qd[naala.
5.	Agxmagx Ederede:	Qmxmaatx nakwa [txle: - Iduaz[; - Ejije Ederede; - Abx Ederede.
6.	Ntxghar[na Qkqwaokwu:	Ntxghar[mkpxrxokwu; Ntxghar[ah[r[okwu; {txle Qkqwaokwu d[icheiche e nwere n'Igbo.
7.	Nnwale n'ime etiti semesta.	Edemede; atxmatx okwu; asxsx nka; agxmagx qd[nala; agxmagx ederede; ntxghar[; qkqwaokwu.
8.	Edemede Okwunka na okwu qhxx:	- Qmxmaatx Okwunka d[iche iche; - Odide Okwunka; - {chqppta Okwunka nakwa okwu qhxx.
9.	Okwunqha:	- Nkenxxd[Okwunqha; - Itinye Atxmatx Okwu n'Okwunqha - Itinye Asxsx Nka n'Okwunqha.
10.	Edechaagxq, Qrxqha na Nkangosi:	Nduzi keesiede iduaz[, abx maqbu ejije;
11.	Edechaagxq; Qrxqha na Nkangosi:	Nkqwa na ngosi ihe nd[a: - Iheqkpx (ngwaejirimara); - Eserese; - Ngwanchara; Ijiri iheqkpx, eserese, na ngwanchara mee ngosi, site n'[gx, maqbx igosi ihe nd[a.
12.	Edemede Ajxjqnx, Ntaakxkq na Qrxnka:	Nta mmxta maqbx ntaakxkq n'ime Mahadum. Ijiri Igbo wee dee ihe nchqppta; Ijiri Igbo wee dee ihe e zutere na njemqrx na njem nchqppta.
13.	Ihe Qmxmx Igbo n'ime Nkanufere I:	Ijiri kqmputa dee Igbo; Ngwaqrx kqmputa maka Igbo; Mkpxrxasxsx Igbo n'ime kqmputa;
14.	Ihe Qmxmx Igbo n'ime Nkanufere II:	Igbo n'ime whatsapp; Igbo n'ime facebook;

		Igbo n'ime google.
15.	Mmxghar[na ule	Ngxppta; Ndeppta; Ngosi; Nch[kqta; Ule

IMSU-STA 112: Probability I

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Explain three differences between permutation and combination;
2. Explain the concept of random variables and relate it to probability and distribution functions
3. Define probability laws, conditional probability, and independence;
4. Describe Bayes' theorem and explain three basic probability distribution for discrete and continuous random variables;
5. Compute expectations and moments of random variables;
6. Explain Chebyshev's inequality and apply it to real life situations;
7. Explain joint marginal, conditional distributions and moments as well as Limiting distributions;
8. Describe standard distributions, moments and moment-generating functions; and explain laws of large numbers and the central limit theorem.

Course Contents

(Pre-requisite –Good Mathematical Knowledge)

Permutation and combination. Concepts and principles of probability. probability laws. conditional probability, independence. Bayes' theorem. Probability and distribution functions of discrete and continuous random variables: binomial, Poisson, geometric, hypergeometric, rectangular (uniform), negative exponential, binomial. Expectations and moments of random variables. Chebyshev's inequality. joint marginal and conditional distributions and moments. limiting distributions. discrete and continuous random variables, standard distributions, moments and moment-generating functions. laws of large numbers and the central limit theorem.

Probability and statistics, mutually exclusive events, independent events, the binomial probability distribution. Dependent events, mathematical expectation, permutations combinations, factorial n, stirling's approximation to N.

IMSU-CHM 114: Physical Chemistry

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. State the kinetic theory of gases and solve problems related to ideal and real gases;
2. Derive the formula for molecular velocity of gases and use the derived formula to solve problems;
3. Describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical Kinetics, quantum mechanics and spectroscopy;
4. Apply simple models to predict properties of chemical systems;
5. Define and state type of solutions; define different concentration terms which include molarity,

normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;

6. Apply numerical or computational methods to calculate physical properties of Chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;
7. Design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and
8. States Ohms law and describe the electrolytic conduction, states the Faraday's Law and Conductance Law of solution and calculation on electrical conductance on different electrolyte solution.

Course Contents

Kinetic theory of gases; science of real gases; the laws of thermodynamics; entropy and free energy; reactions and phase equilibria; reaction rates; rate laws; mechanism and theories of elementary processes; photochemical reactions; basic electrochemistry.

ENT 211: Entrepreneurship and Innovation

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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.

Course Learning Outcomes (CLOs)

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 assess 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;
8. Guide his or her actions, using the knowledge and expertise acquired in philosophy and logic.

Course Contents

(Pre-requisite –Good Academic Standing)

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, etc.

ENT 312: Venture Creation**(2 Units C: LH 15; PH 45)****Course Learning Outcomes (CLOs)**

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

(Pre-requisite –Good Academic Standing)

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), block chain, cloud computing, renewable energy, etc. Digital business and e-commerce strategies).

GST 312: Peace and Conflict Resolution

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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.

IMSU-CSD 401: Career Services Development

(1 Unit C: LH 15)

Course Learning Outcomes (CLOs)

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

1. Establish the difference and relationship between self-confidence and self-consciousness
2. State types of career counselling, assessment and exploration, benefits of virtual career counselling.
3. Understand job search strategies, tools and resources for job market research
4. Explain ethics, legal dimensions and contractual obligations in career services
5. Outline challenges to early career professionals
6. Understand types, benefits and challenges of internships and freelancing
7. Outline types and techniques of mentoring and roles of mentors

Course Contents

(Pre-requisite –Good Academic Standing)

The Human Perspective in Career Development; Self-confidence Development Through Communication; Career Counseling, Assessment and Exploration; Active Job Search; Ethical and Legal Dimensions to Career Choice and Development; Early Career Professionals: Resilience and Adaptability to Career challenges; Broader Perceptives to Career Choices; Growth and Development at Work; Basics of the World of Work; Diversification of Career Choices in Agriculture; Feasibility Study for Career Planning; Resume Writing and Interview Preparation.

11.4.2 General Engineering Coded Courses

GET 101: Engineer in Society

(1 Unit C: LH 15)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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.

IMSU-GET 105: Engineering Drawing

(1 Unit C: PH 45)

Course Learning Outcomes (CLOs)

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

1. Understand the fundamentals of engineering drawing

2. Demonstrate proficiency in basic drawing tools and techniques
3. Interpret and analyze technical drawings
4. Apply drawing standards and conventions
5. Create 2D orthographic projections and isometric views
6. Understand geometric dimensioning and tolerancing (GD&T)
7. Use proper dimensioning and annotation techniques
8. Demonstrate problem-solving skills through engineering drawings apply the concept of engineering drawings to real-world applications

Course Contents

(Pre-requisite –Knowledge of Construction in SS2-SS3 Mathematics or Technical Drawing)

Graphic Tools, Introduction of Drawing, measuring. Lettering and dimensions of objects in various positions. Sketching, Engineering geometry, fundamentals orthographic projections. Graphs, charts and presentation of data and results.

Guided sketching, freehand drawing, creative thinking and multi-view representation. Revolution and conventional practice. Sectional and auxiliary views. Spatial relationships; basic descriptive geometry, vector geometry; developments and intersections, pictorial presentation.

IMSU-GET 121 Workshop Practice I

(1 Unit C: LH 15 P 45)

Course Learning Outcomes (CLOs)

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

1. Observe safety precaution in the workshop.
2. Operate safety equipment e.g. fire extinguisher, safety water hose etc.
3. Use of personal protective equipment.
4. Observe all safety rules and regulations.
5. Use the marking out tools very well.
6. Produce simple objects by using the bench and hand tools.
7. Read the micrometer screw gauge, Vernier calipers etc.

Course Contents

(Pre-requisite –Good Academic Standing)

Behaviour Analysis: Safety consciousness, survey of sources of accidents, general safety instructions, Use of Engineering of measuring instruments, Calipers, micrometer screw gauge, sine bars, angular measuring, etc, sampling and sizing techniques of raw materials, introduction to hand tools, bench tools, power tools, and wood working tools, Bench work: marking out, cutting, filling, drilling.

Assignment: production of (i) a simple door stapler (ii) chair/table

IMSU-GET 122 Workshop Practice II

(1 Unit C: LH 15; PH 45)

Course Learning Outcomes (CLOs)

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

1. Identify and draw different types of plant layout,
2. Identify and produce different types of joints, using rivets, and screws and produce internal and external thread forms,
3. Cut, slot and file straight and curved profiles.
4. Perform a range of operations on workshop machinery, e.g., Drills, Lathe, Mills, and Grinders
5. Form an internal and external threads by use of taps and dies

6. Operate equipment and tools in metal workshop and distinguish between their application
6. Participate in workshop activities individually as well as in a group
7. Turn jobs on the lathe, parallel, taper, and face turning etc
8. Select spindle speeds, feeds, and coolant.
9. Operate equipment and tools in wood workshop and distinguish between their application
10. Show the general purpose and precision colour codes resistors
11. Identify the standard symbols for some of the circuit elements

Course Contents

(Pre-requisite –IMSU-GET 121)

Sheet metal work: layout, plant layout, cutting, shaping, welding, Design of simple jigs and fixtures. Basic wood-working principle, introduction to machine shop; lathe work, shaping, milling, grinding, drilling, and metal spinning, thread and thread cutting, power press, design of die elements, simple Automobile diagnosis and repairs, Electrical Workshop practice: Convention and application of colours, codes, and signs, etc. Use of electrical tools, machines, cables and conductors.

Projects: Safe manufacture and production of five projects involving all aspects of machine-shop applications including drilling, lathe, milling, surface grinding to the tolerances shown on drawings.

IMSU-GET 201: Applied Electricity I

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

On completion of the course, students should 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; 5. explain the basic a.c. circuit theory and
3. Apply to solution of simple circuits.

Course contents

(Pre-requisite – Knowledge of PHY 101 and Good Academic Standing)

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, and susceptance.

IMSU-GET 202: Engineering Materials

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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.
9. Explain the characteristics of phase diagrams and phase transformations of solid solutions (alloys);
10. Determine the components and compositions of phase diagrams and phase transformations of solid solutions (alloys);
11. discuss the different types, causes and effects of corrosion and methods of its prevention and mitigation;

Course Contents

(Pre-requisite –Good Academic Standing)

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. Toughening 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. Corrosion: types, causes and effects of corrosion, corrosion prevention and mitigation. Fabrication processes and applications. 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.

IMSU-GET 203: Engineering Graphics and Solid Modeling II (3 Units C: LH 30 PH 45)

Course Learning Outcomes (CLOs)

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

1. Apply mastery of the use of projections to prepare detailed working drawing of objects and designs;
2. Develop skills in parametric design to aid their ability to see design in the optimal specification of materials and systems to meet needs;
3. Analyze and optimize designs on the basis of strength and material minimization;
4. Get their appetites wet in seeing the need for the theoretical perspectives that create the basis for the analysis that are possible in design and optimization, and recognize/understand the practical link to excite their creativity and ability to innovate; and
5. Translate their thoughts and excitements to produce shop drawings for multiphysical, multidisciplinary design.

Course Contents

(Pre-requisite –GET 102)

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).

GET 204: Students Workshop Practice

(2 Units C: LH 15; PH 45)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –IMSU-GET 121, IMSU-GET 122)

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)

Course Learning Outcomes (CLOs)

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 and others;
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

(Pre-requisite –Good Academic Standing)

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)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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.

IMSU-GET 207: Applied Mechanics

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

At the end of this course, students will acquire the ability to:

1. Explain the fundamental principles of applied mechanics, particularly equilibrium analysis, friction, kinematics and momentum;
2. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, mathematics and applied mechanics;
3. Synthesize Newtonian Physics with static analysis to determine the complete load impact (net forces, shears, torques, and bending moments) on all components (members and joints) of a given structure with a load; and

4. Apply engineering design principles to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

Course Contents

(Pre-requisite –Good Academic Standing)

Forces, moments, couples. Equilibrium of simple structures and machine parts. Friction. First and second moments of area; centroids. Kinematics of particles and rigid bodies in plane motion. Newton's laws of motion. Kinetic energy and momentum analyse

IMSU-GET 208: Strength of Materials

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Recognize 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

(Pre-requisite –IMSU-GET 207)

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)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –MTH 102, MTH 104)

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)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –MTH 102)

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.

Course Learning Outcomes (CLOs)

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

(Pre-requisite – Knowledge of Use of Computer and Good Academic Standing)

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 operator's 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.

IMSU-GET 221 Engineering Laboratory I**(1 Unit C: LH 15 PH 45)****Course Learning Outcomes (CLOs)**

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

1. Practically measure the coefficient of friction between steel plane and various engineering materials.
2. Explain frictional effects using an inclined plane.
3. Practically determine the forces required to support moving and static bodies on inclined plane.
4. Use data to verify the belt friction law.
5. Determine the elasticity of a given rubber band.
6. Determine the stiffness of a specimen spring wire and modulus of rigidity of a given spring wire.
7. Practically determine the modulus of rupture of various timber beams.
8. Take required steps and determine the values of the shear modulus of elasticity for given specimens of steel, brass and aluminum.
9. Measure or estimate the toughness of a material or a test specimen by Charpy test.
10. Take practical steps and determine the endurance limit of specimen of a metal.
11. Determine the hardness of mild steel plate, carbon steel plate and aluminum plate specimens.
12. Describe the macro structure of aluminum ingot sections and state the relationship between the freezing rate of specific areas of any casting.
13. Use the magnetic particle method and detect surface cracks.

14. Describe the microstructure of metallic elements by viewing under a microscope and hence provide information on the material, its history and properties.
15. State the nature and measure the relative magnitudes of the forces in the members of the jib-crane.
16. Use the related apparatus and determine the velocity ratio for a given machine and determine the variation with load of the efforts, friction load and efficiency for the given machine.
17. Take practical steps and determine the mechanical efficiency of power transmission by a given flat belt.
18. Determine the radius of gyration about the mass-centre of a rigid body and calculate the gravitational acceleration in the locality of action.
19. Set up a solar energy scheme and use it to generate potable water from sea or river water.
20. Determine the thermal conductivities of various insulating materials.
21. Quantitatively verify the law of linear motion.

Course Contents

(Pre-requisite –Good Academic Standing)

Assigned laboratory exercises to reflect the basic engineering courses in:

- a. Engineering Mechanics
- b. Materials Science
- c. Engineering Thermodynamics 1
- d. Basic land survey

Guidance on specific experiments and calculations will be provided by the lecturer.

IMSU-GET 222 Engineering Laboratory II

(1 Unit C: LH 15 PH 45)

Course Learning Outcomes (CLOs)

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

1. Determine, in real terms, the support reactions for a simply-supported beam with point load.
2. Practically calculate the variation of deflection of a simply-supported beam with load, beam thickness and beam material.
3. Calculate the elasticity of a specimen of rubber band based on laboratory data.
4. Calculate the modulus of rupture of various timber beams specimens based on laboratory data.
5. State the relationship between torsional moment and the angle of twist of a shaft.
6. Determine the value of the shear modulus of elasticity for steel, brass and aluminium based on laboratory data.
7. Measure inductance and capacitance by Wheatstone bridge.
8. (a). Measure fusing current in a circuit.
(b). Know the relationship between fusing current and the length of fuse wire.
(c). know relationship between fusing current and diameter of the fuse wire.
9. (1).Describe the effect of straining on fusing current.
(2). Clearly state time-current dependence of a circuit breaker.
10. Confirm experimentally, some of the basic electrical network theorems and laws such as Kirchoff's law, superposition and Thevenin theorems.
11. Confirm the maximum power transfer theorem.
12. Describe the relationship between transformer coils windings (number of turns) ratio and voltage output.
13. Confirm the validity of Hooke's law for elastic materials.
14. Determine the endurance limit of a specimen of a metal.

15. Determine the hardness of mild steel plate, carbon steel plate and aluminum plate specimens.
16. Vary the compressor speed and load of a refrigeration system and correspondingly clearly state how the compressor speed changes with the following parameters:
 - (i). Compressor power
 - (ii). Refrigerating effect
 - (iii). COPR
 - (iv). Heat reject speed condenser
 - (v). Compressor efficiency: volumetric, isentropic, mechanical.
17. Understand the validity of theoretical quantifications for the force exerted by a jet of fluid on targets of different shapes.
18. Understand the change in pressure drop due to liquid viscosity along a circular pipe in relation to the mean flow velocity in the pipe.

Course Contents

(Pre-requisite –IMSU-221)

Assigned laboratory exercise to reflect the basic Engineering courses in:

- a. Strength of materials
- b. Fluid mechanics I
- c. Basic Engineering materials
- d. Basic Electrical Engineering

Guidance on specific experiments and calculations will be provided by the lecturer.

GET 299: Students Industrial Work Experience I

(3 Units C: 9 weeks)

Course Learning Outcomes (CLOs)

SIWES 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

(Pre-requisite –Good Academic Standing)

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.

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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, structure Fog and 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 306: Renewable Energy Systems and Technology**(3 units C: LH 30 PH 45)****Course Learning Outcomes (CLOs)**

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

1. Identify the types, uses and advantages of renewable energy in relation to climate change;
2. Design for use the various renewable energy systems;
3. Recognise and analyse the current energy systems in Nigeria, their impacts on development and the global energy demand and supply scenarios;
4. Appreciate the environmental impact of energy exploitation and utilisation, and pursue the sustainable development of renewable energy for various applications; and
5. Recognise the exploitation, excavation, production, and processing of fossil fuels such as coal, petroleum and natural gas, and discuss the sources, technology and contribution to future energy demands of renewable energy.

Course Contents

(Pre-requisite –Good Academic Standing)

Current and potential future energy systems in Nigeria and globally - resources, extraction, concepts in energy conversion systems; parallels and differences in various conversion systems and end-use technologies, with emphasis on meeting 21st-century national, regional and global energy needs in a sustainable manner. Various energy technologies in each fuel cycle stage for fossil (oil, gas, synthetic), nuclear (fission and fusion) and renewable (solar, biomass, wind, hydro, and geothermal). Energy types, storage, transmission and conservation. Analysis of energy mixes within an engineering, economic and social context. Sustainable energy; emphasise sustainability in general and in the overall concept of sustainable development and the link this has with sustainable energy as the fundamental benefit of renewable energy.

Practical Contents

Simple measurement of solar radiation, bomb calorimeter determination of calorific value of fuels and biomass; measurement of the velocity of wind, waves and the energy that abound in them; laboratory production of biogas and determination of energy available in it; simple conversion of solar energy to electricity; trans-esterification of edible oil into biodiesel; simulation of geothermal energy; Geiger-Muller or Scintillation Counters' determination of uranium or thorium energy; simple solid or salt storage of energy; hybrid application of renewable energy.

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

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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.

IMSU-GET 308 Engineering Economics

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Determine an equilibrium and predict changes in an equilibrium in response to market changes
2. Compare and contrast economic profits with accounting profits
3. Identify five economic indicators and utilize them to articulate the state of the economy and prescribe monetary and fiscal policy
4. Conduct and interpret a cost-benefit analysis for an engineering
5. Compare the life cycle cost of two multiple projects using present worth, annual cost, payback and break-even analysis
6. Make a quantitative decision between alternate facilities or systems using Benefit/Cost Ratio
7. Evaluate the feasibility of a project or system by estimating cash demands as a function of time and comparing these with estimated cash flows from available funding source
8. Compute the depreciation of an asset using standard depreciation
9. Communicate the results of an economic modeling process to management and other non - specialist in an informative and professional

Course Contents

(Pre-requisite –Good Academic Standing)

Valuation. Depreciation accounting: Taxes. Equipment replacements based on deterioration and obsolesce. Dynamic equipment policy. MAPI formula. Break even analysis. Minimum cost points. Analysis based on risk and uncertainty. Introduction to micro-economics: Theory of consumer behavior, theory of demand and supply, market equilibrium, elasticities and behaviour (perfect competition, monopolistic, monopoly and oligopoly), Theory of the firm. Production functions. Introduction to macroeconomics; Level of Investment. Stocks and flows. Investment functions. Economic dynamics.

GET 399: Students Industrial Work Experience II

(4 Units C: 12 weeks)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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 troubleshooting, and wooden 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 Base · Basic assembly modelling, and solid Works 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 solid works; and
- d. technical report writing.

IMSU-GET 481 Computer Aided Design and Manufacturing (1 Unit C: LH 15 PH 15)

Course Learning Outcomes (CLOs)

Upon successful completion of this course, the student should be able to:

1. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
2. Use the techniques, skills, and modern engineering tools necessary for engineering practice
3. Analyse system designs using application software.
4. Realise designs within short period of time
5. Integrate computers into manufacturing processes.
6. List and explain CAD software
7. Program Robots

Course Contents

(Pre-requisite –GET 211 and Good Academic Standing)

Review of computer hardware and software. CAD fundamentals: Modelling, application of CAD models, functions of CAD systems. Role of CAD in Engineering. CAD software and applications: AutoCAD, ArchiCAD, CivilCAD, Electronic workbench, Proteus, CorelDraw etc. Algorithms and software. System designs and analysis using MATLAB and Programming in C, C++. Computer integrated manufacturing (CIM) and flexible design and manufacturing system: CIM objectives, CIM systems, benefits. Barriers to CIM adoption. Computer controlled machines. Numerical control process. Applications and economics of NC. Computer Numerical control. Computer Aided Manufacturing (CAM): CAM system, design and manufacturing interface. Application of computers in planning and control in manufacturing. Types and sources of data used in manufacturing. Manufacturing automation. CAM implementation. Robots: Definition, characteristics of Robots, basic elements and types of Robots. Robot programming, operating methods and application. Introduction to geometric modelling, properties and representation of solids. Interactive computer graphics.

IMSU-GET 493 Engineering Research Methods

(1 Units C: LH 15)

Course Learning Outcomes (CLOs)

Upon successful completion of this course, students will be able to:

1. Describe and explain key research concepts, issues, types of research and the systematic process of research gap identification and documentation and use contexts;
2. Search for, assembling and critically analysing research articles, papers and reports and general literature;
3. Formulate and evaluate research objectives, questions and hypotheses;
4. Developing a research proposal or industry project plan;
5. Identify and develop appropriate data acquisition and analysis methods and instrument;
6. Design/structure and lead the research process using appropriate research designs;
7. Use appropriate tools/techniques, including computer soft- and hardware /technologies to interpret, discuss and report/present the result and conclusions derived from research data analysis in oral or written form; and
8. Prepare/format/package research results/output for academic, journal articles, technical and other reports and exhibitions/fairs (scientific, trade, etc.) as an individual or team/work group.

Course Contents

(Pre-requisite –Good Academic Standing)

Origins and definitions of research. Problem identification and formulation. Research types/design. Qualitative, quantitative and mixed methods of research. Measurement. Experiments. Sampling. Data collection. Data presentation. Data analysis. Interpretation of data and technical report writing. Use of encyclopedia, research guides, handbooks, academic databases for engineering disciplines. Use of tools/techniques for research production: referencing and citation formats/styles and software. Research management and reporting best practices. Plagiarism definitions, types, detection software. Basics of document analysis, systematic review and management methods. Practical documentation/presentation projects/seminars.

GET 499: Students Industrial Work Experience III

(8 Units C: 24 weeks)

Course Learning Outcomes (CLOs)

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 devise 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

(Pre-requisite –GET 299, GET 399)

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.

GET 501: Engineering Project Management

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –Good Academic Standing)

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)

Course Learning Outcomes (CLOs)

At the end of the course, students should 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

(Pre-requisite –Good Academic Standing)

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.

10.4.3 Departmental Coded Courses

TCH 101: Introduction to Chemical Engineering

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Appreciate the role of the chemical engineer in the industry and society;
2. Be able to use basic engineering units in both SI and imperial systems in solving problems;
3. Develop problem solving skills and engage more effectively in solving different types of problems;
4. Formulate and solve basic steady state material balances for single units; and
5. Perform stoichiometry analysis for chemical conversions and apply it to material balance.

Course Contents

(Pre-requisite –Good Academic Standing)

The role of the chemical engineer. Units and dimensions. The mole unit. Conventions in the method of analysis and measurement. Temperature. Pressure. Physical and chemical properties and measurement. Techniques of solving problems. The chemical equation stoichiometry, material balances in single units, recycle, bypass, purge. This course will be supported with guest lectures from senior chemical engineers in industries, government and academia.

TCH 201: Chemical Engineering Fundamentals

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Formulate and solve closed steady state material balances on multi-stage systems with and without a recycle and purge;
2. Formulate and solve closed steady state Material balances on multi-stage systems that include single and multiple chemical reactions;
3. Formulate and solve closed steady state material balances on multi-stage systems that include complete and incomplete conversions;
4. Formulate and solve problems involving species and elements for reacting and non-reacting systems;
5. Formulate and solve energy balances
6. Formulate and solve combined material and energy balances.

Course Contents

(Pre-requisite –Good Academic Standing)

Analysis of material balances for multiple systems. Analysis of material balances problems with direct solutions. Material balances using algebraic techniques control surface and stage balances for open and closed system. Problems involving species and elements for reacting and non-reacting systems. Material balances in process flow sheets. Energy balances procedures; energy balances for reactive and non-reactive processes; combined mass and energy systems. Computer aided balance calculations.

TCH 206: Statistics for Chemical Engineers

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Construct appropriate graphical displays of data and understand the role of such displays in data analysis;
2. Perform statistical inference tasks using software and understand the calculations involved in such tasks and be aware of assumptions necessary for the validity of results;
3. Use and interpret statistical software package such as MINITAB, Design Expert to summarise and analyse industry data;
4. Make appropriate conclusions based on experimental results;
5. Plan and execute an experimental program to determine the performance of a chemical engineering system;
6. Evaluate the accuracy of the measurements taken; and
7. Communicate the results of the investigation in a number of ways.

Course Contents

(Pre-requisite –IMSU-STA 112)

Chemical engineers must have an appreciation of the accuracy and reliability of measurements. This course provides a broad introductory knowledge of statistical techniques used in data analysis. It also seeks to link the measurement of various quantities with statistics to enable the analysis of the accuracy of the measurements. Statistical inference intervals, tests hypothesis and significance. Regression and correlation. Introduction to big data analytics and cloud computing applications. Students to have weekly or fortnightly computer laboratory-based assignments.

IMSU-CME 224 Engineering Chemistry I

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Describe and explain the fundamental concepts of physical chemistry including those of statistical mechanics, chemical Kinetics, quantum mechanics and spectroscopy;
2. Apply simple models to predict properties of chemical systems;
3. Define and state type of solutions; define different concentration terms which include molarity, normality etc. explain vapour pressure lowering of the solvent, boiling point elevation of solutions, freezing point depression of solution and measurement of osmotic pressure;
4. Apply numerical or computational methods to calculate physical properties of Chemical systems and assess the appropriateness of different computational techniques and numerical approximations for solving chemistry problems;
5. Design and plan an investigation by selecting and applying appropriate practical, theoretical, and/or computational techniques or tools; and
6. States Ohms law and describe the electrolytic conduction, states the Faraday's Law and Conductance Law of solution and calculation on electrical conductance on different electrolyte solution.
7. Describe the general knowledge of Gibbs function;
8. Explain the concept of thermodynamics compare to kinetics; and
9. Explain the concept of statistical thermodynamics and use statistical equation to solve problems in ideal and non-ideal solution.

Course Contents

(Pre-requisite –CHM 101, CHM 102, CHM 114)

The laws of thermodynamics; entropy and free energy; reactions and phase equilibria; reaction rates; rate laws; mechanism and theories of elementary processes; photochemical reactions; basic electrochemistry.

A review of Gibbs Function. Chemical thermodynamics. Introduction to statistical thermodynamics. Ideal solutions and non-ideal solutions. Properties of electrolytes. Colligative Properties. Studies on biochemical systems.

IMSU-PBL 300: Problem Based Learning I

(2 Units C: PH 90)

Course Learning Outcomes (CLOs)

By the end of the exercise, students will be able to:

1. **Identify and define problems** within real-life or simulated scenarios, demonstrating critical thinking and analytical skills.
2. **Apply interdisciplinary knowledge** to explore and evaluate possible solutions to complex, open-ended problems.
3. **Develop problem-solving strategies** by generating, testing, and refining alternative solutions.
4. **Work collaboratively in teams**, demonstrating effective communication, leadership, and interpersonal skills.
5. **Manage learning independently** by identifying knowledge gaps, researching relevant information, and applying self-directed learning techniques.
6. **Integrate theory with practice** in formulating feasible and innovative solutions.
7. **Evaluate outcomes critically**, assessing both the process and results of problem-solving activities.
8. **Present findings effectively** through oral, written, and digital communication, tailored to academic, professional, or community contexts.
9. **Reflect on personal and group learning processes**, identifying strengths, weaknesses, and strategies for continuous improvement.
10. **Demonstrate ethical reasoning and professional responsibility** in addressing societal, technical, or organizational problems.

Course Contents for PBL I

(Pre-requisite- Good Academic Standing)

Introduction to PBL: Concept, history, and philosophy of PBL; Differences between PBL and traditional learning approaches; Roles of students and facilitators in PBL; Expected outcomes of PBL.

Problem Formulation: Identifying and defining real-world problems; Structuring open-ended problems; Characteristics of effective problems; Problem analysis techniques (e.g., brainstorming, mind mapping).

Collaborative Learning and Teamwork: Group formation and dynamics; Team roles and responsibilities; Conflict resolution and consensus building; Effective communication and collaboration.

Self-Directed Learning: Information literacy: searching, evaluating, and synthesizing knowledge; Critical thinking and inquiry-based approaches; Independent and guided research skills; Time and resource management in problem-solving.

Problem-Solving and Decision-Making Skills: Analytical and creative thinking techniques; Systems thinking and modeling approaches; Evidence-based reasoning; Decision-making under uncertainty.

Application of PBL in Disciplines: Case studies from engineering, medicine, business, and social sciences; Interdisciplinary problem scenarios; Community-based projects.

Assessment in PBL: Formative and summative assessment in PBL; Peer and self-assessment techniques; Reflective journals, portfolios, and presentations; Rubrics for evaluating teamwork, creativity, and problem-solving.

Reflection and Lifelong Learning: Metacognition and self-evaluation; Continuous improvement through reflection; Transfer of PBL skills to professional practice; Building lifelong learning habits.

Practical Component: Capstone Project / Problem Challenge: Students work on a complex, real-world problem in teams and present solutions (report, prototype, or presentation).

IMSU-GET 301: Engineering Mathematics III (2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

(Pre-requisite –MTH 101, MTH 102, GET 209, GET 210)

Linear Algebra. Elements of Matrices, Determinants, Inverses of Matrices. Theory of Linear Equations. Eigen Values and Eigen Vectors. Analytical Geometry. Coordinate Transformation. 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 quantities. Flux of Vectors. The curl of a vector field, Gauss, Greens and Stoke's theorems and applications. 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.

TCH 301: Transfer Processes I (2 Units C: LH 15; PH 45)

Course Learning Outcomes (CLOs)

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

1. Derive the heat diffusion equation and use it to predict temperature profiles across solid bodies transferring heat by conduction;
2. Derive equations of heat transfer by convection and use them to predict the rate of heat loss under steady state natural and forced convection;

3. Derive the equations of heat loss by radiation, and use them to predict the rate of heat loss under steady state conditions;
4. Perform a procedural design of a heat exchanger for defined process requirements;
5. Derive equations of mass transfer by molecular diffusion and use these to predict the flow rates and composition of output streams from a mass transfer operation under steady state conditions;
6. Determine the performance and size of a given heat exchanger using different methods; and
7. Perform pressure drop calculations and procedural design of different heat exchangers according to defined process requirements.

Course Contents

(Pre-requisite –Good Academic Standing)

Steady State Conduction. Forced and Natural Convection. Reynolds' Analogy. Heat Transfer Film Coefficient Correlations. LMTD Heat Transfer Design. Fouling Factors. Radiation; Blackbody Radiation, Emission from Real Surfaces. Kirchoff's Law. Unsteady-State Conduction. 2-D Conduction. Fundamentals of Mass Transfer. Similarity of Momentum, Heat and Mass Transfer. Convective Mass Transfer. General, Molecular and Turbulent Diffusion Equations. Fick's Law for Diffusion. Molecular Diffusion in Gases, Liquids and Solids. Diffusion Coefficients in Gases. Liquids. Shell and Tube Heat Exchangers. LMTD Correction Factors. Heat Transfer and Pressure Drop Correlations. HX Design and Performance (Kern's and NTU Methods for Multipass and Cross-Flow HX). Compact Heat Exchangers. Plate Heat Exchangers. Operating Principles, Series and Parallel Combination, Use and Limitations. Comparison with Shell and Tube Heat Exchangers.

TCH 302: Chemical Engineering Thermodynamics I

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Perform calculations for various heat effects on industrial reactions as functions of temperature and with or without phase change;
2. Use enthalpy-concentration and related diagrams in the analysis of heat effect on industrial reactions;
3. Perform calculations of equilibrium constants of reversible reactions; and
4. Perform calculations on the effect of temperature and pressure on equilibrium constants and conversions for gas phase, liquid phase and heterogeneous reactions.

Course Contents

(Pre-requisite –GET 206)

Heat Effects. Heat capacities as a function of temperature, specific heats of liquids and solids; Heat effects accompanying phase change Clausius-Clapeyron equation, standard heats of reaction, formation and combustion effect of temperature on heat reaction. Heat of mixing and solution, Enthalpy concentration diagrams for H_2SO_4 , H_2O , etc., partial enthalpies.

Chemical Reaction Equilibria; Standard free energy change and equilibrium constant, Evaluation of equilibrium constants. Effects of temperature and pressure on equilibrium constants; calculation of conversion; Gas phase reactions, Percentage conversion; Liquid phase reaction Heterogeneous reactions.

IMSU-CME 303: Chemical Engineering Process Analysis**(2 Units C: LH 30)****Course Learning Outcomes (CLOs)**

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

1. Apply the principles of mass and energy conservation to analyze chemical processes.
2. Formulate and solve material and energy balance equations for single- and multiple-unit processes, including systems with recycle, bypass, and purge.
3. Analyze non-reactive and reactive systems involving phase changes and chemical reactions
4. Use property estimation methods to determine physical and thermodynamic properties needed for process calculations.
5. Develop and interpret process flow diagrams (PFDs) and perform degree of freedom analysis for process systems.
6. Apply basic computational tools (e.g., spreadsheets, process simulators) to solve process analysis problems.
7. Evaluate process performance metrics such as conversion, yield, selectivity, and efficiency.

Course Contents

(Pre-requisite –IMSU-CME 224)

Introduction to Engineering calculations; processes and process variables. Processes and process descriptions, process data representation and analysis. Industrial stoichiometry (limiting conversion). Material and energy balances on batch, semi-batch and vapours, liquids and solids. Their mixtures; vapour liquid equilibrium (Raoult's law, relative and percent saturation, condensation dew point). Steam (enthalpy-temperature chart, steam table, etc). combustion calculations (solid, liquid and gaseous fuels, excess air, waste gas analysis. Applications to the chemical process industries. Sources of data, Dimensional analysis.

TCH 305: Chemical Engineering Laboratory I**(1 Unit C: PH 45)****Course Learning Outcomes (CLOs)**

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

1. Locate (or identify) relevant literature sources to support/contradict theoretical arguments, and to find data;
2. Demonstrate theoretical principles by means of experiments;
3. Propose theoretical models of experimental data; or
4. Evaluate the accuracy of prescribed theoretical models; and
5. Communicate (or describe) technical information and arguments in a professional manner.

Course Contents

(Pre-requisite –TCH 301, IMSU-CME 313)

Laboratory Experiments in Transfer Processes; Kinetics and Separation Processes

TCH 307: Biochemical Engineering**(2 Units C: LH 30)****Course Learning Outcomes (CLOs)**

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

1. Explain the basic concepts of macromolecules and their building blocks, and their relevance to chemical engineering;

2. Interpret the fundamental of microbial growth, the principles of enzyme and cell kinetics;
3. Calculate cell growth, and enzyme kinetics; and
4. Perform mass balance on cell and enzyme systems

Course Contents

(Pre-requisite –Good Academic Standing)

Introduction to microbiology and biochemistry. Classification and growth characteristics of micro-organisms. Enzymes Engineering: including enzyme kinetics, aerobic and anaerobic respirations, metabolic pathways, cell growth kinetics and models

TCH 308: Numerical Methods in Chemical Engineering (2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Apply numerical method techniques to solve problems arising from heat and mass transfer, chemical reactions, thermodynamics, fluid mechanics and molecular simulations;
2. Apply numerical method techniques to solve different categories of mathematical equations;
3. Apply numerical methods such as navier-stokes, runge kutta, newton-raphson, taylor's series etc to solve ODES and PDES; and
4. Perform numerical integrations and differentiation.

Course Contents

(Pre-requisite – GET 209, GET 210, IMSU-GET 301)

Numerical methods for solving problems arising in heat and mass transfer, fluid mechanics, chemical reaction engineering, and molecular simulation. Topics: numerical linear algebra, solution of nonlinear algebraic equations and ordinary differential equations, solution of partial differential equations (e.g., Navier-Stokes), numerical methods in molecular simulation (dynamics, geometry optimization). Runge Kutta and other methods in the solutions of ODE and PDEs. Numerical integration and differentiation. All methods are presented within the context of chemical engineering problems.

IMSU-CME 311: Chemical Reactions Engineering I (3 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Explain the fundamental concepts of chemical kinetics, reactor types, and rate laws.
2. Derive rate laws from experimental data using integrated and differential methods.
3. Analyze ideal reactor performance for batch, plug flow (PFR), and continuous stirred-tank reactors (CSTR).
4. Design reactors for single and multiple reactions under isothermal and non-isothermal conditions.
5. Evaluate the effects of temperature, pressure, and catalysts on reaction rates and reactor design.
6. Apply the principles of mass and energy balances in chemical reactors.

7. Use numerical methods and software tools (e.g., MATLAB, Python) to simulate and solve reactor design problems.

Course Contents

(Pre-requisite –Good Academic Standing)

Introduction to chemical kinetics; concentration versus time equations for single, irreversible reactions; concentration versus time equations for reversible reaction; design of the ideal PFR, CSTR; batch and semi-batch reactors and CSTRs in series.

Real tubular reactors in laminar flow; Real tubular reactors in turbulent flow; packed bed reactors; unsteady reactors; residence time distribution functions for non-ideal flow reactors.

IMSU-CME 313: Separation Processes I

(2 Units C: LH 15; PH 45)

Course Learning Outcomes (CLOs)

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

1. Explain the principles and mechanisms of phase equilibrium and mass transfer relevant to separation processes.
2. Classify different types of separation processes based on phase interactions and driving forces.
3. Analyze binary distillation processes using McCabe-Thiele and Ponchon-Savarit methods.
4. Design absorption and stripping columns using equilibrium stage and rate-based models.
5. Calculate stage requirements and operating conditions for liquid-liquid extraction and leaching processes.
6. Evaluate the performance of separation equipment such as trays, packings, and membranes under various operating conditions.
7. Apply mass transfer principles to model membrane separation and drying operations.

Course Contents

(Pre-requisite –Good Academic Standing)

Stage-wise and continuous contact equipment. Isothermal gas absorption. Binary distillation, flash distillation; distillation systems - types of condensers and reboilers, plate versus packed columns, reflux ratio, Distillation of binary mixture - McCabe Thiele method: rectifying and stripping section, feed plate; Ponchon-Savarit method.

IMSU-CME 316: Chemical Engineering Laboratory II

(1 Unit C: PH 45)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Demonstrate the start-up and shutdown of the experimental rig in each of the experiments;
2. List at least two (2) safety and environmental hazards present in the laboratory and specific steps to deal with the risks responsibly;
3. Identify at least one (1) theory from the literature to explain the scheduled experiment and support the measured data;
4. Collect data from the process of the scheduled experiment;
5. Evaluate the parameter(s) representing the objective(s) of the scheduled experiment from the measured data;
6. Evaluate the accuracy of the determined parameter based on the prescribed theory from the

literature;

7. Write a technical report on the scheduled experiment.

Course Contents

(Pre-requisite –TCH 305)

Laboratory experiments in Separation processes and Heat transfer operations.

IMSU-CME 333: Engineering Chemistry II (Organic & Analytical 2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Describe and solve problems in chemistry of aromatic compounds;
 2. Describe the structures of simple sugars, starch and cellulose, peptides and proteins and show the difference in their conformation structure;
 3. Describe and solve problems in chemistry of bifunctional compounds;
 4. Explain the mechanisms of substitution, elimination, addition and rearrangement reactions;
 5. Describe stereochemistry and its application;
 6. Describe condition and pathways of the following organic reactions - Grignard reaction, Aldol and related reactions; and
 7. Describe simple alicyclic carbon compounds and their synthesis.
- recognize and distinguish between aromatic and alicyclic compounds by their structures;
8. Identify the properties of aromatic and alicyclic compounds, and the chemical consequences of aromaticity;
 9. Recognize and be able to write the mechanism of electrophilic aromatic and alicyclic substitution;
 10. Outline the completed electrophilic aromatic substitution reactions of the following types: halogenation, nitration, sulfonation, and Friedel-Crafts acylation & alkylation;
 11. Explain the chemistry of heterocyclic Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds);
- explain analytical processes which include description of chemist as a problem solver;
12. Describe and differentiate forms of error, explain its implication on laboratory analysis and state different statistical tool use in treatment of data;
 13. Solve practical problems using the statistical tools, define sampling and give reasons for sampling in field work, state and describe different sampling techniques;
 14. State different forms of sample collection and processing, describe volumetric method of analysis and solve some practical problems and describe gravimetric method of analysis and solve some practical problems.

Course contents

(Pre-requisite –IMSU-CME 224 & Academic Standing)

Chemistry of aromatic compounds. Structures of simple sugars, starch and cellulose, peptides, and proteins. Chemistry of bifunctional compounds. Energetics, kinetics, and the investigation of reaction mechanisms. Mechanisms of substitution, elimination, addition, and rearrangement reactions. Stereochemistry. Examples of various named organic reactions e.g., Grignard reaction, Aldol and related reactions. Simple alicyclic carbon compounds and their synthesis. Aromatic and Alicyclic chemistry. Survey of representative polycyclic compounds. Heterocyclic

Chemistry (3,4,5 and 6-membered ring of O, N, S heterocyclic compounds). Reactive intermediates – carbocations, carbanions, carbenes, nitrenes etc. Selected rearrangement reactions such as, Beckmann, Baeyer-Villiger, and many others to illustrate various reaction mechanisms and types.

Theory of errors; and statistical treatment of data: Theory of sampling. Chemical methods of analysis including volumetric, gravimetric, data analysis. Presentation and physicochemical methods. Optical methods of analysis; separation methods.

Potentiometric and pH methods. Conductometric, electroanalytical, amperometric, colorimetric methods of analysis. Coupled methods of analysis e.g. GC-MS, LC-MS. Radio-chemical methods, chromatograph

IMSU-PBL 400: Problem Based Learning II

(2 Units C: PH 90)

Course Learning Outcomes (CLOs)

By the end of the exercise, students will be able to:

1. **Identify and define problems** within real-life or simulated scenarios, demonstrating critical thinking and analytical skills.
2. **Apply interdisciplinary knowledge** to explore and evaluate possible solutions to complex, open-ended problems.
3. **Develop problem-solving strategies** by generating, testing, and refining alternative solutions.
4. **Work collaboratively in teams**, demonstrating effective communication, leadership, and interpersonal skills.
5. **Manage learning independently** by identifying knowledge gaps, researching relevant information, and applying self-directed learning techniques.
6. **Integrate theory with practice** in formulating feasible and innovative solutions.
7. **Evaluate outcomes critically**, assessing both the process and results of problem-solving activities.
8. **Present findings effectively** through oral, written, and digital communication, tailored to academic, professional, or community contexts.
9. **Reflect on personal and group learning processes**, identifying strengths, weaknesses, and strategies for continuous improvement.
10. **Demonstrate ethical reasoning and professional responsibility** in addressing societal, technical, or organizational problems.

Course Contents for PBL II

(Pre-requisite- Good Academic Standing)

Introduction to PBL: Concept, history, and philosophy of PBL; Differences between PBL and traditional learning approaches; Roles of students and facilitators in PBL; Expected outcomes of PBL.
Problem Formulation: Identifying and defining real-world problems; Structuring open-ended problems; Characteristics of effective problems; Problem analysis techniques (e.g., brainstorming, mind mapping).

Collaborative Learning and Teamwork: Group formation and dynamics; Team roles and responsibilities; Conflict resolution and consensus building; Effective communication and collaboration.

Self-Directed Learning: Information literacy: searching, evaluating, and synthesizing knowledge; Critical thinking and inquiry-based approaches; Independent and guided research skills; Time and resource management in problem-solving.

Problem-Solving and Decision-Making Skills: Analytical and creative thinking techniques; Systems thinking and modeling approaches; Evidence-based reasoning; Decision-making under uncertainty.

Application of PBL in Disciplines: Case studies from engineering, medicine, business, and social sciences; Interdisciplinary problem scenarios; Community-based projects.

Assessment in PBL: Formative and summative assessment in PBL; Peer and self-assessment techniques; Reflective journals, portfolios, and presentations; Rubrics for evaluating teamwork, creativity, and problem-solving.

Reflection and Lifelong Learning: Metacognition and self-evaluation; Continuous improvement through reflection; Transfer of PBL skills to professional practice; Building lifelong learning habits.

Practical Component: Capstone Project / Problem Challenge: Students work on a complex, real-world problem in teams and present solutions (report, prototype, or presentation).

TCH 401: Chemical Product Design

(3 Units C: LH 15; PH 90)

Course Learning Outcomes (CLOs)

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

1. Identify a chemical process or product that is of relevance and of value that will involve application of student knowledge of chemical engineering principles;
2. Develop a strategy for the design and production of this process/product including milestones;
3. Develop the project budget and market analysis of the process/product;
2. Write a proposal for the development/production of the process or product;
3. Apply principles of starting up a chemical engineering business successfully; 4. Package the product for market where possible; and
5. Present process orally and in writing.

Course Contents

(Pre-requisite- Good Academic Standing)

Chemical Engineering open-ended problems/projects that require students to design a chemical process or product. Each team generates and filters ideas; identifies use cases and objectives; evaluates and selects a design strategy; develops a project budget; schedules milestones and tasks; and writes a proposal with supporting documentation. Each project must meet specified requirements for societal impact, budget, duration, person hours, environmental impact, safety, and ethics. Principles of chemical engineering business startups.

IMSU-CME 403: Chemical Reactions Engineering II

(2 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Analyze complex reaction networks involving series, parallel, and reversible reactions in various reactor types.
2. Classify and differentiate between types of reactors
3. Design isothermal and non-isothermal reactors (batch, CSTR, PFR) for multiple and complex reactions.
4. Apply concepts of residence time distribution (RTD), dispersion, and mixing to model non-ideal reactor behavior.
5. Evaluate reactor performance using models such as tanks-in-series, dispersion model, and segregated flow models.

6. Explain the fundamentals of heterogeneous catalysis, including surface reaction mechanisms and catalyst deactivation.
7. Develop rate expressions for catalytic reactions using Langmuir-Hinshelwood and other surface kinetics models.
8. Simulate and optimize reactor systems using computational tools (e.g., MATLAB, Aspen, or Python-based models).
9. Demonstrate awareness of industrial reactor safety, scale-up challenges, and economic considerations in reactor design.

Course Contents

(Pre-requisite- IMSU-CME TCH 305)

Review of kinetics of homogenous reactions, variable and constant volume systems;

Classifications of reactions; variables affecting reaction rates, homogeneous reactions (elementary a-: non-elementary reactions, molecularly and reaction order, rate constant, temperature dependency theories, activation energy; Graphical treatment of complete kinetics; Constant-volume batch reactor (irreversible reactions of zero 1st, 2nd and nth order, series and parallel reactions, overall order, half-life data, reversible reactions of 1st and 2nd order). Homogeneous and auto catalytic reactions, absorption (preparation and properties of absorbents, physical and chemical absorption, equilibrium isotherms)

Classification and type of reactors (batch, mixed, plug flow as examples of ideal reactors); Design equations and calculations for single and multiple reaction and reactors systems; Temperature and Pressure effects; adiabatic operation, non- adiabatic operation, stability and reactors, residence time distribution models for non-ideal flow in reactors, dispersion and tanks in series models, heterogeneous system, solid catalyzed reactors, rate-controlling step, rate expression from postulate mechanisms for solid-catalyzed reactions, effectiveness factor.

General definition of catalysts, catalyst formulation and preparation, rate equation for heterogeneous reactions, fluid partial reaction, un-reacted model for spherical particles (shrinking core model), rate of reaction for shrinking particles, determination of rate controlling step, solid catalyzed reactions; experimental method for finding rates, fluidized bed reactions.

Deviations from ideal reactor performance; Residence time distribution and conversion dispersion models; Tanks-in-series model; Design calculations. Introduction to design for heterogeneous catalytic reactions; Fluid-solid non catalytic reactions and reactors design; Choice of reactor.

IMSU-CME 405: Plant Design and Economics

(2 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Apply fundamental chemical engineering principles to the preliminary and detailed design of chemical process plants.
2. Develop process flow diagrams (PFDs) and piping and instrumentation diagrams (P&IDs) for chemical processes.
3. Perform equipment sizing and specification for major chemical process units, including reactors, heat exchangers, and separation units
4. Conduct detailed economic evaluations of chemical process plants, including capital and operating cost estimation, profitability analysis, and sensitivity analysis.

5. Analyze plant safety, environmental, and regulatory considerations in the design of chemical processes
6. Integrate process simulation tools (e.g., Aspen Plus, HYSYS) for design, analysis, and optimization of chemical processes.
7. Demonstrate an understanding of the iterative nature of plant design, including the trade-offs between technical feasibility, safety, economic performance, and environmental impact.

Course Contents

(Pre-requisite- Good Academic Standing)

Presentation and discussion of real process design problems; sources of design data; process and engineering flow diagram; process outline charts incorporating method study and critical examination; mechanical design of process vessels and piping. Environmental considerations site considerations; process services. Costing of design Process. Formulation of feasibility report evaluation. Economics and safety consideration must be stresses. Computer aided Design; application of software packages in design.

TCH 406: Process Modelling and Simulation

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Generate and solve mathematical models involving chemical process systems such as transfer processes, separation processes, chemical reactions and thermodynamics;
2. Use appropriate software to simulate various aspects of process systems including but not limited to flow sheets, vessels, piping, instrumentations, etc.;
3. Use appropriate software to simulate material and energy balances for process plants; and
4. Use appropriate software to simulate and solve process models.

Course Contents

(Pre-requisite- Good Academic Standing)

Use of computational tools to solve models and implicit equations covering transfer, separation, chemical reactions and thermodynamic systems involving steady and unsteady state. Process simulation using the HYSYS software or any other process simulation software, including ASPEN, MATLAB, Geogebra, Winplot, ESES.

IMSU-CME 413: Chemical Engineering Laboratory III

(1 Unit C: PH 45)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Demonstrate the start-up and shutdown of the experimental rig in each of the experiments;
2. List at least two (2) safety and environmental hazards present in the laboratory and specific steps to deal with the risks responsibly;
3. Identify at least one (1) theory from the literature to explain the scheduled experiment and support the measured data;
4. Collect data from the process of the scheduled experiment;

5. Evaluate the parameter(s) representing the objective(s) of the scheduled experiment from the measured data;
6. Evaluate the accuracy of the determined parameter based on the prescribed theory from the literature;
7. Write a technical report on the scheduled experiment.

Course Contents

(Pre-requisite- IMSU-CME 316, IMSU-CME 403)

Selected experiments in Heat Transfer. Thermodynamics. Chemical Reaction Engineering. Biochemical Engineering. Process Dynamics and control.

Further laboratory experiments in Transport Phenomena, Separation Processes, Thermodynamics, Reactor Systems and Control Systems.

IMSU-CME 425: Separation Processes II

(1 Unit C: LH 30 PH 45)

Course Learning Outcomes (CLOs)

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

1. Explain the principles and operational characteristics of advanced separation techniques such as adsorption, ion exchange, crystallization, and membrane separations.
2. Analyze multicomponent distillation systems and extractive/azeotropic distillation processes.
3. Design adsorption and ion-exchange systems for purification and recovery applications.
4. Evaluate membrane separation processes (e.g., reverse osmosis, ultrafiltration) based on transport mechanisms and performance parameters.
5. Apply thermodynamic and mass transfer principles to model and simulate crystallization and drying operations.
6. Select appropriate separation techniques based on feed composition, product purity requirements, and energy considerations.;
7. Use computational tools (e.g., Aspen Plus, MATLAB) to simulate and optimize complex separation processes.

Course Contents

(Pre-requisite- IMSU-CME 313)

Drying mechanism. Rate of drying and estimation of drying periods. Industrial dryer design. Solvent extraction. Introduction to gas absorption. Evaporation. Evaporation equipment and operation methods. Multiple effect evaporation. Evaporator performance and efficiency. General problems of multicomponent systems. Approximate method for multicomponent multistage operation. Fenske Underwood and Gilliland's method for multistage, multicomponent separation. Kremser Method. Multicomponent gas absorption. Distillation of multicomponent mixtures. Introduction to membrane separation technology. Types of membrane separation processes. Gas permeation, pervaporation and various models for gas separation membrane process. Design of selected multicomponent separation equipment.

Solvent extraction; Extractive and azeotropic distillation; Mui: -component gas absorption. Distillation of multi-components mixtures Novel separation processes. Patterns of change and computational approaches. Energy requirements of separation processes. Optima design and operation of separation processes.

IMSU-CME 431: Fluid Particulate System and Technology (2 Units C: LH 30 PH 15)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Explain the fundamental principles governing the behavior of particulate systems in fluid media, including fluid-particle interactions.
2. Analyze flow behavior in packed beds, fluidized beds, and pneumatic conveying systems.
3. Apply dimensional analysis and empirical correlations to calculate pressure drops, terminal velocities, and drag forces in multiphase systems.
4. Design equipment for solid-liquid and gas-solid separation processes such as filtration, sedimentation, and cyclones.
5. Evaluate fluidization regimes and operating conditions for fluidized bed reactors and related technologies.
6. Use appropriate models and software tools to simulate and optimize particulate handling and separation processes.
7. Demonstrate understanding of industrial applications, scale-up challenges, and safety considerations in fluid-particulate systems.
8. Describe two (2) methods used to synthesize and characterize nanomaterials.

Course Contents

(Pre-requisite- Good Academic Standing)

Particle properties. blending, mixing and classification. Particles in industrial processing; Particle size reduction techniques; Stoke's and Newton's Laws. Motion of particles in a fluid, terminal falling velocities, motion of bubbles and drops. Flow through packed beds. Carman-Kozeny equation and applications. Characteristics of packed columns. Estimation of fluidization point and bed expansion. Regions of fluidisation pressure drop. Heat and mass transfer in fluidized beds. Sedimentation. Flocculation. Filtration. Screening. Classification. Grinding. Centrifugation. Precipitation. Definition of Nano-particles. Principles of developing nanoparticles.

Modern methods of particle size measurement (microscopic, Coulter-counter, X-rays etc.). Solids transport; Introduction to powder technology.

TCH 501: Plant Design II

(4 Units C: LH 15; PH 135)

Course Learning Outcomes (CLOs)

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

1. Analyse existing process and carry-out process retrofitting;
2. Perform flowsheet of the operating principles of reacting, pumping & piping, plant control, and utilities systems and execute the design of the systems;
3. Analyse product/process design options and produce flow diagrams to obtain most suitable option;
4. Perform process design of some units;
5. Plan, produce and implement process calculations using software;
6. Prepare and present findings of engineering design tasks;
7. Perform process economics and determine process profitability, carry-out safety and environmental studies; and
8. Present final design orally and in writing.

Course Contents

(Pre-requisite- IMSU-CME 405)

A design problem involving the study of a process. It should consist of preparation of flow sheet and heat and mass balances of the process and a detailed design of plant or unit operation equipment used in the process. Due consideration must be given to economics and safety. Each student is expected to submit and orally defend a bound copy of technological/engineering design project. A design project should consist of introduction, literature review, process design, detailed design of some of the units of the process, specification of the equipment required, specification of materials of construction, basic mechanical design and drawings, inclusion of process control, modern drawings of the process equipment including a good flow chart, economic and environmental considerations.

IMSU-CME: 501 Process Optimization

(2 Units C: LH 45 PH 15)

Course Learning Outcomes (CLOs)

On completion of the course, students should be able to

1. Understand the Fundamentals of Process Optimization
2. Apply Mathematical Techniques to Optimization Problems
3. Formulate Optimization Models for Industrial Processes
4. Apply Optimization Techniques to Chemical and Mechanical Processes
5. Understand and Apply Dynamic Optimization Methods
6. Model and Optimize Process Control Systems

the importance of process optimization

Course Contents

(Pre-requisite- TCH 308)

Chemical Engineering applications of the calculus of variations, maximum principle, dynamic programming, optimization of stage systems. Single and constrained optimization techniques. Discrete events.

IMSU-CME 507: Process Control, Dynamics and Instrumentation (2 Units C: LH 45)

Course Learning Outcomes (CLOs)

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

1. Explain the importance of process control in chemical engineering industry and classify chemical process variables;
2. Explain the basic concepts of process dynamics, control system components, and instrumentation used in industrial processes.
3. Develop mathematical models for dynamic systems using transfer functions and differential equations.
4. Analyze the transient and steady-state behavior of first- and second-order processes.
5. Design feedback and feedforward control systems including P, PI, and PID controllers.
6. Evaluate system stability and performance using techniques such as root locus, Bode plots, and Nyquist criteria.
7. Select and configure appropriate sensors, transducers, and actuators for process measurement and control.
8. Simulate dynamic systems and control strategies using software tools such as MATLAB/Simulink or equivalent

9. Demonstrate understanding of safety, calibration, and maintenance in instrumentation systems.
- 10 Understand the Fundamentals of Process Dynamics and Model Dynamic Behavior of Process Systems
11. Analyze the Stability of Process Systems
12. Design Feedback Control Systems for Process Control
13. Analyze and Control Multivariable Systems
14. Implement Process Control Using Distributed Control Systems (DCS) and PLCs
15. Apply Process Control to Different Industrial Applications

Course Contents

(Pre-requisite- Good Academic Standing)

Process Dynamics - Time domain Dynamics; Transfer functions (frequency and Laplace domain dynamics); Frequency response analysis. Discrete events. Control: controller types and modes of operation (on / off, proportional, proportional / integral proportional / derivation, proportional / integral / derivation, cascade Control); Feedforward and feedback control; introduction to multi-variable control. Block and signal flow diagram. Analytic and graphical stability criteria; Analog computation; Control valves (type characteristics, positioners); Transmitter and transducers; Controllers timing, Overall process control (control schemes and modes of main variable and unit operations; Overall plant process control schemes.

Measuring instruments for level, pressure, flow, temperature and physical properties. Chemical composition analysers. Measurement. Gas chromatograph. Mass Spectrometer. Sampling systems. Description and use of current instrumentation such as atomic spectroscopy, infra-Red spectroscopy, High Performance Liquid Chromatography, Scanning Electron Microscope (SEM)

IMSU-CME: 511 Environmental Engineering

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

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

1. Understand the Fundamental Principles of Environmental Engineering
2. Analyze and Design Water and Wastewater Treatment Systems
3. Understand the Processes Involved in Air Pollution Control
4. Evaluate and Design Solid and Hazardous Waste Management Systems
5. Assess Environmental Impacts and Sustainability
6. Implement Water Quality and Environmental Monitoring Systems
7. Understand and Apply Environmental Laws and Regulations
8. Develop Solutions for Renewable Energy and Climate Change Mitigation

Course Contents

(Pre-requisite- Good Academic Standing)

Pollution and the environment, definition and interrelationship; natural and man-made pollution; the economics of pollution production, emission and transfer of contaminants, models of air pollution control concepts. Theory and design of control devices. Integration of pollution control in chemical engineering processes. Current research and development in air pollution control.

Sources of water. Introduction to water pollution. Types of water pollution. Sources of water pollution. Analysis of dispersed pollutants in water. Effects of water pollutants on the environment.

Streams. Water treatment processes for domestic uses. Water treatment for industrial uses. Introduction to air pollution. Types of air pollution. types of pollution by industrial effluents, legislation and standards for effluent discharge; Theory, principles and practices related to engineering control of particulate and gaseous emissions from natural, industrial, agricultural, commercial and municipal. Sources of atmospheric pollution. Effect of atmospheric pollution on the various forms of life. Atmospheric pollutant dispersal modelling. Solid waste collection. Solid waste management. Disposal of solid waste by incineration and dumping; future trends including conversion of solid wastes into useful material energy. Refuse processing, recovery and conversion to useful products. Functions of environmental regulatory bodies. Design of facilities for physical and chemical treatment of waste water. Ecology of biochemical reactors, design of facilities of the biological of wastewater. Land pollution; Noise pollution, thermal and nuclear pollutions.

IMSU-CME 512: Soap, Detergent and Food Processing Technologies ((1 Units C: LH 30 PH 15)

Course Learning Outcomes (CLOs)

When this course is completed, the student should be able to:

1. Understand the Basic Principles of Soap and Detergent Technology
2. Learn the Soap and Detergent Manufacturing Processes
3. Analyze the Physicochemical Properties of Soaps and Detergents
4. Understand Environmental and Safety Aspects of Soap and Detergent Production
5. Develop a Strong Understanding of Food Processing Technologies
6. Apply Food Chemistry in Food Processing
7. Learn the Principles of Food Packaging and Shelf Life
8. Understand Quality Control and Assurance in Soap, Detergent, and Food Industries
9. Apply Process Optimization in Soap, Detergent, and Food Manufacturing

Course Content

(Pre-requisite- Good Academic Standing)

Definitions; Historical outline; types of soaps and detergents; their domestic and industrial applications; Mechanism of detergency; modern formulations; Oils and fats; Manufacture of soap by direct signification; Manufacture of fatty acids; Production of solid detergent powders; Manufacture of non-soap detergents; Equipment used in industrial production of soap and detergents; Quality control in soap and detergent production.

Basic methods of food production and preservation; Physical, chemical, biological and thermodynamic properties of food materials; Transport phenomena in food processing; production process for selected foods; Introduction to food package and transportation. Prerequisite Good Academic Standing.

IMSU-CME 513: Petrochemical Processes

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

When this course is completed, the students should be able to:

1. Understand the Fundamental Principles of Petrochemical Processes
2. Understand the Major Petrochemical Production Processes
3. Describe the Production of Key Petrochemicals
4. Analyze Petrochemical Reaction Engineering and Catalysis

5. Design and Optimize Petrochemical Processes
6. Understand the Role of Separation Technologies in Petrochemical Processing
7. Understand the Role of Petrochemicals in Global and Industrial Supply Chains

Course Content

(Pre-requisite- Good Academic Standing)

Petroleum production, natural gas, petroleum refining operation, petrochemical feedstocks, cracking techniques thermal, catalytic, hydro cracking, platinum forming, hydroforming steam forming, dehydrogenation of cyclohexane, dehydrocyclisation of paraffin, isomerisation of butane, cycloparaffins, alkylation of benzene to various products synthesis gas production, methanol, ammonia and formaldehyde manufacture.

IMSU-CME 514: Process Synthesis and Simulation

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

At the end of the course, the students are expected to:

1. Explain the principles of process synthesis, flowsheet development, and process integration.
2. Develop process flow diagrams (PFDs) and block flow diagrams (BFDs) for chemical production systems.
3. Simulate steady-state chemical processes using process simulation software (e.g., Aspen Plus, HYSYS, or equivalent).
4. Analyze the performance of chemical process units (reactors, separators, heat exchangers, etc.) using simulation tools.
5. Optimize process designs for energy efficiency, raw material usage, and economic performance.
6. Integrate heat and mass exchange networks in process designs for improved sustainability.
7. Evaluate process alternatives based on techno-economic and environmental criteria.
8. Demonstrate effective use of simulation tools in solving real-world process design problems, including documentation and reporting.

Course Outlines

(Pre-requisite- TCH 407)

The creation and assessment of alternatives; the synthesis of plausible alternatives, the structure of systems, process specifications, process charts, block diagrams, process flow diagrams. Diagram types, flowsheet from process models. Staged systems with recycles, general serial flowsheet, non-serial flowsheet with recycles. Degree of freedom analysis, sequential modular and equation based simulations; commercial flowsheet packages, convergence and acceleration. Simulation of unsteady state processes. Distillation, chemical reactors.

IMSU-CME 516: Energy Conversion Engineering

(3 Units C: LH 45)

Course Learning Outcomes (CLOs)

At the end of the course, the students are expected to:

1. Understand the Fundamentals of Energy Conversion

2. Analyze Thermodynamic Cycles and Processes
3. Understand and Apply Renewable Energy Technologies
4. Analyze Electrical Power Generation and Conversion Systems.
5. Evaluate Energy Storage Systems and Technologies
6. Understand and Design Fuel Cells and Hydrogen Systems
7. Understand Waste Heat Recovery and Utilization
8. Integrate Energy Conversion Systems with Smart Grids

Course Outlines

(Pre-requisite- GET 306)

Fuel and energy sources, types, availability and characterization of fuel (petroleum, including natural gas, coal tar sands). Modern processing technologies. Energy conversion – combustion and incineration, air requirement. Coal composition, properties, ranking classification, treatment, carbonization, classification hydrogenation, petroleum-origin, production and processing, types of crude oil cracking and refining etc.

Energy transport storage and management, environmental problems and abatement; solar energy calculation, flame temperature calculation, furnace and in calculation, nuclear and atomic energy calculation.

Combustion technology and aerodynamics, energy statistics. Radioactive waste and packed radioactive waste, nuclear critical decontamination, neutron activation, collector, optical and selective surfaces, direct conversion to electricity.

IMSU-CME 518: Petroleum Production Engineering

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand the Fundamentals of Petroleum Production Engineering
2. Analyze Reservoir Properties and Fluid Behavior
3. Design and Optimize Well Completion Systems
4. Evaluate Well Performance and Production Data
5. Design and Optimize Artificial Lift Systems
6. Understand and Apply Reservoir Simulation Techniques
7. Implement Enhanced Oil Recovery (EOR) Methods
8. Understand Well Stimulation and Workover Techniques
9. Implement Enhanced Oil Recovery (EOR) Methods
10. Apply Techniques for Reservoir Management and Optimization
11. Understand Health, Safety, and Environmental Aspects in Production Engineering
12. Implement Technology and Innovations in Petroleum Production

Course Contents

(Pre-requisite- Good Academic Standing)

Subsurface operations: Operational functions and output of subsurface production engineer. Nodal analysis in flow and outflow performances: Governing equations. Inflow performance relationship (IPR). Productivity index. Formation damage. Fines migration and skin effect. Vertical lift wellhead equipment performance and pressure losses. Choke performance. Problems in wells analysis: Sand. Water. Hydrate. Scale. Unstable flow. Surge. Waxy crude production. Surface operation: Gas treatment: Acid gas sweetening. Dehydration. Glycol dehydration. Oil treating: Dehydration.

Water/oil emulsion resolution. Emulsion and demulsification. Metering of oil and gas: Meter proving. Storage facilities. Strainers. Deaerator. Lease Automatic Custody Transfer (LACT). Multi-stage-separation: Separator classification. Separator sizing. Flash calculation. Produced water management. Oil treating considerations. Water treating considerations.

IMSU-CME 522: Polymer Science and Technology

(2 Units C: LH 30)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand the Fundamentals of Polymer Science
2. Classify Polymers Based on Their Structure and Properties
3. Understand Polymerization Techniques and Kinetics
4. Characterize Polymers Using Analytical Techniques
5. Analyze the Thermal and Mechanical Behavior of Polymers
6. Understand Polymer Processing Techniques
7. Understand the Role of Additives and Fillers in Polymer Materials
8. Understand the Applications of Polymers in Various Industries

Course Outlines

(Pre-requisite- Good Academic Standing)

Basic structures of Polymer. Physical stages and Transitions; Polymerization processes; Molecular weight of polymers. Viscous flow; Mechanical properties at small Deformations; Ultimate properties: Failure, Tests, Creeps Failure, fatigue, fabrication processes; Carbon chain polymers; Heterochain polymers, Analysis and identification of polymers.

IMSU-CME 524: Transfer Processes II

(1 Units C: LH 30 PH 15)

Course Learning Outcomes (CLOs)

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

1. Describe the application of Navier-Stocks equation in chemical engineering
2. Explain turbulent flow in pipes and channels
3. Understand convective mass transfer
4. Explain the mechanism of radiative heat transfer coefficient
5. Understand how heat exchange equipment can be designed
6. Describe technique to achieve simultaneous heat and mass transfer

Course Outlines

(Pre-requisite- TCH 301)

Boundary-layer theory, Navier-Stocks equation and applications in Chemical Engineering problems; Turbulent flow in pipes and channels; one-dimensional compression flow; Energy equation; Free and forced convective heat transfer (over a flat plate, in a tube); Convective mass transfer; introduction to multiphase phenomena (bubble dynamics, cavitation, fundamentals of two phase flow).

Mechanism of radiative heat transfer coefficients and application to the design of heat exchange equipment. Connective mass transfer (analogy with heat transfer). Mass transfer with chemical reaction; Simultaneous heat and mass-transfer.

Course Learning Outcomes (CLOs)

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

1. Understand the components of seminar / research background,
2. Generate problem statements
3. Understand and generate objectives
4. State research/seminar significance
5. How to review literatures and obtain research gaps
6. Prepare slides for presentations and state research methods

Course Contents

(Pre-requisite- Good Academic Standing)

Presentation and discussion of backgrounds, problem statements, aim and objectives, significance, literature review of current topics in chemical engineering and technique(s) to solve research problems in chemical engineering. This can be assigned to the 'students and it could be different from the students' research topic or the students' research topic.

TCH 555: Chemical Engineering Research Project I**(2 Units C: PH 180)****Course Learning Outcomes (CLOs)**

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

1. identify the problem or hypothesis to research or tests;
2. identify resources and constraints;
3. identify the best option (Research method, process);
4. carry out research;
5. present data and conclusions according to the nature of research; 6. evaluate techniques and outcomes and suggest improvements; and 7. present the final report (orally and in writing).

Course Contents

(Pre-requisite- Good Academic Standing)

Individual research projects under the supervision of an academic staff. Projects should focus on national and state industrial problems.

TCH 555: Chemical Engineering Research Project II**(2 Units C: PH 180)****Course Learning Outcomes (CLOs)**

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

1. identify the problem or hypothesis to research or tests;
2. identify resources and constraints;
3. identify the best option (Research method, process);
4. carry out research;
5. present data and conclusions according to the nature of research; 6. evaluate techniques and outcomes and suggest improvements; and 7. present the final report (orally and in writing).

Course Contents

Individual research projects under the supervision of an academic staff. Projects should focus on national and state industrial problems.

11.5 BMAS Course Listing

YEAR THREE

FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS			
			L	T	P	TOTAL
1	CME 301	Engineering Analysis I	2	1	-	2
2	CME 305	Process Control	2	1	-	3
3	CME 321	Organic Chemistry	2	-	-	2
4	CME 323	Chemical Process Calculation	2	1	-	3

5	CME 325	Separation Processes I	2	1	-	3
6	CME 329	Chemical Engineering Instrumentation and Measurement	2	1	-	2
7	CME 357	Transport Phenomena I	2	1	-	3
8	CME 391	Chemical Engineering Lab I	1	-	2	2
9	GEN 381	Statistics for Engineers I	2	1	-	2
Semester Total						22

YEAR THREE

SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS			
			L	T	P	TOTAL
1	CME 302	Engineering Analysis II	2	1	-	2
2	CME 312	Chemical Reaction Engineering I	2	1	-	3
3	CME 326	Analytical Chemistry	2	-	-	2
4	CME 328	Separation Processes II	2	1	-	3
5	CME 354	Transport Phenomena II	2	1	-	3
6	CME 364	Chemical Engineering Thermodynamics II	2	1	-	3
7	CME 392	Chemical Engineering Lab II	1	-	2	2
8	GEN 382	Statistics for Engineers II	2	1	-	2
Semester Total						20
Sessional Total						42

YEAR FOUR

FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS			
			L	T	P	TOTAL
1	CME 411	Chemical Process Plant Design and Economics	2	1	-	3
2	CME 417	Chemical Reaction Engineering II	2	1	-	3
3	CME 429	Chemical Process Synthesis & Simulation	2	-	-	2

4	CME 451	Fluid Particulate System and Technology	2	-	-	2
5	CME 455	Transport Phenomena III	2	1	-	3
6	CME 473	Mass Transfer Operations	2	-	-	2
7	CME 495	Chemical Engineering Lab III	1	-	2	2
8	GEN 481	Computer Aided Design & Manuf	2	-	1	2
9	GEN 491	Technical Report Writing and Presentation	2	-	-	1
10	GEN 493	Engineering Research Methods	2	-	-	2
Semester Total						22

YEAR FOUR

SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	L	T	P	TOTAL
1	GEN 490	SIWES	-	-	15	15
		SESSIONAL TOTAL				37

YEAR FIVE

FIRST SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS			
			L	T	P	TOTAL
1	CME 509	Biochemical Engineering	2	1	-	2
2	CME 511	Environmental Engineering	2	1	-	2
3	CME 513	Chemical Process Plant Design II	2	1	-	3
4	CME 521	Process Optimization	2	1	-	3
5	CME 523	Petrochemical Processes	2	-	-	2
6	CME 527	Process Dynamics and Control	2	-	-	2
7	CME 591	Chemical Engineering Seminar	2	-	-	2
8	CME xxx	Elective	2	-	-	2
9	CME 597	Final Year Project I	1	-	3	3
10	GEN 591	Engineering Management and Law	2	-	-	2
Semester Total						23

YEAR FIVE

SECOND SEMESTER

S/N	COURSE CODE	COURSE TITLE	UNITS			
			L	T	P	TOTAL
1	CME 510	Mathematical Techniques and Analysis in Chemical Engineering	2	1	-	2
2	CME 512	Energy Conversion Engineering	2	1	-	3
3	CME 520	Separation Processes III	2	-	1	3
4	CME 522	Polymer Science and Technology	2	-	-	2
5	CME 524	Chemical Process Technology and Quality Systems Engineering	2	-	-	2
6	CME 526	Soap, Detergent and Food Processing Technologies	2	-	-	2
7	CME 528	Petroleum Production Engineering	2	1	-	3
8	CME xxx	Elective	2	-	-	2
9	CME 598	Final Year B.Eng. Project II	-	-	3	3
10	GEN 592	Professional Practice	2	-	-	2
Semester Total						24
Sessional Total						47

ELECTIVES

S/N	COURSE CODE	COURSE TITLE	UNITS			
			L	T	P	TOTAL
1	CME 530	Gas Engineering	2	-	-	2
2	CME 531	Bioreactor Design	2	-	-	2
3	CME 532	Electrochemical Engineering	2	-	-	2
4	CME 533	Refining Technology	2	-	-	2
5	CME 534	Battery Technology	2	-	-	2
6	CME 535	Corrosion Engineering	2	-	-	2
7	CME 536	Fermentation Technology	2	-	-	2
8	CME 537	Introduction to Cement Technology	2	-	-	2
9	CME 538	Fossil Fuel Processing Technology	2	-	-	2
10	CME 539	Plastic Technology	2	-	-	2

11.6 BMAS COURSE DESCRIPTION

11.6.1 General Engineering Coded Courses

GEN 381: Statistics for Engineers I (2 Credits)

Frequency distributions. Measures of location and dispersion in simple and group data. Elements of probability and probability distributions: normal, binomial, poisson, geometric, negative binomial distributions.

GEN 382: Statistics for Engineers II (2 Credits)

Estimation and tests for hypothesis concerning the distributions. Regression, correlation and analysis of variance. Contingency tables. Non-parametric interference.

GEN 490: SIWES (15 Units)

A supervised student industrial work experience scheme. The course is designed to give students ample exposure to realities of engineering industry: the practical exposure of the student through direct participation in the work of an industry, to real life working conditions. During the training, the student becomes familiar with engineering organization, physical layout and the flow of information materials and operation. This exposure is expected to compliment and integrate the student's classroom instruction and laboratory workshop exercises.

GEN 481: Computer Aided Design and Manufacturing (2 Credits)

Review of computer hardware and software, methods of system analysis and applications. Use of computer to aid design and manufacturing and to link design and manufacturing functions. Introduction to geometric modeling, properties and representation of solids, algorithms and software, interactive computer graphics. Application of computers to planning and organization and control of manufacturing of discrete parts. NC and CNC programming languages and software aspects. Computer integrated manufacturing (CIM) and flexible manufacturing system. Industrial Robots. Software development and use of personal computer in designs. Application software used in Engineering to achieve designs such as Auto Cad, Civil soft, Proteus, Spice, Corel Draw etc. Windows operating systems. Programming in C, C++, Pascal languages.

GEN 491: Technical Report Writing and Presentation (1 Credit)

Introduction to principles of effective communication with attention to the importance of emphasis, emotive content and style. Principles of technical writing and organization: data gathering and presentation, technical correspondence. Letters of inquiry and replies, letters of application and memoranda. Illustrating technical writing using tables, graphs, diagrams, equations and appendices.

Report writing: progress reports, proposals, student projects, thesis and dissertations. Oral and visual presentation of technical ideas, technical aids in presentation computer - aided technical report writing and presentation; word processing and word processing software packages. A student is to write a technical report on a topic chosen from a specialized area of interest in (CHEMICAL ENGINEERING) under the guidance of an assigned supervisor.

GEN 493 Engineering Research Methods (2 UNITS)

The course aims at giving the student an opportunity to develop relevant research techniques and writing skills. It incorporates the use of elementary statistical tools in the analysis of problems principles of technical report writing.

GEN 591: Engineering Management and Law (2 Credits)

LAW: Definition and specification, application of business law to engineering. Patents and inventions; trademarks and copyrights

ENGINEERING BUSINESS: Types, the responsibilities, professional liability, and role of engineer in lawsuits. General principles of contracts; law of contract - forms of contract, criteria for selecting contractors offer and acceptance of contracts, terms of contracts; supplier duties-damage and other remedies, termination/cancellation of contracts, liquidation and penalties., exemption clauses., safety and risk. Health and safety, duties of employers towards their employees, duties imposed on employees.

Fire precaution act, Design for safety.

MANAGEMENT: General principles of management and appraisal techniques. Break through and control management theory, personal management, labour and public relations, wages and salary administration, training and man-power development.

The manager and policy development / formulation, objective setting planning, organizing and controlling, motivation and appraisal of results.

Organizational structure, goals and functions. Cost engineering:

Capital and Operating cost estimating, contingencies and allowances.

GEN 592: PROFESSIONAL PRACTICE (1 Credit)

Principles of good practices of professional Engineers in relation to other sister professionals and the interest of Clients and the Public. The Rules of professional Practice; the Registration Bodies and their regulations; Joint Consultative Council; SIWES Programmes; Partnerships and Consortia design and manufacture; Role of Professional Engineers, Tendering and Bidding strategies; Consultancy practice and their regulations; etc code of ethics.

11.6.2 Departmental Coded Courses**CME 301: Engineering Analysis I (2 Credits)****Course Learning Outcomes (CLOs)**

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

Review of Ordinary Differential Equations: Bessel. Lagrange, Partial differential equations: Engineering applications, Laplace transformations and other transform methods. Series solutions and special functions: such as: Gamma functions, Beta, Gauss functions. Basic equation and Fourier series. Complex derivatives and analytic functions, Cauchy's integral theory and residue theorem.

CME 302 Engineering Analysis II (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Apply numerical method techniques to solve problems arising from heat and mass transfer, chemical reactions, thermodynamics, fluid mechanics and molecular simulations;
2. Apply numerical method techniques to solve different categories of mathematical equations;
3. Apply numerical methods such as navier-stokes, runge kutta, newton-raphson, taylor's series etc to solve ODES and PDES; and
4. Perform numerical integrations and differentiation.

Course Contents

Numerical methods and digital computer methods applied to various engineering problems including matrix inversion, approximation of functions, integration, and differentiation, ordinary and partial optimization. Applications in engineering. Runge Kutta and other methods in the solutions of ODE and PDEs. Numerical integration and differentiation. Fast Fourier analysis. Introduction to optimization e.g. transportation problems, Dynamic programming, Design and stimulation of simple engineering components and applications. Monte Carlo simulation. Wave and diffusion equation. Initial and boundary value problems, separation of variables. Introduction to interpolation and curve fittings. Regression analysis and Correlation.

CME 305: Process Control (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Explain the importance of process control in chemical engineering industry and classify chemical process variables;
2. Solve first order and second order ODE's analytically and using Laplace transform;
3. Determine the transfer function of chemical processes; and
4. Determine the stability of chemical processes from their transfer function.
- 11 Explain the principles of various flow, temperature, pressure and liquid level measurements;
6. Explain the principles of some analytical instruments use in physical and chemical characterisation of materials;
7. Identify appropriate instruments applicable for particular characterisation; and
8. Interpret and analyse data obtained from analytical instruments.

Course Contents

Introduction to Process dynamics. Dynamic analysis models, first and second order system response. Transfer functions. Frequency response analysis. Discrete events. Control

system design. Cascade control. Feed forward and feedback control. Introduction to multi-variable control. The control valves.

CME 312: Chemical Reactions Engineering I (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Calculate conversion in batch and flow systems;
2. Size single batch, continuous-stirred tank, and plug flow reactors;
3. Size real reactors in different flow regimes, packed bed reactors catalytic reactors and unsteady state reactors;
4. Identify and determine the parameters in kinetic rate expressions for homogeneous reactions;
5. Maximise product selectivity for systems involving multiple reactions; 6. use residence time distributions to find conversions for non-ideal mixing; and
7. Use computer software packages to assist in sizing reactors.

Course Contents

Review of kinetics of homogenous reactions, variable and constant volume systems; Classifications of reactions; variables affecting reaction rates, homogeneous reactions (elementary a-: non-elementary reactions, molecularly and reaction order, rate constant, temperature dependency theories, activation energy; Graphical treatment of complete kinetics; Constant-volume batch reactor (irreversible reactions of zero 1st, 2nd and nth order, series and parallel reactions, overall order and half-life data, reversible reactions of 1st and 2nd order). Homogeneous and auto catalytic reactions, absorption (preparation and properties of absorbents, physical and chemical absorption, equilibrium isotherms) Classification and type of reactors (batch, mixed, plug flow as examples of ideal reactors); Design equations and calculations for single and multiple reaction and reactors systems; Temperature and pressure effects. Deviations from ideal reactor performance; Residence time distribution and conversion dispersion models; Tanks-in-series model; Design calculations. Introduction to design for heterogeneous catalytic reactions; Fluid-solid non catalytic reactions and reactors design; Choice of reactor.

CME 321: Organic Chemistry (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Name and classify organic compounds
2. Identify the functional group in an organic compound
3. Predict the mechanism of organic reactions
4. Identify spectroscopic equipments and instruments
5. Use Spectroscopic and non-spectroscopic methods in the analysis of solutions

Course Contents

Organic reaction mechanisms. Fundamental concepts and investigation of reaction mechanisms. Aromatic substitution reactions. Aromatic compounds: Modern theory of the structure of benzene, Huckel rule, other aromatic compounds or species. Nomenclature of benzene derivatives. Electrophilic substitution reactions at a saturated carbon atom. Electrophilic aromatic substitution. General mechanism; halogenations, nitration, Sulphonation, Friedel Craft's. Effect of substitution

on reactivity and orientation. Nucleophilic aromatic substitution. Reactions of side chains in alkylbenzenes. Electrophilic substitutions at saturated carbon atoms: S_E1 and S_E2 . mechanisms. Polyfunctional compounds: the chemical properties of dicarboxylic acids, dike tones, hydroxyacids, hydroxyl aldehydes and ketones, keto acids and derivatives of carbonic acid. Pericyclic reactions: electrolytic, cycloaddition and sigma tropic reactions. Molecular rearrangement; conformational analysis. Reactive intermediates, polynuclear aromatic hydrocarbons.

CME 323: Chemical Process Calculation (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Demonstrate a solid understanding of the basic principles of chemical engineering, including thermodynamics, mass transfer, and fluid dynamics, and how they relate to chemical process calculations.
2. Be able to perform mass and energy balances for different chemical processes (open and closed systems), including batch, continuous, and semi-batch operations.
3. Develop and analyze process flow diagrams (PFDs) and block flow diagrams (BFDs), and perform calculations involving unit operations such as heat exchangers, distillation columns, reactors and mixers.
4. Apply thermodynamic principles to calculate enthalpy, entropy, Gibbs free energy, and other thermodynamic properties in chemical processes.
5. Be capable of applying mass and energy balances to reactors (batch, continuous, and semi-batch reactors).
6. Be able to apply both ideal and non-ideal models to real-life chemical systems, including calculations involving real gases, non-ideal solutions, and phase changes.
7. Apply process calculations to optimize operations such as minimizing energy consumption, maximizing yield, or maximizing efficiency of chemical reactions or separations.
8. Demonstrate the ability to handle unit conversions effectively and apply dimensional analysis to ensure the correctness and consistency of calculations.

Course Contents

Introduction to Engineering calculations; processes and process variables. Processes and process descriptions, process data representation and analysis. Industrial stiochemistry (limiting conversion). Material and energy balances on batch, semi-batch and vapours, liquids and solids. Their mixtures; vapour liquid equilibrium (Raoult's law, relative and precent saturation, condensation due point). Steam (enthalpy-temperature chart, steam table, etc). combustion calculations (solid, liquid and gaseous fuels, excess air, waste gas analysis. Applications to the chemical process industries. Sources of date, Dimensional analysis.

CME 325: Separation Processes I (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Identify, analyze and solve engineering problems involving phase separation;
2. Estimate stage requirements for absorption, stripping, and liquid-liquid extraction systems; and
3. Estimate the number of stages, feed plate, product rates, reflux ratios for binary distillation systems using mccabe-thiele, ponchon-savarit methods.

Course Contents

Interface mass transfer. Gas-Liquid operations, Equipment for gas-liquid operations; Humidification operations; Isothermal gas non-stationary heat condition. Molecular diffusion in fluids; inter-phase mass transfer; Diffusion in solids.

CME 326: Analytical Chemistry (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Demonstrate a solid understanding of the fundamental principles and concepts of analytical chemistry, including the importance of accuracy, precision, sensitivity, and selectivity in chemical measurements.
2. Identify and describe various classical and modern analytical techniques
3. Apply instrumental techniques such as spectroscopy, chromatography, and mass spectrometry to analyze chemical samples, and be able to interpret the data.
4. Conduct quantitative chemical analyses using both classical (e.g., titration) and instrumental methods (e.g., spectroscopy, chromatography), ensuring correct application of standards, controls, and calibration curves.
5. Demonstrate proficiency in sample preparation, including techniques such as digestion, extraction, and dilution, ensuring that samples are suitable for accurate analysis.
6. Develop the ability to process, analyze, and interpret analytical data.

Course Contents

Statistical treatment of data. Theory of errors. Volumetric (titrimetric) analysis; Theory of indicators and acid-base titrations. Precipitation titration. Complexometric titrations. Oxidation – Reduction titration. Gravimetric Analysis, Precipitants and Precipitation techniques. Solubility product. Introduction to Separation methods. Introduction to optical methods of analysis, Beer-Lambert's Law. Theories and applications in chemical analysis of IR, UV/Visible, NMR and MS spectroscopic; Colorimetry, flame photometry and atomic absorption, atomic fluorescence, emission spectrography, X-ray fluorescence. Electroanalytical techniques: potentiometry, polarography, amperometry, coulometry and conductometry. Thermometry and differential thermal analysis. Titration in non-aqueous solvent.

CME 328: Separation Processes II (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Describe at least two (2) phases in the drying process and list two modes of drying;
2. State two (2) factors affecting drying rate;
3. State at least two (2) features of chemical and physical adsorption;
4. List five (5) parameters for the design of multiple-effect evaporation systems;
5. Identify the two key components for multicomponent distillation;
6. Calculate the number of equilibrium stages;
7. List at least two (2) methods of solving countercurrent multistage problems;
8. Evaluate the number of equilibrium stages for multicomponent absorption, distillation and extraction operations using the Kremser equation;
9. Construct a model each for distillation and absorption operations in a counter-current cascade equilibrium stages;

10. Identify the two (2) common types of membranes and their significance.

Course Contents

Multistage tray towers. Multi-component systems. Low pressure distillation; Liquid extraction; Drying of solids; Crystallization; Absorption and ion exchange; Reverse osmosis; water-cooling.

CME 329: Chemical Engineering Instrumentation and Measurement (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Demonstrate an understanding of the fundamental principles behind industrial measurement and instrumentation, including sensor principles, signal conditioning, and data acquisition.
2. Identify and explain the measurement of key process variables in chemical engineering, including: Temperature, Pressure, Flow, Level, Composition.
3. Understand and demonstrate the use of process control systems (PCS), including the role of instrumentation in automation, feedback, and feed-forward control.
4. Develop the skills to calibrate and validate instruments, ensuring that they produce accurate and reliable measurements.
5. Identify and quantify sources of error in measurements, and apply appropriate methods to minimize uncertainties in process data.
6. Be able to design measurement systems for monitoring and controlling chemical processes, taking into account the required accuracy, reliability, and safety.

Course Contents

Measuring instruments for level, pressure, flow, temperature and physical properties; Moisture measurement; Chemical composition analyzers and measurements; • Gas chromatography; Mass spectrometer; FUR; Inductively - Coupled Plasma Transform Spectrophotometer; Atomic Absorption and Flame Emission Spectrophotometer; Sampling systems and procedures.

CME 354: Transport Phenomena II (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Describe the application of Navier-Stokes equation in chemical engineering
2. Explain turbulent flow in pipes and channels
3. Understand convective mass transfer
4. Explain the mechanism of radiative heat transfer coefficient
5. Understand how heat exchange equipment can be designed
6. Describe technique to achieve simultaneous heat and mass transfer

Course Contents

Boundary-layer theory, Navier-Stokes equation and applications in Chemical Engineering problems; Turbulent flow in pipes and channels; one-dimensional compression flow; Energy equation; Free and forced convective heat transfer (over a flat plate, in a tube); Convective mass transfer; introduction to multiphase phenomena (bubble dynamics, cavitation, fundamentals of two phase flow).

CME 357: Transport Phenomena I (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Derive the heat diffusion equation and use it to predict temperature profiles across solid bodies transferring heat by conduction;
2. Derive equations of heat transfer by convection and use them to predict the rate of heat loss under steady state natural and forced convection;
3. Derive the equations of heat loss by radiation, and use them to predict the rate of heat loss under steady state conditions;
4. Perform a procedural design of a heat exchanger for defined process requirements;
5. Derive equations of mass transfer by molecular diffusion and use these to predict the flow rates and composition of output streams from a mass transfer operation under steady state conditions;
6. Determine the performance and size of a given heat exchanger using different methods; and
7. Perform pressure drop calculations and procedural design of different heat exchangers according to defined process requirements.

Course Contents

Fundamentals of transport phenomena (fields, flux density, field intensity, rate equation, conservation laws - Newton's Fourier's and Ficks); laminar and turbulent flow of incompressible viscous fluids (isothermal flow over a flat plate, in tubes, non-isothermal flows); Flow non-circular tubes; Non-Newtonian fluids; Heat transport -stationary and absorption; Binary distillation. Hydrodynamics of packed columns.

CME 364: Chemical Engineering Thermodynamics II (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Demonstrate a strong understanding of the **first**, **second**, and **third** laws of thermodynamics.
2. Explain concepts such as energy, enthalpy, entropy, Gibbs free energy, and internal energy.
3. Identify and use appropriate thermodynamic models for ideal and non-ideal gases, liquid-vapor systems, and solutions.
4. Apply the equation of state (like the Van der Waals equation, Redlich-Kwong equation) to solve real-world problems.
5. Analyze and Solve Problems Involving Phase Equilibria
6. Apply Thermodynamics to Chemical Reactions
7. Evaluate Energy and Material Balances in Chemical Processes
8. Solve Problems Related to Chemical Process Efficiency
9. Develop Ability to Use Thermodynamic Tables and Charts

Course Contents

Fundamental concepts of chemical thermodynamics; Second law of thermodynamics and entropy; reversibility and entropy; Thermodynamics diagrams; Heat effects of thermodynamic processes; Definition of thermodynamic potentials of internal energy, enthalpy, Helmholtz free energy and Gibbs free energy; chemical potential, equilibrium and the phase rule; Meaning of fugacity and activity; Fugacity and activity coefficients; Partial molar property and Gibbs-Duhem equation; Ideal, Thermodynamic properties of homogenous mixture; phase

equilibria; chemical reactions equilibria; thermodynamics analysis of processes. Isothermal, isentropic expansion. Thermodynamic cycles. Refrigeration. Steam and gas turbines.

CME 391: Chemical Engineering Laboratory I (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Locate (or identify) relevant literature sources to support/contradict theoretical arguments, and to find data;
2. Demonstrate theoretical principles by means of experiments;
3. Propose theoretical models of experimental data; or
4. Evaluate the accuracy of prescribed theoretical models; and
5. Communicate (or describe) technical information and arguments in a professional manner.

Course Contents

Laboratory experiments in 'transport phenomena, kinetics and separation processes.

CME 392: Chemical Engineering Laboratory II (2 Credits)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Demonstrate the start-up and shutdown of the experimental rig in each of the experiments;
2. List at least two (2) safety and environmental hazards present in the laboratory and specific steps to deal with the risks responsibly;
3. Identify at least one (1) theory from the literature to explain the scheduled experiment and support the measured data;
4. Collect data from the process of the scheduled experiment;
5. Evaluate the parameter(s) representing the objective(s) of the scheduled experiment from the measured data;
6. Evaluate the accuracy of the determined parameter based on the prescribed theory from the literature;
7. Write a technical report on the scheduled experiment.

Course Contents

Further laboratory experiments in Transport Phenomena, Kinetics and Separation Processes.

CME 411: Chemical Process Plant Design and Economics I (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Calculate stream data and present on a process flow-sheet from process descriptions;
2. Explain the general principles of design, the techniques specific to particular products and processes and the characteristics of engineering materials and components;
3. Prepare and present findings of engineering design tasks;
4. Plan and produce process flow sheet for a specified industry or product;
5. Perform mechanical design of process units and piping;
6. Perform basic costing and economic evaluation of process units and systems; and
7. Use CAD software to perform design activities.

Course Contents

Introduction to process design development. General stages of chemical engineering plant project. Design development – types of design; Presentation and discussion of real process design problems; design information gathering, sources of design data; process and engineering flow diagram; mass and energy balance engineering, process outline charts incorporating methods, study and critical examination; mechanical design of process vessels and piping. Flow sheet specification and selection of equipment and materials. Design of heat transfer equipment e.g. heat exchange etc., principles and equations of economics balance. Environmental considerations, site considerations; process services. Costing of design Process; strategies used in designing to optimize production yield and minimized cost. Comparison of different processes. Feasibility study and formulation of feasibility report evaluation. Economics and safety consideration must be stresses. Computer aided Design; application of software packages in design.

Total product costs, gross savings and net profits, interests and investment costs, taxes and insurance. Depreciation and methods for its determination, profitability and investment criteria. Net present worth and discounted cost flow replacement of plants and equipment, patent ability.

CME 417: Chemical Reactions Engineering II (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand homogeneous and auto catalytic reactions
2. Classify and differentiate between types of reactors
3. Develop equations and calculations for single and multiple reaction and reactors systems
4. Understand catalysts with catalyst formulation and preparation
5. Explain rate of reaction for shrinking particles and rate controlling steps
6. Carryout design for heterogeneous catalytic reactions and reactor designs

Course Contents

Temperature and Pressure effects, adiabatic operation, non- adiabatic operation, stability and reactors, residence time distribution models for non-ideal flow in reactors, dispersion and tanks in series models, heterogeneous system, solid catalyzed reactors, rate-controlling step, rate expression from postulate mechanisms for solid-catalyzed reactions, effectiveness factor.

General definition of catalysts, catalyst formulation and preparation, rate equation for heterogeneous reactions, fluid partial reaction, un-reacted model for spherical particles (shrinking core model), rate of reaction for shrinking particles, determination of rate controlling step, solid catalyzed reactions; experimental method for finding rates, fluidized bed reactions.

CME 429: Chemical Process Synthesis and Simulation (2 Credits)

Course Learning Outcomes (CLOs)

At the end of the course, the students are expected to:

1. Explain the principles of process synthesis, flowsheet development, and process integration.
2. Develop process flow diagrams (PFDs) and block flow diagrams (BFDs) for chemical production systems.
3. Simulate steady-state chemical processes using process simulation software (e.g., Aspen Plus, HYSYS, or equivalent).

4. Analyze the performance of chemical process units (reactors, separators, heat exchangers, etc.) using simulation tools.
5. Optimize process designs for energy efficiency, raw material usage, and economic performance.
6. Integrate heat and mass exchange networks in process designs for improved sustainability.
7. Evaluate process alternatives based on techno-economic and environmental criteria.
8. Demonstrate effective use of simulation tools in solving real-world process design problems, including documentation and reporting.

Course Contents

The creation and assessment of alternative, the synthesis of plausible alternating structure of the system process specification, process charts, block diagrams and process flow diagrams.

Process diagram types, flow sheets from process models. Flow-sheeting calculation, paths-continuous flow sheet, staged process with recycles, general serial flow-sheet; non serial flow sheet recycles. Computer aided, balance calculation (flow simulation) degree of freedom analysis, sequential modular and equation based simulations, commercial flow sheeting packages, convergence and acceleration (simulation of unsteady state processes). Distillation, chemical reactors, process control simulation.

CME 451: Fluid Particulate System and Technology (2 Credits)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Explain the fundamental principles governing the behavior of particulate systems in fluid media, including fluid-particle interactions.
2. Analyze flow behavior in packed beds, fluidized beds, and pneumatic conveying systems.
3. Apply dimensional analysis and empirical correlations to calculate pressure drops, terminal velocities, and drag forces in multiphase systems.
4. Design equipment for solid-liquid and gas-solid separation processes such as filtration, sedimentation, and cyclones.
5. Evaluate fluidization regimes and operating conditions for fluidized bed reactors and related technologies.
6. Use appropriate models and software tools to simulate and optimize particulate handling and separation processes.
7. Demonstrate understanding of industrial applications, scale-up challenges, and safety considerations in fluid-particulate systems.
8. describe two (2) methods used to synthesize and characterize nanomaterials.

Course Contents

Particulate solid, particle characteristics, blending, mixing and classification.

Motion of particles in a fluid, terminal falling velocities, motion of bubbles and drops. Flow of fluid through granular beds and packed columns. Carman-Kozeny equation and applications, packed column loadings and flooding, fluidization characteristics of fluidized system, mass heat transfer between fluids and particles.

Physical properties of particles; Particles in industrial processing; Flow of particles in a fluid; Stoke's and Newton's laws; Flow through packed beds; Fluidization; Sedimentation; Flocculation; Particle size reduction techniques; Screening and classification of particles.

Modern methods of particle size measurement (microscopic, Coulter-counter, X-rays etc.). Solids transport; Introduction to powder technology. Pre-requisite: Good Academic Standing.

CME 455: Transport Phenomena III (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Solve Multiphase Transport Problems
2. Apply Transport Phenomena to Chemical Reaction Systems
3. Apply Transport Phenomena to Process Design
4. Develop Computational and Analytical Skills for Transport Problems
5. Integrate Transport Phenomena with Thermodynamics

Course Contents

Mechanism of radiative heat transfer coefficients and application to the design of heat exchange equipment. Convective mass transfer (analogy with heat transfer). Mass transfer with chemical reaction; Simultaneous heat and mass-transfer.

CME 473: Mass Transfer Operations (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand the Fundamentals of Mass Transfer
2. Analyze Mass Transfer in Different Phases
3. Apply the Concept of Mass Transfer Resistance
4. Understand and Apply Mass Transfer Coefficients
5. Solve Problems in Distillation and Absorption

Course Contents

Molecular diffusion / Eddy diffusion. Molecular law; molecular diffusion through non-diffusing medium, equimolar counter diffusion, diffusion coefficient, multicomponent gaseous diffusion. Rate equation for eddy diffusion.

Mass transfer coefficients for gas/liquid systems, dimensionless group in mass transfer, inter-phase mass transfer. Introduction to distillation.

CME 495: Chemical Engineering Laboratory III (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Demonstrate the start-up and shutdown of the experimental rig in each of the experiments;
2. List at least two (2) safety and environmental hazards present in the laboratory and specific steps to deal with the risks responsibly;
3. Identify at least one (1) theory from the literature to explain the scheduled experiment and support the measured data;
4. Collect data from the process of the scheduled experiment;
5. Evaluate the parameter(s) representing the objective(s) of the scheduled experiment from the measured data;

6. Evaluate the accuracy of the determined parameter based on the prescribed theory from the literature;
7. Write a technical report on the scheduled experiment.

Further laboratory experiments in Transport Phenomena, Separation Processes, Thermodynamics, Reactor Systems and Control Systems.

CME 509: Biochemical Engineering (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand the Basic Principles of Biochemical Engineering
2. Analyze and Apply Enzyme Kinetics
3. Understand Cellular Metabolism and Its Engineering Applications
4. Design and Operate Bioreactors
5. Optimize Bioprocesses for Product Recovery and Purification
6. Apply Metabolic Engineering and Synthetic Biology
7. Model Bioprocesses and Bioreactor Systems

Course Contents

Role of Chemical Engineering in microbial technology. Microorganisms in food and industrial chemicals production, in waste treatment and environmental management, and in pharmaceutical and enzymes development. Introduction to micro-biology - cell structure, classification of micro-organisms, growth and influencing factors, metabolism; Biokinetics; Transport phenomena in bio-conversion systems; Integrated biological processes; Bio-reactor types-batch, fed-batch and continuous. Introduction to the modeling of bio-conversion systems.

CME 510: Mathematical Techniques and Analysis in Chemical Engineering (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand the basics of Microcomputers and apply computers in solving engineering problems
2. Understand and Apply Mathematical Methods to Engineering Problems
3. Solve Chemical Engineering Problems Using Numerical Methods
4. Understand and write computer program in one or more programming language.
5. Apply Optimization Techniques to Chemical Engineering Systems
6. Use Statistical Methods and Probability in Process Analysis

Course Contents

Microcomputers basics and terminologies; operating systems; introduction to different programming languages: basic, Fortran, Pascal, Assembly language, C etc. Introduction to electronic spread sheet, data base programmes. Word processing and desk top publishing. Recent developments in hardware and software. Prerequisite: Good Academic Standing.

Applied ordinary and partial differential equations. Chemical Engineering operations and their numerical solutions. Statistics: types of observations, ANOVA and design experiments.

Tests of significance. Regression analysis.

CME 511: Environmental Engineering (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand the Fundamental Principles of Environmental Engineering
2. Analyze and Design Water and Wastewater Treatment Systems
3. Understand the Processes Involved in Air Pollution Control
4. Evaluate and Design Solid and Hazardous Waste Management Systems
5. Assess Environmental Impacts and Sustainability
6. Implement Water Quality and Environmental Monitoring Systems
7. Understand and Apply Environmental Laws and Regulations
8. Develop Solutions for Renewable Energy and Climate Change Mitigation

Course Contents

Pollution and the environment, definition and interrelationship; natural and man-made pollution; the economics of pollution production, emission and transfer of contaminants, models of air pollution control concepts. Theory and design of control devices. Integration of pollution control in chemical engineering processes. Current research and development in air pollution control.

Water pollution sources, types of pollution by industrial effluents, legislation and standards for effluent discharge; waste water treatment objectives and methods. Design of facilities for physical and chemical treatment of waste water. Ecology of biochemical reactors, design of facilities of the biological of wastewater.

Land pollution; disposal of solid waste by incineration and dumping; future trends including conversion of solid wastes into useful material energy. Noise pollution, thermal and nuclear pollutions.

CME 512: Energy Conversion Engineering (3 credits)

Course Learning Outcomes (CLOs)

At the end of the course, the students are expected to:

1. Understand the Fundamentals of Energy Conversion
2. Analyze Thermodynamic Cycles and Processes
3. Understand and Apply Renewable Energy Technologies
4. Analyze Electrical Power Generation and Conversion Systems.
5. Evaluate Energy Storage Systems and Technologies
6. Understand and Design Fuel Cells and Hydrogen Systems
7. Understand Waste Heat Recovery and Utilization
8. Integrate Energy Conversion Systems with Smart Grids

Course Contents

Fuel and energy sources, types, availability and characterization of fuel (petroleum, including natural gas, coal tar sands). Modern processing technologies. Energy conversion – combustion and incineration, air requirement. Coal composition, properties, ranking classification, treatment, carbonization, classification hydrogenation, petroleum-origin, production and processing, types of crude oil cracking and refining etc.

Energy transport storage and management, environmental problems and abatement; solar energy calculation, flame temperature calculation, furnace and in calculation, nuclear and atomic energy calculation.

Combustion technology and aerodynamics, energy statistics. Radioactive waste and packed radioactive waste, nuclear critical decontamination, neutron activation, collector, optical and selective surfaces, direct conversion to electricity.

Pre-requisite: Good Academic Standing.

CME 513: Chemical Process Plant Design II (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Analyse existing process and carry-out process retrofitting;
2. Perform flowsheet of the operating principles of reacting, pumping & piping, plant control, and utilities systems and execute the design of the systems;
3. Analyse product/process design options and produce flow diagrams to obtain most suitable option;
4. Perform process design of some units;
5. Plan, produce and implement process calculations using software;
6. Prepare and present findings of engineering design tasks;
7. Perform process economics and determine process profitability, carry-out safety and environmental studies; and
8. Present final design orally and in writing.

Course Contents

Here, the undergraduate curriculum is coordinated and brought together to accomplish, by team effort, the basic dream of the process engineer: the design of an integrated process. The process involves drawing up a flow sheet, preparation of heat and material balances and detailed design of some plant items. Students are divided into groups and each group is assigned a process design problem. They are to be given two months to complete and submit the design. The design problem is intended to be a test of the student's ability to solve practical problems similar to the problems they likely to meet in real life. A complete *individual* student report, which should include details of energy and manpower needs, costing economics, construction and start-up, and pollution control considerations must be submitted.

CME 520: Separation Processes III (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Design and Analyze Distillation Systems
2. Understand and Apply Absorption and Stripping Techniques
3. Apply Principles of Liquid-Liquid Extraction
4. Design and Optimize Filtration and Membrane Separation Systems
5. Understand and Apply Centrifugation Techniques
6. Design and Analyze Adsorption Processes
7. Optimize Separation Process Operations

Course Contents

Solvent extraction; Extractive and azeotropic distillation; Mui: -component gas absorption. Distillation of multi-components mixtures Novel separation processes. Patterns of change and computational approaches. Energy requirements of separation processes. Optima design and operation of separation processes.

CME 521: Process Optimization (3 Credits)**Course Learning Outcomes (CLOs)**

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

1. Understand the Fundamentals of Process Optimization
2. Apply Mathematical Techniques to Optimization Problems
3. Formulate Optimization Models for Industrial Processes
4. Apply Optimization Techniques to Chemical and Mechanical Processes
5. Understand and Apply Dynamic Optimization Methods
6. Model and Optimize Process Control Systems

Course Contents

Chemical Engineering applications of the calculus of variations, maximum principle, dynamic programming, optimization of stage systems. Single and constrained optimization techniques. Discrete events.

CME 522: Polymer Science and Technology (2 Credits)**Course Learning Outcomes (CLOs)**

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

1. Understand the Fundamentals of Polymer Science
2. Classify Polymers Based on Their Structure and Properties
3. Understand Polymerization Techniques and Kinetics
4. Characterize Polymers Using Analytical Techniques
5. Analyze the Thermal and Mechanical Behavior of Polymers
6. Understand Polymer Processing Techniques
7. Understand the Role of Additives and Fillers in Polymer Materials
8. Understand the Applications of Polymers in Various Industries

Course Contents

Basic structures of Polymer. Physical stages and Transitions; Polymerization processes; Molecular weight of polymers. Viscous flow; Mechanical properties at small Deformations; Ultimate properties: Failure, Tests, Creeps Failure, fatigue, fabrication processes; Carbon chain polymers; Heterochain polymers, Analysis and identification of polymers.

CME 523: Petrochemical Processes (2 Credits)**Course Learning Outcomes (CLOs)**

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

1. Understand the Fundamental Principles of Petrochemical Processes
2. Understand the Major Petrochemical Production Processes

3. Describe the Production of Key Petrochemicals
4. Analyze Petrochemical Reaction Engineering and Catalysis
5. Design and Optimize Petrochemical Processes
6. Understand the Role of Separation Technologies in Petrochemical Processing
7. Understand the Role of Petrochemicals in Global and Industrial Supply Chains

Petroleum-crude oil, natural gas, petroleum refining operation, petrochemical feedstocks, cracking techniques (thermal, catalytic, hydro cracking and deep catalytic, platinum forming, hydro-forming, steam forming etc.)

Dehydrogenation of cyclohexane, dehydrogenation of paraffin, isomerization of butane, cycloparaffins, alkylatin, desulphurization. Sources of petrochemical hydrocarbons, liquids, crackates, reformers and hydrocracks.

Processes for the precaution of pure hydrocarbons, BAST flame-cracking process of acetylene, steam-cracking processes for ethane and propane, hourly process for butadiene, dehydrogenation process for isoprene and styrene. BIX from catalytic reformat by SHEEL SULFOLSNE solvent extraction. LURGI Aerosol van process production of styrene and cyclohexane alkylation of benzene to various products. Synthesis gas production; methanol, formaldehyde and ammonia manufacture from synthesis gas. Acetaldehyde from ethane (water process). The OXO processes and products.

CME 524: Chemical Process Technology and Quality Systems Engineering (2 Credits) **Course Learning Outcomes (CLOs)**

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

1. Understand the Principles of Chemical Process Technology
2. Analyze Chemical Process Design and Integration
3. Apply Thermodynamics and Kinetics in Process Design
4. Understand the Role of Quality Systems Engineering in Chemical Processes
5. Design and Implement Process Control Systems
6. Integrate Quality Management Tools with Chemical Process Operations
7. Apply Risk Management and Safety Engineering
8. Develop Process Improvement Strategies

Course Contents

Process calculations on management of material and energy. Integration of process types and equipment in industrial practice. Practical steam generation (solid, oil and gas-fired boilers, water and fire-tube boilers, economizers, super heaters, distribution systems colour coding, condensate return, efficient operation); Boiler-feed water treatment (chemical, ion exchange method); Sampling techniques (solids, liquids, gases); review of the manufacturing processes of selected heavy chemical and intermediates such as acid and fertilizers, vegetable oils, brewing and fermentation, cement and refractors, iron and steel, metal ores etc. The review is to include raw materials, processing, utilities, products and by-products, manpower, market demand and pollution control.

Quality: definition and concept; standardization; Quality systems (ISO 9000 series, TQM, TQC etc.); Quality planning; Quality function deployment; Quality measurement and evaluation; Certification and Accreditation schemes; Production planning and control; Applications; ISO

9000 Certification in selected engineering production and services; Quality manuals (development and uses); Introduction to -ACCP; Quality improvement techniques; Quality and the environment. (ISO 11000 series or BS 7750).

CME 526: Soap, Detergent and Food Processing Technologies (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand the Basic Principles of Soap and Detergent Technology
2. Learn the Soap and Detergent Manufacturing Processes
3. Analyze the Physicochemical Properties of Soaps and Detergents
4. Understand Environmental and Safety Aspects of Soap and Detergent Production
5. Develop a Strong Understanding of Food Processing Technologies
6. Apply Food Chemistry in Food Processing
7. Learn the Principles of Food Packaging and Shelf Life
8. Understand Quality Control and Assurance in Soap, Detergent, and Food Industries
9. Apply Process Optimization in Soap, Detergent, and Food Manufacturing

Course Contents

Definitions; Historical outline; types of soaps and detergents; their domestic and industrial applications; Mechanism of detergency; modern formulations; Oils and fats; Manufacture of soap by direct signification; Manufacture of fatty acids; Production of solid detergent powders; Manufacture of non-soap detergents; Equipment used in industrial production of soap and detergents; Quality control in soap and detergent production. Pre-requisite: Good Academic Standing

Basic methods of food production and preservation; Physical, chemical, biological and thermodynamic properties of food materials; Transport phenomena in food processing; production process for selected foods; Introduction to food package and transportation.

CME 527: Process Dynamics and Control (2 Credits)

Course Learning Outcomes (CLOs)

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

1. Understand the Fundamentals of Process Dynamics
2. Model Dynamic Behavior of Process Systems
3. Analyze the Stability of Process Systems
4. Design Feedback Control Systems for Process Control
5. Analyze and Control Multivariable Systems
6. Implement Process Control Using Distributed Control Systems (DCS) and PLCs
7. Apply Process Control to Different Industrial Applications

Course Contents

Process Dynamics - Time domain Dynamics; Transfer functions (frequency and Laplace domain dynamics); Control: controller types and modes of operation (on / off, proportional, proportional / integral proportional / derivation, proportional / integral / derivation, cascade Control); Feedforward and feedback control; introduction to multi-variable control. Block and signal flow diagram. Analytic and graphical stability criteria; Analog computation; Control value

(type characteristics, positioners); Transmitter and transducers; Controllers timing, Overall process control (control schemes and modes of main variable and unit operations; Overall plant process control schemes.

CME 528: Petroleum Production Engineering (3 Credits)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand the Fundamentals of Petroleum Production Engineering
2. Analyze Reservoir Properties and Fluid Behavior
3. Design and Optimize Well Completion Systems
4. Evaluate Well Performance and Production Data
5. Design and Optimize Artificial Lift Systems
6. Understand and Apply Reservoir Simulation Techniques
7. Implement Enhanced Oil Recovery (EOR) Methods
8. Understand Well Stimulation and Workover Techniques
9. Implement Enhanced Oil Recovery (EOR) Methods
10. Apply Techniques for Reservoir Management and Optimization
11. Understand Health, Safety, and Environmental Aspects in Production Engineering
12. Implement Technology and Innovations in Petroleum Production

Course Contents

Oil field development, techniques for oil well drilling. Functions and compositions of drilling fluids, mud properties, testing, classification, chemical analysis of crude oil samples; drilling mud calculations, contest of mud properties, fundamental properties of fluid saturated rocks; porosity, permeability, relative permeability, compressibility, capillary pressure, surface forced, wettability, Christmas tree and various correlation between rock properties reservoir fluid behavior; PVT analysis, formulation volume factors, techniques for estimation of reserves, concepts of fluid flow through porous media. Darcy Law, diffusivity equation, material balance equation, steady state and transient flow in reservoirs. Reservoir testing and performance analysis; displacement of oil and gas differential equations for radial flow in a porous medium.

CME 530: Gas Engineering (2 Credit)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand the Basics of Gas Engineering and Gas Reserves
2. Analyze Gas Reservoirs and Production Techniques
3. Understand Gas Processing Technologies
4. Design Gas Pipeline Systems
5. Apply Gas Storage and Transportation Techniques
6. Study Gas Combustion and Utilization
7. Understand Gas Measurement and Control Systems
8. Apply Computational Tools for Gas Engineering Design and Analysis

Course Contents

Introduction to Gas Engineering: Fundamentals of Gas Engineering, History and evolution of the natural gas industry, Types of gases (natural gas, liquefied petroleum gas, biogas), Gas properties and composition, Gas industry standards and regulations (API, ISO, ASME, etc.)

Thermodynamics and Fluid Mechanics: Basic Thermodynamic principles (First and Second Laws), Gas laws (Boyle's Law, Charles' Law, etc.), Gas compressibility, Fluid dynamics (Bernoulli's principle, Reynolds number, flow rate), Heat transfer and heat exchangers

Gas Reservoir Engineering: Formation and discovery of gas reservoirs, Reservoir properties (porosity, permeability), Methods of gas extraction (drilling, fracturing, etc.), Reservoir simulation and modeling, Wellbore mechanics and completion techniques.

Gas Production and Processing: Exploration and production of natural gas, Gas processing (removal of impurities, dehydration, CO₂ removal), Gas separation techniques (cryogenic, absorption), Storage methods (underground storage, LNG), Field operations and maintenance

Gas Transport and Distribution Systems: Pipeline design and operation, Gas transmission systems (compressor stations, valves, meters), Gas distribution networks (distribution lines, pressure regulation), SCADA systems for pipeline monitoring, Maintenance and safety of transport systems

Gas Utilization and Energy Systems: Power generation using natural gas (Gas turbines, combined cycle plants), Gas-fired heating systems (HVAC, industrial applications), Gas use in transportation (CNG and LNG vehicles), Renewable gas sources (biogas, hydrogen), Energy conversion and efficiency.

CME 531: Bioreactor Design (2 Credit).

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand the Principles of Bioreactor Design
2. Design and Analyze Bioreactor Systems
3. Apply Bioprocess Control and Monitoring Techniques
4. Design Bioreactors for Large-Scale Production
5. Analyze and Optimize Mass and Heat Transfer in Bioreactors
6. Design for Bioreactor Performance and Product Yield
7. Implement Bioreactor Design for Different Types of Cultures
8. Address Bioreactor Safety, Sterility, and Contamination Control
9. Apply Computational Tools for Bioreactor Design and Simulation

Course Contents

Introduction to Bioreactors: **Overview of Bioreactors**, Definition, Types (e.g., stirred-tank, airlift, bubble column, membrane reactors), Industrial applications (biopharmaceuticals, biofuels, food production, wastewater treatment), Historical context and evolution of bioreactor technologies; **Basic Bioreactor Operation**: Role of bioreactors in biotechnology, Biological and engineering interactions. Biological Principles in Bioreactor Design: **Microbial Growth Kinetics**, Monod growth model (specific growth rate, yield coefficients), Inhibition kinetics (substrate inhibition, product inhibition), Growth phases: lag, exponential, stationary, and death phases, **Fermentation and Bioprocess Fundamentals**- Aerobic vs anaerobic processes, Metabolic pathways in microbial growth, Substrate utilization and product formation; **Cell Culture Techniques** - Mammalian cell culture (bioreactors for cell culture and protein production), Animal and plant cell-based bioreactors.

Mass and Heat Transfer in Bioreactors: **Gas-Liquid Mass Transfer**- Oxygen transfer rate (OTR) and factors affecting OTR (kLa, gas flow, agitation), Carbon dioxide transfer and removal, Use of spargers and diffusers. **Heat Transfer**- Heat generation from microbial metabolism, Temperature control (cooling jackets, internal heat exchangers), Heat dissipation and thermal efficiency; **Substrate and Product Transfer** - Diffusion and convection of substrates and products, Effect of mixing and agitation on transfer rates. Bioreactor Hydrodynamics and Design Parameters: **Mixing and Agitation**- Impeller types (e.g., Rushton, marine propeller, pitched blade), Power consumption for mixing, Shear stress and its effect on cell viability, Agitation vs. mass transfer trade-offs; **Flow Dynamics**- Laminar vs. turbulent flow regimes, Flow patterns in different reactor types (e.g., stirred-tank vs. airlift), Baffling and its effects on flow and mixing, **Bioreactor Geometry and Size**-Reactor volume, aspect ratio, and geometry, Scale-up challenges (laboratory to industrial scale), **Design of Oxygen Transfer Systems** - Oxygen supply requirements for microbial growth, Sparger design and bubble size distribution. Bioreactor Control and Monitoring: **Control Strategies in Bioreactors** - Control of key parameters: pH, temperature, dissolved oxygen (DO), substrate concentration, Feedback and feedforward control systems, **Sensors and Instrumentation**-pH, dissolved oxygen, and temperature sensors, Online measurement of metabolic parameters (e.g., glucose, ethanol); **Automated Bioreactor Systems** - Programmable logic controllers (PLCs), SCADA systems for data collection and process control; **Control of Process Variables** - Maintaining optimal growth conditions, PID control strategies and their implementation in bioreactors.

CME 532: Electrochemical Engineering (2 Credit)

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

1. Understand the Fundamentals of Electrochemical Principles
2. Analyze Electrochemical Kinetics and Thermodynamics
3. Design and Optimize Electrochemical Cells and Systems
4. Study and Apply Electrochemical Energy Storage Systems
5. Analyze and Design Electrochemical Reactors for Industrial Applications
6. Study Corrosion and Its Prevention

Course Contents

Introduction to Electrochemical Engineering: **Fundamentals of Electrochemistry**- Electrochemical cells: Galvanic vs Electrolytic cells, Standard electrode potential and Nernst equation, Faraday's Law of Electrolysis, Electrochemical reactions and their thermodynamics, Overview of the role of electrochemical processes in industry, Evolution of electrochemical devices and technologies (batteries, fuel cells, corrosion), Key applications in modern industries,

Thermodynamics of Electrochemical Systems: Electrochemical Potential and Energy, Electrochemical Cells, Electrode Potentials, Energy and Power in Electrochemical Systems

Kinetics of Electrochemical Reactions: Electrode Reactions, Mass Transport and Diffusion, Reaction Mechanisms. Electrochemical Cell Design and Operation: Types of Electrochemical Cells, Primary and secondary cells (batteries), Cell Components and Configurations, Design Parameters for Electrochemical Cells. Electrochemical Energy Storage Systems: Batteries and Fuel Cells, Charge/Discharge Kinetics, Battery Modeling and Simulation. Electrochemical Materials and Catalysis: Materials for Electrochemical Devices, Catalysts for Electrochemical Reactions, Nanomaterials in Electrochemistry. Electrochemical Engineering in Environmental Applications: Electrochemical Water Treatment, Electrochemical Sensors, Corrosion Prevention and Protection. Electrochemical Engineering in Industry: Electrochemical Process Engineering.

CME 533: Refining Technology (2 Credit)

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

1. Understand the Fundamentals of Crude Oil and Refining
2. Analyze Refining Processes and Technologies
3. Evaluate Product Quality and Specifications
4. Apply Mass and Energy Balances in Refinery Operations
5. Use Modern Tools and Technologies
6. Understand Economic and Regulatory Factors

Course Contents

Introduction to Refining Technology: What is Refining Technology? Historical Perspective, Key Challenges in Refining Technology. Problem Identification and Assessment: Understanding Technological Problems, Assessing Performance and Efficiency, Design Thinking in Refinement. Methods and Approaches for Refining Technology: Process Optimization, Software Refinement Techniques, Hardware and System Refinement. Scaling and Sustainability: Scalability in Technology Refinement, Sustainability in Tech Refinement. Innovation and Technological Adaptation: Innovative Approaches to Refinement, Adapting to New Challenges and Trends. Tools and Technologies for Refinement: Software Tools for Technology Refinement, Hardware Tools and Prototyping, Data-Driven Refinement.

CME 534: Battery Technology (2 Credit)

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

1. Understand Basic Principles of Electrochemical Energy Storage
2. Differentiate Battery Types and Chemistries
3. Evaluate Materials and Manufacturing Techniques
4. Assess Battery Performance and Degradation

5. Apply Battery Technology in Real-World Systems
6. Design and Innovation in Battery Technology

Course Contents

Introduction to Battery Technology: History and Evolution of Batteries, Applications of Batteries, Importance of Batteries in Sustainable Energy. **Basic Principles of Electrochemistry:** Atomic Structure and Electrochemical Reactions, Thermodynamics and Kinetics of Batteries. **Types of Batteries:** Primary Batteries, Secondary Batteries, Solid-State Batteries, Flow Batteries, Fuel Cells. **Battery Components and Design:** Electrodes (Anode and Cathode), Electrolytes, Separators, Current Collectors. **Battery Performance and Characterization:** Capacity and Energy Density, Voltage and Power Density, Efficiency and Cycle Life, Charge/Discharge Behavior, Internal Resistance and Impedance Spectroscopy, Temperature Effects on Battery Performance. **Battery Manufacturing and Processes:** Fabrication of Electrodes and Cells, Battery Testing and Quality Control, Scaling Up: From Lab to Commercial Production, Challenges in Manufacturing (e.g., cost, scalability, safety). **Battery Management Systems (BMS):** Purpose and Function, Battery Monitoring: Voltage, Current, Temperature, State-of-Charge (SOC) and State-of-Health (SOH) Estimation, Cell Balancing and Protection, Safety Considerations in Battery Operation. **Battery Safety and Environmental Impact:** Safety Hazards and Failure Modes, Battery Recycling, End-of-Life Management and Disposal.

CME 535: Corrosion Engineering (2 Credit)

Course Learning Outcomes (CLOs)

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

1. Understand the Fundamentals of Corrosion
2. Analyze Corrosion Mechanisms and Influencing Factors
3. Apply Corrosion Testing and Monitoring Techniques
4. Select and Evaluate Corrosion Control Methods
5. Understand Corrosion in Engineering Applications

Course Contents

Introduction to Corrosion Engineering: Definition and Importance of Corrosion, Types of Corrosion, Corrosion Terminology and Mechanisms. **Thermodynamics of Corrosion:** Electrochemical Cells and Reactions, Theoretical Overview of Corrosion. **Corrosion Kinetics:** Rate of Corrosion, Mechanisms of Corrosion Rate. **Metals and Alloys:** Environmental Factors Influencing Corrosion. **Corrosion Testing and Monitoring:** Corrosion Rate Measurement Techniques, Corrosion Monitoring Devices. **Corrosion Prevention and Control:** Material Selection and Design for Corrosion Resistance, Cathodic Protection, Corrosion Inhibitors.

CME 536: Fermentation Technology (2 Credit)

Course Learning Outcomes (CLOs)

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

1. Understand Fundamentals of Fermentation
2. Analyze Microorganisms and Culture Techniques
3. Design and Operate Fermentation Systems
4. Monitor and Control Fermentation Processes
5. Apply Downstream Processing Techniques

6. Evaluate Industrial Applications and Economics

Course Contents

Introduction to Fermentation Technology: Overview of Fermentation, Basic Microbial Physiology. **Microorganisms in Fermentation:** Selection of Microorganisms, Microbial Growth and Control. **Fermentation Kinetics:** Monod Model for Microbial Growth, Batch, Continuous, and Fed-Batch Fermentation, Product Formation and Yield Coefficients. **Bioreactor Design and Operation:** Types of Bioreactors, Bioreactor Components and Control, Scale-Up of Fermentation Processes. **Fermentation Media and Nutrient Optimization:** Composition of Fermentation Media, Optimization of Media and Feeding Strategies. **Product Recovery and Downstream Processing:** Separation Techniques, Purification of Fermentation Products, Drying and Formulation. **Industrial Fermentation Processes:** Fermentation for Biofuels, Fermentation for Pharmaceuticals, Fermentation for Food and Beverages. **Quality Control and Assurance in Fermentation:** Microbial Contamination and Control, Types of contamination (bacterial, fungal, viral), Sterility maintenance in fermentation processes, Monitoring and Control of Fermentation Parameters. **Environmental and Economic Aspects of Fermentation:** Environmental Impact of Fermentation, Economic Considerations.

CME 537: Introduction to Cement Technology (2 Credit)

Course Learning Outcomes (CLOs)

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

1. Understand Raw Materials and Manufacturing Processes
2. Classify Types and Properties of Cement
3. Analyze Chemical and Physical Reactions in Cement Hydration
4. Apply Quality Control and Testing Techniques
5. Evaluate Environmental and Sustainable Aspects
6. Understand Applications in Construction

Course Contents

Introduction to Cement and Its History: Definition and Importance of Cement, History of Cement. **Raw Materials for Cement Production:** Raw Materials Overview, Minerals in Cement, Extraction and Processing of Raw Materials. **Cement Manufacturing Process:** Types of Cement Production Processes, Stages of Cement Manufacturing, Preheating and Precalcining, Clinker Production, Cooling and Grinding, Additives, Modern Cement Plants and Automation. **Cement Clinker and Its Chemistry:** Formation of Clinker, Cement Clinker Phases, C3S (Tricalcium Silicate): Key component responsible for early strength development. C2S (Dicalcium Silicate): Contributes to long-term strength, C3A (Tricalcium Aluminate) and C4AF (Tetracalcium Aluminoferrite): Influence setting time and workability, Mineralogical Composition of Clinker. **Types of Cement:** Portland Cement, Special Types of Cement, Alternative Cements. **Properties of Cement:** Physical Properties of Cement, Chemical Properties of Cement, Strength Development in Cement, Durability of Cement. **Cement Hydration and Setting:** Cement Hydration Process, Heat of Hydration, Factors Affecting Setting Time and Hardening. **Cement Testing and Quality Control:** Laboratory Tests for Cement, Quality Control in Cement Production, Standards and Specifications. **Cement Applications:** Cement in Concrete, Cement in Mortar and Other Construction Materials, Innovations in Cement Applications.

CME 538: Fossil Fuel Processing Technology (2 Credit)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand the Nature and Types of Fossil Fuels
2. Explain the Processing Techniques for Fossil Fuels
3. Analyze Process Operations and Equipment
4. Evaluate Product Quality and Specifications
5. Address Environmental and Safety Considerations
6. Understand Economic and Regulatory Aspects
7. Apply Modern Tools and Industry Trends

Course Contents

Introduction to Fossil Fuels: Overview of Fossil Fuels, Fossil Fuels and Energy Systems, Environmental and Economic Considerations. **Coal Processing:** Coal Formation and Types, Coal Mining and Extraction Methods, Coal Preparation and Cleaning, Coal Conversion Technologies. **Oil and Gas Processing:** Petroleum Exploration and Extraction, Crude Oil Refining, Refining by-products and Value-Added Chemicals, Natural Gas Processing. **Environmental Impact of Fossil Fuels:** Combustion and Emission Control, Greenhouse Gas Emissions and Climate Change, Waste Management in Fossil Fuel Industries, Environmental Monitoring and Remediation. **Coal and Gasification Technologies:** Coal Gasification, Natural Gas Liquefaction, Integrated Gasification and Carbon Capture. **Renewable Alternatives and Hybrid Systems:** Transition to Cleaner Fuels, Biofuels from Fossil Fuels, Hybrid Power Systems. **Fossil Fuel Processing Equipment and Technology:** Refinery and Petrochemical Plant Equipment, Gas Processing Plants, Fossil Fuel Power Generation - Power generation from coal, oil, and gas: thermal power plants, combined-cycle power plants, -Supercritical and ultra-supercritical steam cycles in coal-fired plants.

CME 539: Plastic Technology (2 Credit)

Course Learning Outcomes (CLOs)

Upon completion of this course, students will be able to:

1. Understand Fundamentals of Plastics and Polymers
2. Analyze Polymerization and Processing Techniques
3. Evaluate Properties and Performance of Plastics
4. Identify Plastic Materials and Applications
5. Understand Additives, Blends, and Composites
6. Apply Standards, Testing, and Quality Control
7. Consider Environmental and Recycling Aspects

Course Contents

Introduction to Plastics and Polymers: Definition of Plastics and Polymers, Classification of Plastics, Polymerization Techniques, History and Development of Plastics. **Properties of Plastics:** Physical Properties of Plastics, Chemical Properties, Mechanical Properties, Viscoelasticity of Polymers. **Raw Materials and Additives:** Polymer Resins, Additives in Plastics, Blends and Alloys, Bio-based and Biodegradable Plastics. **Plastic Processing Techniques:** Extrusion, Injection Molding, Blow Molding, Compression Molding, Rotational Molding, Thermoforming, Casting and Solvent Molding. **Tooling and Mold Design:** Mold Design and Materials, Mold Construction, Mold Cooling and Heat Transfer, Surface Finish and Mold Polishing. **Quality Control and Testing of**

Plastics: Quality Control in Plastic Manufacturing, Plastic Testing Methods, Plastic Failure Analysis. **Applications of Plastics:** Plastics in Packaging, Plastics in Automotive and Aerospace, Plastics in Electronics and Electrical Industry, Plastics in Medical Devices, Plastics in Consumer Goods and Construction. **Environmental Impact and Recycling of Plastics:** Environmental Issues with Plastics, Plastics Recycling Techniques, Sustainable Plastics Development.

CME 591: Technical Seminar (2 Credit)

Course Learning Outcomes (CLOs)

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

1. Develop skills in Research and Topic Analysis
2. Apply Critical Thinking and Synthesis
3. Develop skills in Technical Communication and Presentation
4. Possess Writing and Documentation Skills
5. Develop skills Engagement and Feedback

Course Contents

Presentation and discussion of literature review of current topics in chemical engineering to be assigned to the 'students. It should normally be different from the students' research topic.

CME 597: Final Year Project I (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Develop skills in Problem Identification and Requirement Analysis
2. Develop skills in Design and Planning
3. Develop skills in Implementation and Technical Development
4. Develop skills in Testing, Validation, and Analysis
5. Develop skills in Communication and Documentation

Contents

An individually supervised research project on any Chemical Engineering (or related) subject chosen by the student-lecturer team. Pre-requisite: Good Academic Standing.

CME 598: Final Year Project II (3 Credits)

Course Learning Outcomes (CLOs)

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

1. Develop skills in Problem Identification and Requirement Analysis
2. Develop skills in Design and Planning
3. Develop skills in Implementation and Technical Development
4. Develop skills in Testing, Validation, and Analysis
5. Develop skills in Communication and Documentation

Contents

An individually supervised research project on any Chemical Engineering (or related) subject chosen by the student-lecturer team. Pre-requisite: Good Academic Standing.

12.0 PROJECT REPORTING FORMAT

12.1 Undergraduate Project Reporting Format

Project report is classified into two which include: 1) Preliminary pages and 2) Main Body of the work.

Preliminary Pages

The followings pages make up preliminary pages. (i) The Title Page (ii) Declaration Page (iii) Approval Page (iv) Certification Page (v) Dedication Page (vi) Acknowledgement Page (vii) Abstract Page (viii) Table of Contents Pages (ix) List of Figures Page(s) (x) List of Table(s) page(s) (xi) List of Symbols Page(s) (xii) List of Abbreviation and Meanings Page(s) (xiii) List of Appendices Page(s).

Main Body of the Project

The main body of the project report is reported in five (5) chapters

CHAPTER ONE (Centralise)

INTRODUCTION (Centralise)

- 1.1 Background of the Study
- 1.2 Statement of the Problem
- 1.3 Aim and Objectives
- 1.4 Scope of the Project
- 1.5 Significance of the Project
- 1.6 Project Report Organisation
- 1.7 Problems Encountered.

CHAPTER TWO (Centralize)

LITTERATURE REVIEW (Centralise)

- 2.1
 - 2.2
 - etc
- } The sub titles should start with the key words of your project topic. Your supervisor will guide you appropriately

CHAPTER THREE (Centralise)

MATERIALS AND METHODS (Centralise)

- 3.1 Materials Used
 - 3.1.1
 - 3.1.2 etc
 - 3.2 Methods
- } Your supervisor will guide you appropriately

CHAPTER FOUR (Centralise)

SYSTEM DESIGN, IMPLEMENTATION AND TESTING (Centralise)

- 4.1 System Design
 - 4.1.2 Design Calculation
 - 4.1.3 Software System Design (where applicable)

4.1.4 Completed Design

Etc

4.2 System Implementation

4.3 Testing and Packaging

CHAPTER FIVE (Centralise)

BEME, CONCLUSION AND RECOMMENDATION (Centralise)

5.1 BEME

5.2 Conclusion

5.3 Recommendations

References

Appendices

NOTE

1. The wordings of the “Declaration” is as seen below

DECLARATION

I certify that this work titled “**Your Topic**” is an original investigative work done by me **Your Name, Your MAT. NO** which was executed under the supervision of **Name of Your Project Supervisor**. I affirm that all research associated with this work rests on information sourced by me, from authorized references which are acknowledged both within the body of the text and the reference section of this study.

Your Name

Sign

Date

2. The Departmental Board Agreed wordings of Approval and Certification Pages are as seen below.

APPROVAL PAGE

This is to certify that the Department of Chemical Engineering academic board of the Imo State University, Owerri has approved the project topic titled: **Your Project Topic** for **Your Name and MAT. No**

NAME OF HOD
(HEAD OF DEPARTMENT)

DATE

CERTIFICATION

This is to certify that this project titled: “**Your Project Topic**” was carried out by **Your Name and MAT. No** under the supervision of **Name of Your Project Supervisor** of the Department of Chemical Engineering, Imo State University, Owerri.

Name of Your Project Supervisor

(Supervisor)

Date

NAME OF HOD
(HEAD OF DEPARTMENT)

DATE

3. For referencing and citations, Chemical Engineering Department use APA Referencing and Citation format.
4. Font size recommended is **12** while Times New Romans is the **typeface** recommended
5. The numbering in preliminary pages are in **Roman Numerals** while that of the Main Body is in **Arithmetic numerals**
6. **Double line spacing** is also recommended and **NOT** more than that.
7. **Abstract** is one paragraph with single line spacing

12.2 Disclaimer

This Student Handbook, Curriculum and Information Guide is solely intended to be an aid and guide to Chemical Engineering students and other persons interested in the study of Chemical Engineering or have general knowledge of Chemical Engineering as offered in IMSU. It is not intended to be an authority on the status of the issues contained therein as the University, its Departments, Faculties and sections modify its official documents periodically and regularly.