DEPARTMENT HANDBOOK

Bachelor of Engineering [B.Eng.]

in

PETROLEUM AND ENERGY RESOURCES ENGINEERING

[2022 – 2027]

AFRICAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

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1.0 INTRODUCTION TO AFRICAN UNIVERSITY OF SCIENCE AND TECHNOLOGY (AUST)

Although situated in Nigeria, The African University of Science and Technology, Abuja (AUST-Abuja) was set up to be a pan-African university to serve all of sub-Saharan Africa. It is the first of a small group of institutions created to be part of a framework called the African Institute of Science and Technology (AIST), others are now to be found in Burkina Faso and Arusha, Tanzania. The AIST concept drew its inspiration from the highly successful Indian Institutes of Technology (IIT) and the Indian Institute of Science (IIS). AUST is a respected, not-for-profit world-class technological university, whose purpose is to train, and help retain in Africa, top-level scientists and engineers. The medium of instruction at AUST-Abuja is English. Special language courses are provided for non-English speakers to prepare them for participation in programs in English. The AUST-Abuja campus is located within the Abuja Technology Village (ATV), a planned cluster of leading research institutions and technology companies, located on a 1,000-hectare site where it occupies 240 hectares. The land was donated by the Government of Nigeria for this purpose. It is conveniently situated just 10 minutes from Abuja's city centre and 20 minutes from Nnamdi Azikiwe International Airport. AUST received accreditation from the Nigerian Universities Commission (NUC) in 2007 and received its first batch of students in 2008. Since then, true to the philosophy behind its establishment, as a pan-African institution to build science, engineering and technology capacity in all of sub-Saharan Africa, AUST has educated students from more than 26 African countries in East, West, Central and Southern Africa

In its short 16 years of teaching, research and innovation, AUST has already matured into a promising institution with a combination of Resident Faculty, over 40 full-time staff members, 80 visiting Faculty, world renowned specialists in their fields, brought in every year to teach and supervise research for over 160 MSc/PhD students in Computer Science, Materials Science and Engineering, Petroleum Engineering, Pure and Applied mathematics and Theoretical and Applied Physics. It is not surprising that AUST is already emerging as a noteworthy research university in the heart of Africa; the University has already become one of the very few African universities designated as a Center of Excellence by the World Bank, with a special focus on its programs in Material Science and Engineering and thus serves as the coordinating center for the region's Pan African Materials Institute (PAMI). Our groups in materials science and physics are developing the next generation of organic solar cells and light emitting devices. They are also developing the next generation of nanoparticles now being used in the detection and treatment of such medical conditions as cancer and cardiovascular disease. Similarly, our groups in petroleum engineering are working on using cutting-edge theoretical and computational tools to develop new tools for the oil and gas industry. These include theoretical and computational tools for flow assurance and reservoir management, as well as the introduction of nano-mechanics and fracture mechanics to the management of pipelines, reservoirs and offshore structures.

In the area of computer science, our DEVS team has won a number of top awards at International Conferences and professional events. The groups in computer science are also working on e-learning platforms and wireless technologies that are being integrated with mobile telecommunications. This is being done in an environment that has a 64-node multi-processor that has been used as the basis for the setting up of a high-performance computing (HPC) array. Our mathematics group has established

itself as one of the leading groups in functional analysis. With its recent focus on fixed point theory and equations of the Hammerstein type, they are solving problems at the frontiers of mathematics.

The fundamental objective of the African University of Science and Technology (AUST) is to educate the next generation of African scientists and engineers – providing them with the technical and leadership capacities to solve real African problems and contribute to the economic and social transformation of the continent. AUST will deliver a strong foundation in the fundamentals of mathematics and science; a deep understanding of the research frontiers; and an orientation towards entrepreneurship and service. AUST is committed to excellence in teaching, research and service. It is also motivated to build collaborative partnerships with for-profit and not-for-profit institutions to support the millennium goals for the development of the African Continent. The goal of the curriculum is to prepare students to become very high-level professionals who can play a transformational role in African industry/business and academia.

2.0 INTRODUCTION TO THE PETROLEUM AND ENERGY RESOURCES ENGINEERING PROGRAMME

The Petroleum and Energy Resources Engineering Department at AUST focuses on academic excellence. The program has very close links with the oil and gas industries, government and related agencies in the private sector. The program was established to meet the need of manpower in the oil and gas industries and renewable Resource technology. The Petroleum and Energy ressource Engineering program consists of faculty largely drawn from the field but also from academia around the worldwide, all active in current research, and representing very diverse origins, from countries in Africa, South-east Asia and the United States. The goal of the curriculum in Petroleum and Energy Resource Engineering is to prepare advanced professionals who can play a transformational role in African industry, business and academia.

The department started in 2007 as a Petroleum Engineering department. In line with the global perspective's energy development and infrastructure to mitigate against global warming by reducing carbon emission from fossil fuel consumption, the department has innovated its programme to include training in other forms of energy sources. Hence, the department is now called Petroleum and Energy Resources Engineering. At first degree and Master level, students have the option of graduating in Petroleum Engineering or Petroleum and Engergy resources Engineering. Students in Petroelum Engineering will go through the normal Petroleum Engineering curriculum. Students in Petroleum and Energy Resources Engineering will in addition to taking some core courses in Petroleum Engineering take all the courses in Energy Resources Engineering. In general, students can take ellectives in either programmes.

The department started with M.Sc in Petroleum Engineering from 2007 and admitted its first set of PhD students in 2010. Up to date, the department has graduated 171 M.Sc students and five PhD candidates with six students currently enrolled. The department is fully accredited by the National University Commision.

2.1 Vision

To be a world-class department dedicated to academic freedom and pursuit of excellence. This represents a global vision to foster sub-Saharan Africa's economic growth and development through the promotion of excellence in science and technology and their application.

2.2 Aim and Objectives

The general goal and objectives of engineering and technology education and training are in consonance with the realization of national needs and aspirations vis-à-vis industrial development and technological emancipation. The graduates must therefore be resourceful, creative, knowledgeable and able to perform the following functions:

- To design engineering projects and supervise their implementation.
- To design and implement components, machines, equipment and engineering systems.
- To design and develop new products and production techniques in industries.

- To install and maintain complex engineering systems for optimal performance in our environment.
- To adapt and adopt exogenous technology in order to solve local engineering problems.
- To be able to exercise original thought, have good professional judgment and be able to take responsibility for the execution of important tasks.
- To be able to manage people, fund, materials and equipment.
- To improve on indigenous technology for deployment to the solution of local problems in Materials and Metallurgical Engineering.

2.3 Admission Requirements

2.3.1 Entry Requirement and Duration

The entry requirements are at least credit level passes in five subjects to include English Language, Mathematics/Further Mathematics, Physics, Chemistry, and any other science subjects, at the Senior Secondary School Certificate or its equivalent.

2.3.1.1 Nigerian Students

The entry requirements shall be at least credit level passes in five subjects to include English Language, Mathematics/Further Mathematics, Physics, Chemistry, and any other science subjects, at the Senior Secondary School Certificate or its equivalent. In addition, an acceptable pass in the Unified Tertiary Matriculation Examination (UTME) is required for admission into 100-level. Candidates are admitted into the degree programme in any of the following three ways:

- The University Tertiary Matriculation Examination (UTME)
- Direct Entry
- Inter-University Transfer

2.3.1.2 UTME Entry Mode

The minimum academic requirement is credit level passes in five subjects at O'Level in national Examination/Cambridge O'Level: Mathematics/ Further Mathematics, English Language and three (3) other Science subjects.

UTME SUBJECTS: Physics, Mathematics and Chemistry

2.6.1.3 Direct Entry Mode

- In addition to O'Level requirements stipulated above, applicants should possess at least two A'Level papers in Level in relevant subjects (Chemistry, Mathematics and Physics, Biology) may be considered for admission into 200-level.
- OND in relevant discipline with at least upper credit grade in addition to the five credit passes as stated above.
- HND in relevant discipline with at least upper credit in addition to five credit passes as stated above.
- Joint Universities Preliminary Examinations Board (JUPEB)/ Interim Joint Matriculation Board Examination (IJMBE) and AUST Foundation Program are also acceptable.

2.6.1.4 Foreign Students

The University proposes to admit foreign students through the options listed below and will comply with the admission policy into Nigerian Universities and JAMB:

- Scholastic Aptitude Test (SAT) – An international entrance exam for admission into Universities in the United States and American University abroad, which is conducted in over 130 countries.
- Any other internationally recognized University Entrance Exam, equivalent of the JAMB in Nigeria.
- Joint Universities Preliminary Examinations Board (JUPEB)/ Interim Joint Matriculation Board Examination (IJMBE) and AUST Foundation Program are also acceptable.

2.6.2 Duration

A student will not be allowed to exceed an additional 50 per cent of the duration of the programme if he fails to graduate within the minimum number of years.

2.6.2.1 UTME

Five (5) academic sessions or Ten (10) semesters.

2.6.2.2 Direct Entry

Four (4) academic sessions or Eight (8) semesters. In general, no student will be allowed to exceed an additional 50% of the normal duration of the programme.

2.7 Graduation Requirements

To qualify for the 5-year Bachelor of Engineering (B.Eng.) degree award in the Petroleum and Energy Resources Engineering programme, a student must pass the minimum number of credit units as shown in the Tables 1-3. This table is based on Minimum Academic Standards and guidelines of National Universities Commission (NUC).

2.7.1 Course Credit System

Students in Department of Petroleum and Energy Resources Engineering are expected to take a minimum of 150 credit units for the award of a Bachelor's degree in Petroleum and Energy Resources Engineering. A minimum of 15 credit units and a maximum of twenty-four (24) credit units should be taken by each student per semester. Each of the courses in the programme is expected to be taught for a semester which will last for a minimum of fifteen (15) weeks. The teaching should be distributed into lectures, tutorials and workshops/studio practical.

2.7.2 Grading of Courses

The grading system provided by the University is an indicative policy for the calculation of grade point average (GPA). The grading system policy for students at AUST showing the letter grades, its corresponding grade point and the score range is shown overleaf:

Table 1: Grading System at AUST

Grades on 4.0 Scale	Letter Grade	Score Out of 100
4.00	A	95 – 100
3.75	A-	89 – 94
3.25	B+	83 – 88
3.00	B	77 – 82
2.75	B-	71 – 76
2.25	C+	65 – 70
2.00	C	59 – 64
1.75	C-	53 – 58
1.00	D	48 – 52
0	F	0 – 47

2.7.3 Grade Point Average and Cumulative Grade Point Average

For the purpose of determining a student's standing at the end of every semester, the Grade Point Average (GPA) system shall be used. The GPA is computed by dividing the total number of Units x Grade Point (TUGP) by the total number of units (TNU) for all the courses taken in the semester. The Cumulative Grade Point Average (CGPA) over a period of semesters is calculated in the same manner as the GPA by using the grade points of all the courses taken during the period. Calculation of GPA or CGPA is shown in Table 2.

Table 2: GPA Calculation

Course	Units	Grade Point	Units x Grade Point (UGP)
C_1	U_1	GP_1	U_1 x GP_1
C_2	U_2	GP_2	U_2 x GP_2
-	-	-	-
-	-	-	-
C_i	U_i	GP_i	U_i x GP_i
-	-	-	-
-	-	-	-
C_N	U_N	GP_N	U_N x GP_N
TOTAL	TNU		TUGP

$$TNU = \sum_{i=1}^{N} U_i \qquad TUGP = \sum_{i=1}^{N} U_i * GP_i \qquad CGPA = \frac{TUGP}{TNU}$$

2.7.4 Degree Classifications

Classes of degree are to be awarded depending on the cumulative GPA obtained. The classes of degrees that may be awarded are First Class Honours, Second Class Honours (Upper Division), Second Class Honours (Lower Division) and Third Class Honours. Table 3 shows the degree classification.

Table 3: Degree Classification

CGPA	CLASS OF DEGREE
3.50 – 4.00	First Class Honours
2.50 – 3.49	Second Class Honours (Upper Division)
1.40 – 2.49	Second Class Honours (Lower Division)
0.50 – 1.39	Third Class Honours

2.7.5 Probation

Probation is a status granted to a student whose academic performance fall below an acceptable standard. A student whose Cumulative Grade Point Average is below 0.50 at the end of a particular year of study, earns a period of probation for one academic session.

2.7.6 Withdrawal

- A student shall be requested to withdraw from a programme if at the end of a probation period, the student still does not make satisfactory progress. Such student shall be at liberty to apply for a change of programme within the University.
- Subject to the conditions for withdrawal and probation, a student may be allowed to repeat the failed course Unit(s) at the next available opportunity, provided that the total number of credit units carried during that semester does not exceed 24, and the Grade Points earned at all attempts shall count towards the CGPA.

2.8 Evaluation

2.8.1 Techniques of Students Assessment

The evidence, on which the assessment of a student's achievement is based, will include the following:

- Formal examinations
- Laboratory Reports
- Problem Solving Exercises
- Oral Presentations
- Essay Assignments/Term Papers
- Collaborative Project Work
- Individual Project Work
- Report on External Placement (SIWES)
- External Examiners Report
- Surveys and Evaluations

2.8.2 External Examiner's System

External examiners shall be appointed once in a year particularly at the end of each session to moderate examination questions, review the scripts of the students, and provide an overview of the work of the students in all classes, particularly those in the final year. It shall be mandatory on the Chief Examiner to review the questions set by his colleagues before those questions are forwarded to the External Examiner in order to ensure that they reflect the coverage of the syllabi and the manner in which they

were taught. The system also provides avenues for assessing comparability of programmes and the maintenance of minimum standards.

2.8.3 SIWES Rating and Assessment

The Nigerian Universities Commission (NUC) has mandated and approved Students Work Experience Programme (SWEP) and Students Industrial Work Experience Scheme (SIWES), for Nigerian Universities and other institutions of higher learning; for its students to undergo various training in their respective fields of studies due to lack of relevant facilities and machinery within the Nigerian Universities. Thus, mandatory for all students offering relevant courses in higher institutions to undergo the SWEP and SIWES programme at their assigned level and stipulated time. The exposure to a combination of field and office experience both in the public and private sectors and/or construction activities relevant to their individual disciplines. All students in the Petroleum and Energy Resources Engineering discipline will be exposed to a period of compulsory, supervised SIWES in addition to Laboratories/Workshop/Practical/Studio Training as reflected in the individual programmes. Such training shall be undertaken in an approved establishment. A minimum period of a semester is considered to be adequate. The student is expected to submit a systematic log-book for assessment at the end of the training period. Students with unsatisfactory performance shall be required to repeat the training programme.

2.8.4 Students' Evaluation of Courses

At the end of every semester, students shall be given the opportunity to evaluate the courses taken in the semester based on the following criteria:

- relevance
- adequacy in terms of time and content coverage
- students understanding of the courses
- adequacy of lectures, tutorials and practical
- standards of continuous assessment and examinations

2.8.5 Maintenance of Curricula Relevance

The various curricula for the Petroleum and Energy Resources Engineering would be reviewed from time to time as reflected in each individual programme. General review will be conducted every five (5) years, in full consultation with the relevant professional bodies.

2.8.6 Performance Evaluation Criteria

The general performance indices useful to accreditation assessors and for internal review terms are as specified in each individual programme, especially as these relate to the following: staff/student ratio, facilities such as laboratories, workshops, library/Information and Communication Technology (ICT), staff composition and minimum space requirements.

3.0 RESOURCES

3.1 Staffing

	ACADEMIC STAFF				SNR. TECH. STAFF	SNR. ADMIN. STAFF		JUNIOR STAFF	
	PROF.	READER/ ASSOC. PROF.	SNR. LECT.	LECT. 1 & BELOW		SEC.	NON-SEC.	TECH.	NON-TECH.
Core Staff on the ground for the programme		2	2	4	1				
Staff available for the programme from other source (s)	3		3						
Total	3	2	5	4	1				

Table 4: List of Existing Academic Staff for The Programme

NAME OF ACADEMIC STAFF	AREA OF SPECIALIZATION	DISCIPLINE	QUALIFICATION	RANK
Alpheus O. Igbokoyi	Drilling, Production & Well Testing	Petroleum Engineering	PhD, MBA	Assi. Professor (FT)/HOD
Adeola G. Olugbenga	Drilling & Production	Chemical Engineering	PhD	Asso. Professor (PT)
Kunle Idowu	Petroleum Economy	Petroleum Engineering	PhD	Senior Lecturer (FT)
Yetunde Aladeitan	Petroleum Economy	Petroleum Engineering	PhD	Senior Lecturer (PT)
Morgan Leo	Geophysics/Geology	Geophysics	M.Sc	Assistant Lecturer (FT)
Mojeed Oluogun	Reservoir Engineering & Well Testing	Petroleum Engineering	M.Sc	Assistant Lecturer (FT)
Oghenerume Ogolo	Drilling & Production	Petroleum Engineering	M.Sc	Assistant Lecturer (PT)
Shadrack Ogiriki	Reservoir Engineering	Petroleum Engineering	M.Sc	Assistant Lecturer (PT)
Haruna Onuh	Formation Evaluation	Petroleum Engineering	PhD	Senior Lecturer (PT)
Akeem Arinola	Reservoir Engineering	Petroleum Engineering	PhD	Senior Lecturer (PT)
Saka Matimiola	Reservoir Engineering	Petroleum Engineering	PhD	Asso. Professor

Mukthar Abdulkadir	Multiphase Flow	Chemical Engineering	PhD	Asso. Professor (PT)
David Ogbe	Reservoir Engineering	Petroleum Engineering	PhD	Professor (PT)
Omowuumi Iledare	Petroleum Economy	Petroleum Economy	PhD	Professor (PT)
Djjebar Tiab	Reservoir Engineering, Well Testing and Petrophysics	Petroleum Engineering	PhD	Professor (PT)

FT – Full time PT – Part time

3.2 Library Facility

The library is the heart of teaching and research. The central library has a huge collection of books and bound periodicals. The department also has a departmental library. In order to facilitate all the readers in selecting the reading materials of their choice, the access to stacks is open to its members.

It works as nerve center of the institution by keeping the knowledge of students and faculty members updated. Information data bank is constantly updated and facilities are added. The central library is equipped with Ebscohost database, which contains large number of e-books and e-journals. Some e-journals are: ACM Transactions and IEEE Transactions etc. E-books are available for most of the international publishers.

3.3 ICT

The responsibilities of the Information and Communication Technology (ICT) unit comprise: the development and maintenance of the AUST ICT infrastructure; the provision of ICT advice for projects; the management of online services and databases.

3.4 Laboratory

AUST has two dedicated computer lab (20 computers each), one advanced lab (10 high configuration Apple computers) and one High performance computer (HPC), which provides computer services to the students. Computer labs are typically provided by libraries to the public, by academic institutions to students who attend the institution, or by other institutions to the public or to people affiliated with that institution.

4.0 COURSE CONTENT/SYLLABUS

Course Structure at 100 Level

Course Code	Course Title	Units	Status	LH*	PH*
GST 111	Communication in English I	2	C*	30	-
GST 112	Logic, Philosophy and Human Existence	2	R	30	-
GST 113	Nigerian Peoples and Culture	2	R	30	-
GST 121	Use of Library, Study Skills and ICT	2	C	30	-
GST 122	Communication in English II	2	C	30	-
GST 123	Basic Communication in French	2	E	30	-
GST 124	Basic Communication in Arabic	2	E	30	-
GST 125	Contemporary Health Issues	2	R	30	-
GET 111	Basic Engineering Drawing	2	C	15	45
CHM 101	General Chemistry I	3	C	45	-
CHM 102	General Chemistry II	3	R	45	-
CHM 107	General Practical Chemistry I	1	C	-	45
CHM 108	General Practical Chemistry II	1	R	-	45
MTH 101	Elementary Mathematics I	3	C	45	-
MTH 102	Elementary Mathematics II	3	R	45	-
PHY 101	General Physics I	3	C	45	-
PHY 102	General Physics II	3	R	45	-
PHY 107	General Practical Physics I	1	C	-	45
PHY 108	General Practical Physics II	1	R	-	45
TOTAL UNITS		**40**			

NOTE: C = Compulsory, E = Elective, R = Required, LH = Lecture Hours per semester PH = Practical Hours per semester

Course Structure at 200 Level

Course Code	Course Title	Units	Status	LH	PH
GST 211	Environment and Sustainable Development	2	R	30	-
GST 222	Peace and Conflict Resolution	2	R	30	-
GST 223	Introduction to Entrepreneurship	2	R	30	-
GST 224	Leadership Skills	2	R	30	-
GET 201	Applied Electricity I	3	C	45	-
GET 202	Applied Electricity II	3	C	45	-
GET 203	Engineering Drawing I	2	C	15	45
GET 222	Engineering Drawing II	2	C	15	45
GET 204	Students Workshop Experience	1	C	-	45
GET 205	Fundamentals of Fluid Mechanics	3	C	45	-
GET 206	Fundamentals of Thermodynamics	3	C	45	-
GET 207	Applied Mechanics	3	C	45	-
GET 208	Strength of Materials	3	C	45	-
GET 209	Engineering Mathematics I	3	R	45	-
GET 210	Engineering Mathematics II	3	R	45	-
GET 211	Computer Programming I	3	R	30	45

GET 212	Engineering Materials	3	R	45	-
GET 213	General Engineering Laboratory Course	1	R	-	45
GET 299	SIWES I	2	C	8 weeks	
TOTAL UNITS		**46**			

Course Structure at 300 Level

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
EEE 316	Electromechanical System	3	R	45	-
GET 301	Engineering Mathematics III	3	R	45	-
GET 302	Engineering Mathematics IV	3	R	45	-
GET 303	Engineer-in-Society	2	R	30	-
GET 304	Engineering Communication	2	R	30	-
GET 399	SIWES II	3	C	12 weeks	
GST 311	Entrepreneurship	2	C	30	-
MEE 310	Fluid Mechanics I	2	R	30	-
MEE 321	Mechanics of Materials	3	R	45	-
PET 301	Transport Phenomena	4	C	45	45
PET 302	Separation Process	3	C	30	45
PET 303	Structural Geology	2	C	30	-
PET 304	Petroleum Geology	2	C	30	-
PET 305	Unit Operations in Natural Gas Engineering	2	C	30	-
PET 307	Fluid low Through Porous Medium	2	C	30	-
PET 308	Formation Evaluation & Geophysical Methods	3	C	45	-
PET 310	Basic Petroleum Reservoir Engineering	3	C	45	-
PET 311	Drilling Methods	3	C	45	-
PET 312	Petroleum Engineering Laboratory I	4	C	0	180
TCH 302	Chemical Engineering Thermodynamics I	2	C	30	-
TOTAL UNITS		**53**			

Course Structure at 400 Level

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
GET 499	SIWES III	6	C		
MME 405	Corrosion Science and Engineering	3	R	45	-
PET 403	Petroleum Reservoir Engineering	3	C	45	-
PET 404	Petroleum Production Engineering	3	C	45	-
PET 405	Pressure Build-up and Test Methods	2	C	30	-
PET 406	Gas Processing Equipment	2	C	30	-
PET 407	Gas Dynamics	3	C	45	-
PET 408	Petroleum Engineering Laboratory II	3	C	0	135
PET 409	Introduction to Well Logging &Interpretation	2	R	30	-

TCH 404	Plant Design I	4	C	60	-
TIE 402	Engineering Economics	2	R	30	-
TOTAL UNITS		**33**			

Course Structure at 500 Level

Course Code	**Course Title**	**Units**	**Status**	**LH**	**PH**
GET 501	Engineering Management	3	C	45	-
GET 502	Engineering Law	2	C	30	-
PEE 503	Petroleum Refining Technology	3	E	45	-
PET 503	Absorption and Fractionation	3	C	45	-
PET 504	Gas Transportation	2	C	30	-
PET 506	Refrigeration and Liquefaction	3	R	45	-
PET 507	Petroleum Economics	3	C	45	-
PET 508	Gas Sweetening & Sulphur Recovery	2	C	30	-
PET 509	Gas Process Control	2	C	30	-
PET 510	Valves and Pipeline Design	2	R	30	-
PET 511	Gas Process, Vessel & Equipment Design	2	R	30	-
PET 512	Research Project	6	C	-	270
PET 514	Environmental Pollution	3	E	45	-
PET 515	Petrochemical Science & technology	3	E	45	-
PET 516	Reservoir Modeling and Simulation	3	E	45	-
PET 517	Petroleum Engineering Laboratory III	3	C	-	135
TCH 513	Polymer Science and Technology	3	E	45	-
TOTAL UNITS		**48**			

COURSES SYNOPSES

GST 111: Communication in English I (2 Units: LH 30)

Effective communication and writing in English Language skills, essay writing skills (organization and logical presentation of ideas, grammar and style), comprehension, sentence construction, outlines and paragraphs.

GST 112: Logic, Philosophy and Human Existence (2 Units: LH 30)

A brief survey of the main branches of Philosophy; Symbolic logic; Special symbols in symbolic logic-conjunction, negation, affirmation, disjunction, equivalent and conditional statements, law of tort. The method of deduction using rules of inference and bi-conditionals, qualification theory. Types of discourse, nature or arguments, validity and soundness, techniques for evaluating arguments, distinction between inductive and deductive inferences; etc. (Illustrations will be taken from familiar texts, including literature materials, novels, law reports and newspaper publications).

GST 113: Nigerian Peoples and Culture (2 Units: LH 30)

Study of Nigerian history, culture and arts in pre-colonial times; Nigerian's perception of his world; Culture areas of Nigeria and their characteristics; Evolution of Nigeria as a political unit; Indigene/settler phenomenon; Concepts of trade; Economic self-reliance; Social justice; Individual and national development; Norms and values; Negative attitudes and conducts (cultism and related vices); Re-orientation of moral; Environmental problems.

GST 121: Use of Library, Study Skills and ICT (2 Units: LH 30)

Brief history of libraries; Library and education; University libraries and other types of libraries; Study skills (reference services); Types of library materials, using library resources including e-learning, e-materials, etc.; Understanding library catalogues (card, OPAC, etc.) and classification; Copyright and its implications; Database resources; Bibliographic citations and referencing. Development of modern ICT; Hardware technology; Software technology; Input devices; Storage devices; Output devices; Communication and internet services; Word processing skills (typing, etc.).

GST 122: Communication in English II (2 Units: LH 30)

Logical presentation of papers; Phonetics; Instruction on lexis; Art of public speaking and oral communication; Figures of speech; Précis; Report writing.

GST 123: Basic Communication in French (2 Units: LH 30)

Introduction to French, Alphabets and numeracy for effective communication (written and oral), Conjugation and simple sentence construction based on communication approach, Sentence construction, Comprehension and reading of simple texts.

GST 124: Basic Communication in Arabic (2 Units: LH 30)

Introduction to Arabic alphabets and writing systems. Elementary conversational drills. Basic reading skills and sentence construction in Arabic.

GST 125: Contemporary Health Issues (2 Units: LH 30)

Diet, exercise and health, nutritional deficiency diseases, malaria, other infections, hypertension, organ failure, air-borne diseases, sexually transmitted diseases, cancer and its prevention, sickle cell disease. HIV/AIDS: Introduction, epidemiology of HIV, natural history of HIV infection, transmission of predisposing factors to HIV, Impact of HIV/AIDS on the society, management of HIV infection, prevention of HIV. Drugs and Society: sources of drugs, classification of drugs, dosage forms and routes of drug administration, adverse drug reactions, drug abuse and misuse, rational drug use and irrational drug use. Human kinetics and health education: personal care and appearance, exercise and health, personality and relationship, health emotions, stress, mood modifiers, refusal to tobacco, alcohol and other psychoactive drugs.

GET 111: Basic Engineering Drawing (2 Units: LH 15; PH 45)

Introduction to Engineering Drawing as a means of communication. Drawing paper format. Use of drawing instruments. Types of lines and their uses in Engineering Drawing. Circles and tangent. Circles to satisfy conditions involving other circles, lines and points. Conic sections, various methods of their construction. Cycloid, epi and hypocycloids. Involute. Archimedes spiral. Loci: the helix (cylindrical and conical) single and multi-start threads. Coiling of compression and tension springs. Loci – Paths of points on moving link work. The theory of projection. Perspective (briefly), parallel projections (oblique – general, cavalier, cabinet). (Orthographic – Multi-view, two views, three views, auxiliary views). (Axonometric – Isometric, dimetric, trimetric). Multiview representation. 1st and 3rd angle representations. Isometric drawing. Oblique drawings. Revisions.

CHM 101: General Chemistry I (3 Units: LH 45)

Atoms, molecules and chemical reactions. Modern electronic theory of atoms. Electronic configuration, periodicity and building up of the periodic table. Hybridisation and shapes of simple molecules. Valence Forces; Structure of solids. Chemical equations and stoichiometry; Chemical bonding and intermolecular forces, kinetic theory of matter. Elementary thermochemistry; rates of reaction, equilibrium and

thermodynamics. Acids, bases and salts. Properties of gases. Redox reactions and introduction to electrochemistry. Radioactivity.

CHM 102: General Chemistry II (3 UNITS: LH 45)

Historical survey of the development and importance of Organic Chemistry; 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 groups IA, IIA and IVA elements. Introduction to transition metal chemistry.

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

Laboratory experiments designed to reflect the topics taught in CHM 101 and CHM 102 such as qualitative and quantitative chemical analysis, acid-base titrations. Gravimetric analysis. Calculation, data analysis and presentation. Functional group analysis.

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

Continuation of laboratory experiments designed to reflect the topics taught in CHM 101 and CHM 102. Some of the experiments will have been carried out in CHM 107.

MTH 101 Elementary Mathematics I (3 Units: LH 45) (Algebra and Trigonometry)

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

MTH 102 Elementary Mathematics II (3 Units: LH 45) (Calculus)

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 101 General Physics I (3 Units: LH 45) (Mechanics, Thermal Physics and Waves)

Space and Time, Units and Dimension, Kinematics; Fundamental Laws of Mechanics, statics and dynamics; work and energy; Conservation laws. Moments and energy of rotation; simple harmonic motion; motion of simple systems; Elasticity; Hooke's law, Young's shear and bulk moduli, Hydrostatics; Pressure; buoyance, Archimedes' Principles; Surface tension; adhesion, cohesion, capillarity, drops and bubbles; Temperature; heat; gas laws; laws of thermodynamics; kinetic theory of gases; Sound. Types and properties of waves as applied to sound and light energies. Superposition of waves. Propagation of sound in gases, solids and liquids and their properties. The unified spectra analysis of waves. Applications.

PHY 102 General Physics II (3 Units: LH 45) (Electricity, Magnetism and Modern Physics)

Electrostatics; conductors and currents; dielectrics; magnetic fields and electro- magnetic induction; Maxwell's equations; electromagnetic oscillations and waves; Coulomb's law; methods of charging; Ohm's law and analysis of DC circuits; AC voltages applied to Inductors, capacitors and resistance; Applications.

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

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

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

This is a continuation of the experiments designed for PHY 101 and PHY 102 some of which have been covered under PHY 107.

GST 211 Environment and Sustainable Development (2 Units: LH 30)

Man – his origin and nature; Man and his cosmic environment; Scientific methodology, Science and technology in the society and service of man. Renewable and non-renewable resources – man and his energy resources. Environmental effects of chemical plastics, Textiles, Wastes and other materials, Chemical and radiochemical hazards, Introduction to the various areas of science and technology. Elements of environmental studies.

GST 222 Peace and Conflict Resolution (2 Units: LH 30)

Basic Concepts in peace studies and conflict resolution; Peace as vehicle of unity and development; Conflict issues; Types of conflict, e. g. Ethnic/religious/political/ economic conflicts; Root causes of conflicts and violence in Africa; Indigene/settler phenomenon; Peace – building; Management of conflict and security. Elements of peace studies and conflict resolution; Developing a culture of peace; Peace mediation and peace-keeping; Alternative Dispute Resolution (ADR). Dialogue/arbitration in conflict resolution; Role of international organizations in conflict resolution, e.g. ECOWAS, African Union, United Nations, etc.

GST 223 Introduction to Entrepreneurship (2 Units: LH 30)

Introductory Entrepreneurial skills: Relevant Concepts: Enterprise, Entrepreneur, Entrepreneurship, Business, Innovation, Creativity, Enterprising and Entrepreneurial Attitude and Behaviour. History of Entrepreneurship in Nigeria. Rationale for Entrepreneurship, Creativity and Innovation for Entrepreneurs. Leadership and Entrepreneurial Skills for coping with challenge. Unit Operations and Time Management. Creativity and Innovation for Self-Employment in Nigeria. Overcoming Job Creation Challenges. Opportunities for Entrepreneurship, Forms of Businesses, Staffing, Marketing and the New Enterprise. Feasibility Studies and Starting a New Business. Determining Capital Requirement and Raising Capital. Financial Planning and Management. Legal Issues, Insurance and Environmental Considerations. Also to be incorporated, on the other side of the spectrum, are employability skills – interview techniques, Oral Presentation Skills, etc.

GST 224 Leadership Skills (2 Units: LH 30)

Transformation is a fundamental shift in the deep orientation of a person, organization or society such that the world is seen in new ways and new actions and results become possible that were impossible prior to the transformation. Transformation happens at the individual level but must be embedded in collective practices and norms for the transformation to be sustained. Leadership Development Programme (LDP) proposes novel approaches to teaching and learning, which emphasizes the practical involvement of participants. It is interactive and involves exercises and actual implementation of breakthrough projects by teams that make difference in the lives of the target population. In this course, leadership concepts comprising of listening, conversation, emotional intelligence, breakthrough initiatives, gender and leadership, coaching and leadership, enrolment conversation and forming and leading teams will be taught.

GET 201 Applied Electricity (3 Units: LH 45)

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 – notion, AC circuits, impedance, admittance, susceptance.

GET 202 Applied Electricity II (3 Units: LH 45)

Basic machines – DC, synchronous alternators, transformers, equivalent circuits. Three phase balanced circuits, PN junction Diode, Transistors, Thyristors FETs, Zener, Rectifiers. Basic control systems, open/closed loop systems. Communications fundamentals, introduction of TV, Radio, Telephone systems.

GET 203 Engineering Drawing I (2 Units: LH 15; PH 45)

Revision of multi-view representation. Harder examples on two and three view representation (1st and 3rd angles). Harder examples on isometric drawing to include simple pictorial assembly drawing in isometric. Harder examples on oblique drawing (Cavalier, Cabinet and Angles other than 45 degrees). Dimensioning. Sections and Conventions. Auxilliary views. Representation and specification of threads. Bolted joints. Keys and cottered joints. Conventional representations (see BS 308).

GET 222: Engineering Drawing II (2 Units: LH 15; PH 45)

Cams. Interpretation of solids. Development of surfaces. Detail drawing. Belts, Chains, Gears. Bearing and lubrication arrangements. Couplings brakes, Flexible shafts, Universal joints, etc. Assembly drawings. Revisions.

GET 204 Students Work Shop Experience (1 Unit: PH 45)

Introduction to practices and skills in general engineering through instruction in operation of hand and powered tools for wood and metal cutting and fabrication. Supervised hands on experience in safe usage of tools and machines for selected tasks.

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

Properties of fluids, Fluids statics, Basic conservation laws, friction effects and losses in laminar and turbulent flows in ducts and pipes. Dimensional analysis and dynamic similitude, principles of construction and operation of selected hydraulic machinery. Hydropower systems.

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

Basic concepts, quantitative relations of Zeroth, first, second and third laws of thermodynamics. Behaviour of pure substances and perfect gases. Ideal gas cycles.

GET 207 Applied Mechanics (3 Units: LH 45)

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 analyses.

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

Consideration of equilibrium; composite members, stress-strain relation. Generalized 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: LH 45)

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: LH 45)

Second order differential equations, line integral, multiple integral and their applications, differentiation of integral. Analytical functions of complex variables. Transformation and mapping. special functions.

GET 211 Computer Programming I (3 Units: LH 30; PH 45)

Introduction to computers and computing. Problems solving on computer algorithm, design using flowchart and pseudo-code. Introduction to high level programming languages, Basic and FORTRAN syntax, flow of control, input/output constructs, data types. Programming in FORTRAN. Extensive exercises in solving engineering problems using flowchart and pseudo-code.

GET 212 Engineering Materials (3 Units: LH 45)

Introduction to electronic configuration, atomic structures, inter-atomic bonding mechanisms, crystal and microstructure. Relationships between structure and properties of metals, alloys, ceramics and plastics. Principles of the behaviour of materials in common environments. Fabrication processes and applications.

GET 213 General Engineering Laboratory Course (Unit 1: PH 45)

Laboratory investigation and report submission for selected experiments and projects in Thermodynamics, Applied Mechanics and Applied Electricity and Fundamentals of Fluid Mechanics.

GET 299 Students Industrial Work Experience (2 Units: 8 weeks)

On the job experience in industry chosen for practical working experience but not necessarily limited to the student's major (8 weeks during the long vacation following 200 level).

PET 301Transport Phenomena (4 Units: LH 45; PH 45)

Compressible flow: Normal shock waves.Non-Newtonian fluids.Radiation: Mechanism of radiative heat transfer. Heat exchange betweenradiating surfaces. Unsteady state conduction. Free and forced convective heat transfer. Determination of heat transfer coefficients. Application to design of heat exchanges. Diffusion of vapours. Diffusion in liquids and solids.

PET 302 Separation Processes (3 Units: LH30; PH45)

Stage-wise and continuous contact equipment. Isothermal gas absorption. Binary distillation. Leading. Hydrodynamics of packed and plate columns.

PET 303 Structural Geology (3 Units: LH 45)

The Dynamic Earth. Model convection and plate movement. Rock cycle, Rocks and rock types Geologic symbols. Folding and faulting. Lithography Reservoir rocks. Traps stratography.

PET 304 Petroleum Geology (2 Units: LH 30)

Requirement for petroleum accumulation; plate tectonic. Origin of hydrocarbon, migration and trapping mechanisms. Reservoir rock properties. Depositional environment, petro-physical properties.

PET 305 Unit Operations in Natural Gas Engineering (2 Units: LH 30)

Design of natural gas facilities-pressure losses in pipes. Pressure losses in armature and fittings. Pumps. Nozzle theory and mass transfer. Dehydration. Need for dehydration of gas; Dew point depression; Absorption with glycol and adsorption with solids; Sulphur removal; Scale problems. Control of gas quality. Adsorption facilities. Fractionation and heat exchange design. Storage.

PET 307 Fluid Flow through Porous medium (2 Units: LH 30)

Darcy's Law. This viscosities of water, natural gas and oil under reservoir conditions. Types of fluids and fluid compressibility. Classification of reservoir flow systems. Linear flow of incompressible fluids-steady state. Linear flow of gases-study state. Linear beds in series and in parallel. Poiseuilles's law for Capillary flow. Flow through fractures. Radial flow of incompressible and compressible fluids. Flow of compressible fluids in bounded drainage areas. Average pressure in radial flow systems and re-adjustment time. Productivity index, Permeability variations. Zonal damage and well stimulation. Gas well spacing, recovery and deliverability. Displacement of Oil and Gas.

PGE 308 Formation evaluation and applied geophysical methods (3 Units: LH 45)

Application of geophysical methods to formation evaluation.

PET 310 Basic Petroleum Reservoir Engineering (3 Units: LH 45)

General composition of Petroleum. Fundamental properties of fluid permeated rocks. Properties of Porous media containing multiple fluid saturations. Fundamentals of the behaviour of hydrocarbon fluids. Determination and application of reservoir fluid properties. Properties of water. Data Evaluation for calculations. The material Balance.

PET 311 Drilling Methods (3 Units: LH 45)

Petroleum explorations methods and general teasing practices. Cable tool Drilling rotary Drilling, Rotary Drilling hydraulics. Factors affecting penetration, Rotary Drilling techniques including vertical drilling, directional drilling and fishing operations. Drilling fluids. Well logging Formulation damage. Well cementing and casing practices well completion.

PET 312 Petroleum Engineering Laboratory 1 (4Units: PH 180)

Laboratory analysis of Reservoir rocks.

PET 403 Petroleum Reservoir Engineering (3 Units: LH 45)

Study of Gas-condensate and under-saturated reservoirs including recovery methods. Oil reservoirs under simultaneous dissolved Gas drive, Gas cap drive and water drive. Water Influx.

PET 404 Petroleum Production Engineering (3 Units: LH 45)

Theoretical basis for the rise of fluids in production columns. Pottman and Carpenter, Gilbert, Duns and Ros and other methods. Production of crude oil by natural eruption. Gas Lift method. Production by pumping collection of Oil well gases and use of compressed gases. Secondary recovery method.

PET 405 Pressure Build-up and Test methods (2 Units: LH 30)

Mathematical Basis for pressure analysis, Determination of average reservoir pressure, pressure drawdown analysis. Multiple-Rate flow Test analysis, well interference tests, Pulse Tests, Drill Stem tests. Effect of reservoir Heterogeneities on pressure behaviour.

PET 406 Gas Processing equipment (2 Units: LH 30)

Study of compressors, valves including valve mechanics pumps and other processing equipment.

PET 407 Gas Dynamics (3 Units:LH 45)

Review of Thermodynamics concepts. One-dimensional Gas dynamics. The continuity equation, Energy and Euler's equations reservoir conditions. The momentum equation, Isentropic condition, Bernoulli equation. Dynamic Pressure and flow at constant area. I-D wave motion including propagating shock wave and isentropic equations. Supersonic flow in Ducks. Measurement methods. Frictionless flow effects of viscosity and conductivity.

PET 408 Petroleum Engineering Laboratory II (3 Units: PH 135)

Coring and core analysis. Porosity and permeability measurements. Liquid saturation measurements.

PET 409 Introduction to well logging and Interpretation (2 Units: LH 30)

Driller's logs, Sample logs, Mud logging. Electric Logging Radioactivity logging. Miscellaneous logging devices. Wire line logs. Well logging interpretation.

PET 503 Adsorption and Fractionation (2 Units: LH 30)

Isothermal adsorption curves. (Gas-solid equilibrium curves) applied industrial gas and liquid adsorption process. Mechanism and technology of adsorption on carbon of mixtures of hydrocarbons. Fractional distillation of an ideal mixture of components (n>2). Fractional columns extractive fractionation.

PET 504 Gas Transportation (2 Units: LH 30)

Fluid statics and kinematics. Dynamics of ideal fluids. One dimensional motion of a fluid, Linear flow of viscous fluid. Turbulent flow. Flow of fluids through orifices ands valves. Gas pipelines. Gas transportation through pipes classification for pipes. Pipeline economics. Compression and production pipes application of jet compressors to gas transportation. Gas preparation for transport and distribution.

PET 506 Refrigeration and Liquefaction (2 Units: LH 30)

Basic principles of refrigeration and liquefaction application of First and Second Laws of Thermodynamics cycles. Refrigerants. Vapour compression systems and equipment. Multistage refrigeration cycles compression fundamentals. Introduction to cryogenic systems. Joule - Thompson effect. Expansion turbines. Equipment selection.

PET 507 Petroleum Economics (2 Units: LH 30)

Uncertainty in Evaluations. Decision methods and yardsticks. Petroleum Evaluation review. Return on investment properties of probability Distributions and applications.

Appraisal of uncertain ventures. Decision trees and economic models. Simulation – The Monte Carlo method. Evaluation of expected discoveries in mature regions, Bayos strategies and estimates of valve Evaluation of future production by performance trends.

PET 508 Gas Sweetening and Sulphur recovery (2 Units: LH 30)

Gas purification and odourisation. Absorption processes. Use of DEA, Cuprous solution and Na2CO3 in gas purification. Extraction processes. Removal of H 2S from Liquefied gas. Sulphur recovery processes.

PET 509 Gas process Control (3 Units: LH 45)

Review of Mathematical Concepts process dynamics. Non-Linear systems. Lumoed parameters Feedback control and higher level control systems. Case studies. Multi-variable control systems.

PET 510 Valves and Pipeline Design (2 Units: LH 30)

Design of simple pipelines, pipes in series, in parallel, branched pipes and pipelines with continuous flow regime, design of valves.

PET 511 Gas Process, Vessel and Equipment Design (2 Units: LH 30)

Design of gas compressors and allied equipment.

PET 514 Environmental Pollution (3 Units: LH 45)

Causes of environmental pollution – oil pollution; blowout; pipeline and flow line leakages, sour gas production, sea transportation hazards. Need for oil spill prevention and control; Impact on the environment – ecology. Methods of control; Mechanical, chemical and biological methods. Global pollution problems; Government regulations.

PET 515 Petrochemical Science and Technology (3 Units: LH 45)

The petroleum oil industry and its relevance to the petrochemical industry. The non-oil fossil fuels and their relevance to the petrochemical industry. Petrochemical precursors. Socio-economic, socio-political and geographical implications of the petrochemical industry. Planning petrochemical industry for a developing country.

PET 516 Petroleum Reservoir Modelling and Simulation (3 Units: LH 45)

Basic principles of Reservoir modelling. Modelling gas, oil and Gas-condensate Reservoir. Numerical techniques-Finite Difference Method, Finite element, Method of weighted residuals etc. Setting up a simulation study: data collection, fluid properties etc. History matching, Performance prediction. Case studies. Specialized applications: Water flooding, Gas Cycling, Infill drilling, Miscible flooding etc.

ENERGY RESOURCES ENGINEERING OPTION

DETAILS OF UNDERGRADUATE COURSES

200 LEVEL

Common engineering course

In addition to the Energy Resources Engineering Courses, candidate for BEng Petroleum and Energy Resources Engineering must also take the following courses: MEE 310, MEE 321, EEE 316, TCH 302, TIE 402, GET 301, GET 302, GET 303, GET 304, GET 501, GET 502, PET 301, PET 304, PET 308, PET 310, PET 311, PET 403, PET 404, PET 405, PET 409, PET 507 and PET 516.

Course Structure at 300L-Energy Resources Engineering

Course Code	Course Tile	Units	Status	LH	PH
PERE 301	Principles of Energy Resources Engineering	3	R	45	-
PERE 302	Energy and the Environment	3	R	45	-
PERE 303	Fundamentals of Renewable Power	3	R	45	-
PERE 304	Sustainable Energy	3	R	30	-

Course Structure at 400L-Energy Resources Engineering

Course Code	Course Tile	Units	Status	LH	PH
PERE 401	Heat and Mass Transfer	3	R	45	-
PERE 450	Electrochemical Engineering Fundamentals	3	R	45	-
PERE 453	Carbon Capture and Sequestration	3	R	45	-
PERE 470	Environmental Science and Technology	3	R	30	-

Course Structure at 500L- Energy Resources Engineering

Course Code	Course Tile	Units	Status	LH	PH
PERE 576	Energy Efficient Buildings	3	R	45	-
PERE 591	Energy storage and conversion	3	R	45	-
PERE 593	Energy from Wind and Water Currents	3	R	45	-
PERE 595	Design of Solar Energy Conversion Systems	3	R	45	-
PERE 597	Transition to 100% Clean, Renewable Energy and Storage for Everything	3	R	45	-
PERE 599	A 500-Level Project and Seminar in Energy Resources	3	R	45	-
PERE 512	Research project for final year	6	R		270

PERE 301 Principles of Energy Resources Engineering (3 Credits: LH 45)

Basic engineering calculations and mathematical methodologies on material and energy balances and reaction rates during chemical transformations in energy systems. This introductory energy engineering course enables students to identify and apply fundamental principles of chemistry and physics, as they pertain to energy and fuels, and mathematics to describe materials and energy flow through a process. Examples of the processes studied will include stoichiometry in combustion and other reactions and material flows with recycle streams. This course also enables students to describe the energy

transformations in energy systems. The examples of the processes we would be applying energy conservation principles to include calculation of adiabatic flame temperature during combustion of fuels. In addition, the course will present an introduction to chemical kinetics with an overview of solid, liquid and gaseous fuel transformations.

PERE 302. Energy and the Environment (3 Credits: LH 45)

Energy use in modern society and the consequences of current and future energy use patterns. Case studies illustrate resource estimation, engineering analysis of energy systems, and options for managing carbon emissions. Focus is on energy definitions, use patterns, resource estimation, pollution.

Recommended: Advanced Calculus and Linear Algebra

PERE 303. Fundamentals of Renewable Power (3 Credits: LH 45)

Do you want a much better understanding of renewable power technologies? Did you know that wind and solar are the fastest growing forms of electricity generation? Are you interested in hearing about the most recent, and future, designs for green power? Do you want to understand what limits power extraction from renewable resources and how current designs could be improved? This course dives deep into these and related issues for wind, solar, biomass, geothermal, tidal and wave power technologies.

Recommended: Advanced Calculus and Linear Algebra

PERE 304. Sustainable Energy (3 Credits: LH 45)

This course explores the transition to a sustainable energy system at large scales (national and global), and over long time periods (decades). Explores the drivers of global energy demand and the fundamentals of technologies that can meet this demand sustainably. Focuses on constraints affecting large-scale deployment of technologies, as well as inertial factors affecting this transition. Problems will involve modeling global energy demand, deployment rates for sustainable technologies, technological learning and economics of technical change.

Prerequisite: PERE 302, 303.

PERE 401 Heat and Mass Transfer (3 Credits: LH 45)

Introduces the fundamentals of heat and mass transfer. Conduction, convection, radiation, and diffusion mass transfer will be emphasized. This course will emphasize the modes of heat and mass transport in energy engineering systems. Students will know, understand, and solve heat transfer problems that involve conduction, convection, and radiation. The course will provide an integrated treatment of heat, mass and momentum transfer by convection and mass transfer by diffusion. Students will also learn and use software that will enable them to solve problems that involve exploratory, what-if, and parameter sensitivity considerations. The course will also assist students to understand the design and operation of

different types of heat exchangers. This course also enables students to identify and describe the energy transformations in energy systems. The examples of the processes we would be applying energy conservation principles to include power plant, geothermal energy systems, and industrial reactors and combustors.

Prerequisite: Engineering Fluid Mechanics. Engineering Thermodynamics

PERE 450. Electrochemical Engineering Fundamentals (3 Credits: LH 45)

Course covers fundamental principles of electrochemistry, including electrochemical thermodynamics, kinetics, catalysis, and corrosion and focuses on applications such as fuel cells, batteries, and photovoltaics. Each application covers: principles of method, criteria determining performance, present state of development, and advantages/disadvantages. Laboratory demonstration of the performance (current-voltage) measurements of an electrochemical converter is scheduled in this course.

PERE 453. Carbon Capture and Sequestration (3 Credits: LH 45)

CO2 separation from syngas and flue gas for gasification and combustion processes. Transportation of CO2 in pipelines and sequestration in deep underground geological formations. Pipeline specifications, monitoring, safety engineering, and costs for long distance transport of CO2. Comparison of options for geological sequestration in oil and gas reservoirs, deep unmineable coal beds, and saline aquifers. Life cycle analysis.

PERE 470. Environmental Science and Technology (3 Credits: LH 45)

Introduction to environmental quality and the technical background necessary for understanding environmental issues, controlling environmental degradation, and preserving air and water quality. Material balance concepts for tracking substances in the environmental and engineering systems.

PERE 576. Energy Efficient Buildings (3 Credits: LH 45)

Quantitative evaluation of technologies and techniques for reducing energy demand of residential-scale buildings. Heating and cooling load calculations, financial analysis, passive-solar design techniques, water heating systems, photovoltaic system sizing for net-zero-energy all-electric homes.

PERE 591. Energy storage and conversion (3 Credits: LH 45)

This course provides an introduction and engineering exposure to energy storage and conversion systems and will cover the basic physics, chemistry and electrochemistry of solar cells, fuel cells, batteries and supercapacitors, state of the art of such technologies and recent developments. The course will also cover experimental methods and modeling tools for simulation and optimization aimed

at characterizing efficiency and performance issues. Prerequisites: Equivalent coursework in thermodynamics, electronic properties, chemical principles, electricity, and magnetism.

PERE 593. Energy from Wind and Water Current (3 Credits: LH 45)

Principles of sustainability and renewable energy conversion with emphasis on the extraction of energy from wind, waves and tides. The emphasis in the course is technical leading to a solid understanding of established extraction systems and discussion of promising new technologies. Concentration is placed on the relationships between the renewable resources, conversion technology and economic feasibility along with consideration of the associated risks and environmental impacts. We will also cover resource planning and production optimization through observations and computer simulations. The course includes at least one weekend field trip; team projects and class presentations. Prerequisites: computer programming experience, understanding of fluid mechanics, electrical systems, and engineering optimization.

PERE 595. Design of Solar Energy Conversion Systems (3 Credits: LH 45)

A review of fundamental concepts in solar energy conversion including photovoltaic (PV) and solar thermal conversion systems. The course examines the principles of solar energy conversion to build a foundation for explaining the basic concepts and implementation of conversion processes. It reviews the properties and availability of solar radiation and geometric relationship of sun/collector, principles of photovoltaic conversion and properties of materials used in PV systems, designing PV systems, procedures for solar thermal engineering calculations, and thermal power plants for electricity generation.

Prerequisite: PERE 401; PERE 591

PERE 597. Transition to 100% Clean, Renewable Energy and Storage for Everything
(3 Credits: LH 45)

This course discusses elements of a transition to 100% clean, renewable energy in the electricity, transportation, heating/cooling, and industrial sectors for towns, cities, states, countries, and companies. It examines wind, solar, geothermal, hydroelectric, tidal, and wave characteristics and resources; electricity, heat, cold and hydrogen storage; transmission and distribution; matching power demand with supply on the grid: efficiency; replacing fossil with electric appliances and machines in the buildings and industry; energy, health, and climate costs and savings; land requirements; feedbacks of renewables to the atmosphere; and 100% clean, renewable energy roadmaps to guide transitions.

PERE 599. A 500-Level Project and Seminar in Energy Resources (3 Credits: LH 45)

Individual or group capstone project in Energy Resources Engineering. Emphasis is on report preparation.