POSTGRADUATE PROGRAMME

DEPARTMENT OF CIVIL ENGINEERING

FACULTY OF ENGINEERING

UNIVERSITY OF NIGERIA, NSUKKA

2015

University of Nigeria, Nsukka

DEPARTMENT OF CIVIL ENGINEERING

POSTGRADUATE PROGRAMMES IN CIVIL ENGINEERING

PHILOSOPHY:

The postgraduate programme in Civil Engineering is designed to meet the needs of the government and private consulting and construction firms in specialized and advanced areas within the Civil Engineering discipline. Furthermore, the staff of the department recognizes the prime role Civil Engineering at postgraduate level can play in modern and future technological development of our country. A survey of fields of interest shows that postgraduate courses in Water Resources, Environmental Engineering, Soil Mechanics and Foundation Engineering, Structural Engineering, Highway Engineering, Materials and Construction Management appear to be in great demand. These courses are fashioned to produce graduates who are properly equipped to face challenging Civil Engineering problems of the developing countries.

OBJECTIVES OF PROGRAMME:

Postgraduate programme in Civil Engineering is aimed at:

1. Training personnel in advanced and specialized fields; and
2. Meeting the need of specialists in various fields of Civil Engineering both in the public and private sectors.

SCOPE:

Postgraduate studies cover the following areas of specialization: Structural Engineering, Water Resources engineering, Materials and Construction Management, Soil Mechanics and Foundation, Highway Engineering, and Environmental Engineering. The programmes for these courses are planned in two phases. The first phase consists of lectures, field trips and laboratory work while the second phase involves guiding the students in techniques of research for the preparation of thesis, reports or dissertation on particular topics of their choice. The programmes provide the student with information on current practice and recent advances in the various areas of specialization. Research topics are based on relevance to the needs of the society and the need to advance the frontiers of knowledge. The Department of Civil Engineering offers graduate courses leading to the award of PGDCE, M.Sc., M.Eng. and Ph.D degrees in various areas of specialization. This prospectus was prepared to provide vital information for all prospective candidates and already admitted students of the Department of Civil Engineering. The areas of specialization include: Structural Engineering,

Water Resources, Environmental Engineering, Materials and Construction Management, Highway Engineering, Soil Mechanics and Foundation Engineering.

ADMISSION REQUIREMENTS:

a. POSTGRADUATE DIPLOMA IN CIVIL ENGINEERING (PGDCE)

Candidates must possess at least a third class Bachelor's Degree in Civil Engineering or in any other related field of Engineering. Candidates with at least second class bachelor's degree in related fields of science are also eligible for Postgraduate Diploma. Students admitted into PGDCE programme will take all the fourth year and final year undergraduate courses and must satisfy 75% class attendance to qualify for examination.

b. M.ENG and M.Sc

Candidates who wish to apply for a master's degree in Civil Engineering must satisfy ***any*** of the following requirements.

(i) Possess at least a 3.50 GPA on a 5-point scale in postgraduate diploma in Civil Engineering

(ii) Possess at least a second class honours degree in Civil Engineering to qualify for admission into the M.Eng programme.

Candidates who meet the first admission criteria above but do not possess a Bachelor's Degree in Engineering will be admitted into M.Sc. programme.

c. Ph.D

Candidates must possess M.Sc. or M.Eng in the same area of specialization being applied for with an average grade point of not less than 3.5 on a 5-point scale from the University of Nigeria, Nsukka. Applicants who already possess a Masters degree at the same level of pass from recognized institutions may be considered for entry to the Ph.D programme.

AREAS OF SPECIALIZATION FOR M.ENG, M.Sc and Ph.D:

i. Water Resources Engineering
ii. Environmental Engineering
iii. Soil Mechanics and Foundation Engineering
iv. Structural Engineering
v. Materials and Construction Management
vi. Highway Engineering

DURATION OF PROGRAMMES:

PGDCE (Full-time)

Minimum of 4 semesters

M.ENG and M.Sc

Full-Time: Minimum of 4 semesters
Part-Time: Minimum of 6 semesters

Ph.D

Full-Time: Minimum of 6 semesters

Part-Time: Minimum of 6 semesters

REQUIREMENTS FOR GRADUATION:

PGDCE Programme

I) To be eligible for the award of PGD in Civil Engineering, a student must have taken and passed all the forth year and fifth year undergraduate courses with a total of 62 units as follows:

Forth year courses	26 units
Fifth year courses	30 units
Project	6 units
Total	62 units

II) In addition, PGDCE students must write and submit to the department a comprehensive project report. The project must be duly supervised by a lecturer approved by the Department.

M.ENG and M.Sc

I) To be awarded the M.Eng or M.Sc. degree, a student must have taken and passed the prescribed number of compulsory and required courses selected from the approved list with a total of 36 units as follows:

Core courses	30 units
Thesis/Dissertation	6 units
Total	36 units

II) In all cases, M.ENG and M.Sc students must write and submit to the department a comprehensive project report on the candidate's specific area of specialization. The thesis must be duly supervised by a lecturer in the department who must be an approved higher degree supervisor by the School of Postgraduate Studies. Such a thesis must be sent to an External Examiner nominated by the Department and appointed by Senate for that purpose.

Ph.D. Programme

To be eligible for the award of a Ph.D, a candidate must take and pass all the requisite courses as prescribed in the Ph.D course list, a total of 30 units as follows:

Core Courses	18 units
Thesis	12 units
Total	30 units

Every Ph.D. student must submit a thesis on a chosen and approved topic in the candidate's specific area of specialization. The work must be supervised by a lecturer in the department who must be an approved higher degree supervisor (Ph.D) by the School of Postgraduate Studies. The Ph.D. thesis must be defended before an External Examiner duly nominated for that purpose and appointed by Senate.

LIST OF APPROVED SUPERVISORS

PROFESSORS

F. O. Okafor B.Sc.; M.Sc., (Denmark), Ph.D., (Nig), MNSE, COREN	Highway Engineering, Materials and Construction Management. Approved higher degree supervisor – PhD
J. O. Ademiluyi B.Sc. (Ibadan), M.Sc., Ph.D. (Nig)	Water Resources and Environmental Engineering Approved higher degree supervisor – PhD
J.C. Agunwamba B.Eng., M.Eng., Ph.D (Nig)	Water Resources and Environmental Engineering Approved higher degree supervisor – PhD
O. O. Ugwu B.Eng (Nig), M.Sc., (Glasgow), PhD (London)	Materials and Construction Management Approved higher degree supervisor – PhD

SENIOR LECTURERS

C. U. Nwoji B.Eng., M.Eng., PhD (Nig), MNSE, COREN	Structural Engineering, Materials and Construction Management Approved higher degree supervisor – M.Eng.
M. E. Onyia B.Eng., M.Eng., PhD. (Nig) MNSE, COREN	Structural Engineering, Soil Mechanics and Foundation Engineering. Approved higher degree supervisor – M.Eng
C. C. Nnaji B.Eng., M.Eng., PhD. (Nig) MNSE, COREN, MIWA	Water Resources & Environmental Engineering Approved higher degree supervisor – Ph.D

LECTURER I

H.N. Onah B.Eng. (Nig), M.Eng, PhD. (France)	Structural Engineering Approved higher degree supervisor – M.Eng.
B. O. Mama B.Eng., M.Eng, PhD. (Nig)	Structural Engineering Approved higher degree supervisor – M.Eng

EMPLOYMENT OPPORTUNITIES:

Civil Engineering graduates have several employment opportunities in government establishments and private firms either as consulting or construction engineers. Some of the establishments include Ministry of Works (State and Federal), Federal Ministry of Environment, Ministry of Water Resources, River Basin Development Authorities, Oil Companies, Research Institutes, Institutions of Higher Learning etc.

STRESS AREAS:

Stress areas in Civil Engineering programme are as stated below:

Stress Areas	**Stress No**
Core Courses	0
Structural Engineering	1
Water Resources Engineering	2
Materials and Construction Management	3
Soil Mechanics and Foundation Engineering	4
Highway Engineering	5
Environmental Engineering	6
Project/Thesis	6

M.ENG/M.Sc PROGRAMME

3.1.1 Compulsory Courses for All M.Eng Students

In this revised prospectus, new courses have been introduced at the Faculty level in order to equip M.Eng students with skills that will make them better researchers. These are compulsory courses which must be taken in addition to the specified courses for the candidate's area of specialization. Minimum credit unit for M.Eng is 30 units.

First Semester
Structural Engineering Option
First Semester (Compulsory Course)

Course No	Title	Units
PGC 601	Research Methodology and ICT in Engineering	3
CVE 601	Computation Methods in Civil Engineering	3
CVE 610	Elastic Theory of Plates and Shells	3
CVE 611	Theory of Elasticity	3
CVE 612	Dynamics of Structures	3
CVE 613	Stability of Structures	3
CVE 614	Analysis and Design of Bridges	3
	Total	**21 Units**

Second Semester

Course No	Title	Units
CVE 615	Design of Shell Structures	3
CVE 616	Analysis and Design of Tall Building	3
CVE 690	Project	6
Elective Courses	**(Candidates should select only one)**	
CVE 617	Variation Methods in Structural Mechanics	3
CVE 618	Seismic Analysis and Design of Structures	3
CVE 619	Theory and applications of Thin-Walled Structures	3
	Total	**15 Units**

COURSE DESCRIPTIONS FOR STRUCTURAL ENGINEERING

M.ENG/M.Sc PROGRAMME

PGC 601 Research Methodology and ICT (3 Units)

Use of advanced analytical tools like MATLAB/SIMULINK, SCILAB/XCOS, etc for solution of engineering problems and their applications (application of these software depends on the various problems formulated in different departments). Information literacy, information sources (media, publishers, aggregators); validity of information, plagiarism and legal aspects. Information search – search engines, journal repositories, academic (social) networks, search strategies, personal contacts, tools for managing references. Integrating information literacy in research, cloud computing, audiovisual tools, e.g PowerPoint presentations.

Literature review: Reading and summarizing relevant articles, critical analysis and evaluation of research, identification of themes and comparators, writing review documents and identification of research (or knowledge) gaps. Scientific method and nature of evidence: Experimental methods and

design methods (as may be applicable to individual departments and research areas), data collection and management of quantitative data. Human participants – expert reviews, focus groups, questionnaires and interviews. Project management and report writing: project planning, report structure and style, general report writing techniques.

CVE 601 Computation Methods in Civil Engineering (3 Units)

Revision of computer programming. Computational methods for solving system of linear and non-linear equations. Roots of equations. Eigen-value problems. Numerical differentiation and integration. Runge-Kutta methods. Finite difference methods. Finite element methods. Applications of finite different and finite element methods in Civil Engineering. Optimization techniques and multivariate analysis. Application of different software in solving environmental problems. Use of computer-based statistical packages.

CVE 610 Elastic Theory of Plastics and Shells (3Units)

Fundamental assumptions. Equation of statics equilibrium by energy method and static method. Solutions of rectangular, circular and annular plates for various support (boundary) conditions. Local loads on plates: Design formula. Numerical solutions. Ribbed plates. General Theory of shells. Shell or revolution. Cylindrical shells. Design of cylindrical shells for storage purposes.

CVE 611 Theory of Elasticity (3 Units)

Two and three-dimensional stress and strain analysis in Cartesian and curvilinear coordinates. Introduction to tensor calculus. Elastic half spaced subjected to distributed and concentrated loads. Two-dimensional problems in Cartesian and polar coordinates. Closed form and numerical solutions. Torsion of prismatic bars. Prandtl's analogy. Approximate solutions of bars with thin-walled sections subjected to Torsion. Torsion of multi-cell bars- Baredits theory

CVE 612 Dynamics of Structures (3 Units)

Subject matter of structural dynamics. Different types and sources of dynamic loads. Single degree of freedom and multi-degrees of systems. Natural frequencies and modes. Forced and damped vibrations of single and multi-degrees of freedom systems. Infinite-degrees of freedom systems. Determination of Normal force, shear force and bending moments of continuous beams and redundant frames subjected to dynamic disturbances. Introduction to earthquake engineering.

CVE 613 Stability of Structures (3 Units)

Concept of instability second order and third order theories of beams. Critical load of systems with finite degrees of freedom. Beam-columns. Stability functions systems boundary value and initial value approaches. Buckling analysis of struts, continuous beam and frames-force methods and displacement method. Built up columns. Buckling of arches, deep beams in bending, and rectangular plates. Classical and numerical solutions.

CVE 614 Analysis and Design of Bridges (3 Units)

Fourtsmal aspects, Typology of statistical schemes. Detailed analysis of bridge decks, piers and footings. Prestressing of long continuous elements. Soil testing: settlement forecast. Construction technology.

CVE 615 Design of Shell Structures (3 Units)

Shell of revolutions, paraboloid and cylindrical shells as roof structures. Cylindrical shells for storage purposes.

CVE 616 Analysis and Design of Tall Buildings (3 Units)

Analysis and design of shear walls in reinforced concrete or lateral bracing systems in the steel structures

CVE 617 Variational Methods in Structural Mechanics (3Units)

Introduction to variational calculus, principles of virtual work and complementary virtual work. The potential energy and complementary energy of an elastic body. Extremum of functional. Euler's equations. Extremum of functional expressed by multiple integrals. Generalized functional by Lagrangian multipliers. Hamilton's principle. Direct variational calculus. Garlerkin's, Ritz and Kantoroviens method.

CVE 618 Seismic Analysis and Design of Structures (3 Units)

Characteristics of earthquakes, seismicity: Probabilistic distribution of response spectral ordinates. Response of linear multi-degree of freedom systems. Response of non linear systems. Determination of earthquake loading material and structural component behavior under earthquakes. Design of earthquake resistant structures – high rise buildings, tower, masts etc.

CVE 619 Theory and Applications of Thin Walled Structures (3 Units)

Introduction, fundamental assumptions, peculiarities of thin-walled structures, Vlasov's theory. Thin-walled members with open profile: geometric properties, stresses and stability. Applications. Thin-walled closed structures – single and multi-cell. Shear flows. Flexural, distortional and warping stresses. Applications

Water Resources Engineering Option

First Semester (Compulsory Courses)

Course No	Title	Units
PGC 601	Research Methodology and ICT in Engineering	3
CVE 601	Computational Methods in Civil Engineering	3
CVE 620	Advanced Applied Hydraulics	3
CVE 621	Advanced Hydrology	3

CVE	622	Unit Operations in Water and Waste Water Treatment	3
CVE	623	Contaminant Transport and Water Quality	3
CVE	647	Soil Erosion	3
		Total	**21 Units**

Second Semester (Compulsory Course)

Course No		**Title**	**Units**
CVE	627	Design of Water and Sewage Collection Systems	3
CVE	660	Environmental Health Engineering	3
CVE	690	Project	6
Elective courses (Candidates should select only one)			
CVE	661	Environmental Impact Assessment and Economic Analysis	3
CVE	624	Water Supply Planning and Management	3
CVE	625	Advanced Ground Water Flow Analysis	3
CVE	626	Hydro-Electric Engineering	3
CVE	644	Dams, Embankment and Seepage	3
		Total	**15 Units**

COURSE DESCRIPTION FOR WATER RESOURCES ENGINEERING

CVE 620 Advanced Applied Hydraulics (3 Units)

Advanced hydraulics of Open Channels – families of water surface profiles; super critical flow, unsteady flow in open channels, waves, surges, methods of characteristics. Fluidity and non-Newtonian Flows. Rotodynamic machines and pumps – basic equations, similarity laws, specific speeds, cavitation theory and applications. Effects on hydraulic systems, measurement, control and elimination. Hydraulic structures. Design of water transmission and energy dissipating structure. Coastal Engineering – Basic wave theories, forces, tide analysis, coastal processes. Sediment Transports in open channels, Turbulence, dispersion equation of pollutants. Regime concept. Types of sediments, model laws.

CVE 621 Advanced Hydrology (3 Units)

Revision of elements of hydrology. Parametric hydrology. Linear and non-linear analysis of hydrological systems. Unit and instantaneous hygrograph theory, conceptional and digital models for watershed stimulation, overland flow and flood routing. Analytical Techniques: Statistical analysis, extreme value frequency analysis, double curve analysis. Advanced precipitation analysis area precipitation from point values, depth-area-duration analysis of storm precipitation, point rainfall analysis, relationship of point to area rainfall.

CVE 622 Unit Operations in Water and Wastewater Treatment (3 Units)
Water contaminants, characteristics of water and wastewater. Microbiology of water and wastewater systems. Enzymatic reactions. Kinetics. Unit processes. Primary and pretreatment systems, secondary and tertiary processes. Physical, chemical and biological treatment of toxic and hazardous wastes. Sludge treatment, reuse and disposal. Appropriate water and waste treatment for the developing countries. Case studies.

CVE 623 Contaminant Transport and Water Quality (3 Units)
Transport of pollutants. Processes and models. Waste outfall discharge structures. Monitoring of impact on receiving waters. Deoxygenation and reaeration rates. Self-purification of streams. Eutrophication; effects, prevention and control. Water quality: management and models.

CVE 624 Water Supply Planning and Management (3 Units)
Hydrological data collection and use in water supply planning. Water supply: population analysis, design periods, consumption estimates and demand for various uses. Water resources engineering economy.

CVE 625 Advanced Groundwater Flow Analysis (3 Units)
Revision of groundwater in sedimentary rocks. Flow nets and graphical solution of Laplace equation, Hydromechanics of confined and unconfined flow of water through soils potential theory conformal mapping transient flow. Application of underground water flow, steady and radial flows. Ground water systems – characteristics of complex combined ground-groundwater-surface water systems, deterministic and stochastic inputs and responses; error and sensitivity analysis. Application of optimization technique.

CVE 626 Hydroelectric Engineering (3 Units)
Evaluation of the hydrological properties of hydroelectric plants. Theory of operation and development of operational criteria for multiple purpose projects. Operation of power plants for peaking and base load. Integration of hydroelectric plants into other water resources plants. Theory of pumped storage plants. Selection of turbines and pumps. General layout and arrangement of power plants and pumping stations.

CVE 627 Designing of Water and Sewage Collection System (3 Units)
Type of water distribution systems and applications. Design of water distribution systems. Drainage design. Design of waste water collection systems.

Materials and Construction Management Option

First Semester (Compulsory Courses)

Course No	Title	Units
PGC 601	Research Methodology and ICT in Engineering	3
CVE 601	Computational Methods in Civil Engineering	3
CVE 630	Designs, Production and Quality Control of Cement Based Materials	3
CVE 631	Properties of Cement Based Materials and Resins	3
CVE 632	Materials and Methods for the Construction of Highways	3
CVE 635	Management of Infrastructure Megaprojects	3
CVE 633	Management of Construction	3
	Total	**21 Units**

Second Semester (Compulsory Courses)

Course No	Title	Units
CVE 634	Civil Engineering Materials & Practice	3
CVE 636	Management Information Systems for Construction	3
CVE 690	Project	6

Elective Courses (Candidates should select only one)

CVE 637	Construction Methods for Foundations and Retaining Walls	3
CVE 640	Subsurface Exploration and Testing of Soils	3
CVE 642	Shallow Foundations and Pavement Design	3
	Total	**15 Units**

COURSE DESCRIPTION FOR MATERIALS AND CONSTRUCTION MANAGEMENT

CVE 630 Design, Production and Quality Control of Cement Based Materials (3Units)

Concrete mix design: the principle of mixtures of particulate systems; classification, properties and behavior of concreting materials; review and details of methods of concrete mix design; production of concrete; storage of concreting materials, batching; different types of concrete mixers and their uses; transportation of concrete mixers and their uses; transportation of concrete mixes, dumper trucks, conveyer belts, cranes mobile pumps etc; placement and compaction of concrete in formwork; concrete pressure on formwork and formwork design. Quality control; properties of fresh concrete and the methods of their measurement, classical approach to quality control of concrete, accelerated concrete curing and concrete maturity for quality control.

CVE 631 Properties of Concrete, Concrete Materials and Resins (3 Units)

Manufacture of Portland cement, types and their properties; cementitious materials of different types, their properties and uses; properties of natural aggregates. Sources of natural aggregates in Nigeria: synthetic aggregates; blending of aggregates. Effect of aggregate on the behavior of concrete. Concretes with particular properties. Resins types, properties and applications.

CVE 632 Methods and Materials for the Construction of Highway (3 Units)

Road formation, preparation of scheme and road surveys, subsoil, material for subgrade; laterite; composition and properties of bituminous materials. Cost analysis of road works. Critical path method for organization of the works. Stabilization. Concrete road construction.

CVE 633 Management of Construction (3 Units)

Construction industry, management history. Management theory with particular reference to the construction industry, decision theory, evaluating risk and uncertainty, probability theory, estimating and building theory. Budgeting, balance sheets and company finance. Construction planning; network analysis and precedence diagrams, pert and line of balance. Scheduling of repetitive construction work. Cost benefit analysis. Plant management: selection, classification, purchasing and replacement. Hiring, leasing operation, maintenance and performance. Manpower planning, contract procedure. Optimization of construction techniques.

CVE 634 Civil Engineering Materials & Practice (3 Units)

Types of Construction Materials, Properties & Applications, Materials Testing & Quality Control, Innovative Construction Materials (Nanotechnology and Nanomaterials in Civil Engineering/Construction, High Performance Concrete etc), Construction Planning, Construction Plant & Equipment Management, Project Team Formation & Management, Method Statements, Site Level Project Organization, Health & Safety in Construction, Theory & Practice of Sustainable Construction

CVE635: Management of Infrastructure Megaprojects (3Units)

Due process in project procurement, Procurement systems for infrastructure megaprojects (e.g. BOOT, PPP, PFI. Partnering etc), Megaproject risks : Risk analysis & management, Managing multiparty contractual links, Work package design & Interface Management, Decision Analysis (Methods & Tools) for Infrastructure project management, Critical Success Factors & Best Practices, Critical Infrastructure Systems & Security Vulnerability Analysis, Infrastructure Sustainability : Assessment Methods & Tools, Case Studies (Local & International

CVE 636 Management Information Systems in Construction (3 units)

Students will be introduced to: Concepts of systems infrastructure, data, information, knowledge, technology, user requirements analysis, evolution of ICT systems in construction, methodologies used in building information systems, computing paradigms (e.g. Object-Oriented systems analysis and development), programming languages and constructs such as BASIC, JAVA etc. Systems development: **Decision Support Systems** (DSS) framework, **Database Management Systems** (data, information and construction process modelling), **Knowledge Management** and **Socio-technical** aspects of information systems in construction, ICT Applications in Construction including state-of-the-art IT tools and Artificial Intelligence (AI) techniques, Web-based project management, e-Business & e-Construct, **ICT & Knowledge Management Systems** in Construction, Benchmarks, benefits, costs, barriers and enablers, and risks in ICT in construction., Systems selection and acquisition. Implementing new systems within construction organisations and Case studies

CVE 637 Construction Method of Foundations and Retaining Walls (3 units)

Special features of foundations. Site exploration. Pile and caisson foundations, raft foundation. Earth retaining structures. Cofferdams. Tunnels and conduits, retaining walls. The stability of vertical cuts and of slopes. Lateral earth pressures. Compaction and stabilization of soil.

Soil Mechanics and Foundation Engineering Option

First Semester

Course No	Title	Units
PGC 601	Research Methodology and ICT in Engineering	3
CVE 601	Computational Methods in Civil Engineering	3
CVE 640	Subsurface Exploration and Testing of Soils	3
CVE 641	Advanced Theoretical Soil Mechanics	3
CVE 642	Shallow Foundations and Pavement Design	3
CVE 643	Deep Foundations	3
CVE 644	Earth Embankment and Dams	3
	Total	**21 Units**

Second Semester

Course No	Title	Units
CVE 645	Soil Structure Interaction	3
CVE 646	Soil Erosion	3
CVE 690	Project	6
Elective Courses (Candidates should select only one)		
CVE 647	Soil Instrumentations	3
CVE 648	Ground Engineering	3
	Total	**15 Units**

COURSE DESCRIPTION FOR SOIL MECHANICS AND FOUNDATION ENGINEERING

CVE 640 Subsurface exploration, Sampling and Testing of Soil (3 units)

Planning of subsurface exploration, principles, features and operations of major methods of subsurface exploration; ground water observation. Method and equipment for soil sampling and their application in various soil types; disturbance to soil samples handling and preservation of soil sample; boring and sampling records. Modern techniques of triaxial, consolidation and permeability tests for fully and partially saturated soil; recent developments in tests for pavement design; other specialized tests.

CVE 641 Advanced Theoretical Soil Mechanics (3 Units)

Stress and strain tensors. Stress and strain transformations in three dimensions. Stress. Invariants and Principal stresses. Octahedral shear and normal stresses. Strength theories and failure envelopes. Theory of elastoplastic deformations -yield and plastic potential surfaces; associated and non-associated flow. Critical state soil mechanics and evolution of theoretical stress-strain curves for CAM clay. Generalization of CAM clay to three-dimensional space. The elastoplastic D-matrix. Two and three-dimensional consolidation. Consolidation of sand drain embedded soils-Baron's and Rendulic's solutions. Bishop's pore pressure parameters and application to consolidation settlement. Consolidation acceleration by pre-compression. Advanced slope stability techniques. Advanced earth pressure theories. Advanced stress distribution theories-Michell's and Burmister's. Arching in soils and pressures on buried structures. Shear strength characteristics of fully and partially saturated clays- Mohr -Coulomb and nonlinear failure envelopes. Clay Mineralogy. Stress paths. Soil suction. Finite element applications in geomechanics. Computer implementations.

CVE 642 Shallow Foundations and pavement design (3 Units)

Detailed consideration of the application of classical bearing capacity theories and their recent developments; determination of settlement, differential settlement and angular distortion in structures, foundation design in relation to ground movement, buoyancy rafts and basements. Recent development in the design of flexible and rigid pavements. Control of groundwater in excavations and protection of foundation structure against attack by soil and groundwater.

CVE 643 Deep foundations (3 Units)

Pile foundations: different types of piles; pile loading test; pile group effect; design of piles (including structural consideration and details; stresses induced by piles; piles subjected to lateral loads and movements; negative skin friction and its effects, large diameter bored piles and under-reamed piles. Vibrofloation, stone columns and sand piles. Diaphragm walls. Caissons and cofferdams.

CVE 644 Dams, Embankments and Seepage (3 units)

DAMS: Different dam types and their selections. Masonry dams-Gravity, arch and buttress dams. Embankment dams- Earth, rock-fill dams. Dam construction techniques. Dam foundation

preparation treatment-grouting. Seepage control below masonry dams and through earth dams. Design of dams. Slope Stability analysis of embankment dams. Instability from seepage-seepage forces, quick sand, boiling and piping. Design of filters. Dam site investigation-boreholes and geophysical methods

SEEPAGE: Laplace's equation. Confined flow below masonry dams. Methods of solving Laplace equation for confined flow- flow net construction; model study; electrical analogy; analytical method of Schwarz-Christoffel conformal mapping; Numerical methods of finite element and finite difference. Unconfined flow through earth dams- Dupuit's and Kozeny's equations and their modifications.

SPILLWAYS: Spill ways and their hydraulics. Design flood. Synthetic unit hydrographs. Spillway design capacity. Reservoir routing. Control of erosion below spillways-stilling basins; flip buckets. Dewatering of excavations in water-logged grounds. Pore pressure and settlement monitoring of dams- pressure cells, piezometers.

CVE 645 Soil Structure Interaction (3 Units)

Winkler and elastic half space models to represent soil: coupled spring models, Reprikers models. Theory of beams and plates on elastic foundation. Metenys solutions. Methods of solving soil structures interaction problems. Details of finite difference and finite element methods. Method of concordant deflections. Application to foundations, sheet pile walls and anchored Bulkheads. Effects of super structure rigidity on foundation design. Method of substructure analysis.

CVE 646 Soil Erosion (3 Units)

The significance of geographical, geomorphological and geological processes in soil erosion occurrence. Causes, processes and occurrence of soil erosion in Nigeria. Mechanics of sheet erosion. The universal soil loss equation and other models. Gully erosion and its evaluation, erosion gully growth model; the mechanics of gully erosion and the analytical procedures for investigating gully formation and growth. Socio-economic consequences of soil erosion. Management of soil erosion.

CVE 647 Soil Instrumentation (3 Units)

Special instruments for soil exploration and field testing; Piezometers, settlement gauges, Strain gauges inclinometers; pressure meters. Instruments for geophysical exploration like electrical resistivity and seismic refraction surveys, instruments for terrain evaluation, aerial photography. Special instruments for laboratory testing of soil like pore pressure and volume change measuring instruments. High pressure triaxial cells.

CVE 648 Ground Engineering (3 Units)

Soil compaction and stabilization: subsidence of fills: grounding, vibroflotation, dewatering and other ground treatment technologies: reinforced Earth and ground anchors.

Highway Engineering Option

First Semester

Course No	Title	Units
PGC 601	Research Methodology and ICT in Engineering	3
CVE 601	Computational Methods in Civil Engineering	3
CVE 632	Materials and Methods for the Construction of Highways	3
CVE 656	Site Characterization and Industrialization	3
CVE 654	Pavement Design and Analysis	3
CVE 650	Geometric and Formation Design of Highway	3
CVE 651	Traffic Studies	3
	Total	**21 Units**

Second Semester

Course No	Title	Units
CVE 655	Geo-Informatics in Transportation Engineering	3
CVE 652	Drainage and Maintenance of Highway	3
CVE 690	Project	6

Elective Courses (Candidates should select any two)

Course No	Title	Units
CVE 645	Soil Structure Interaction	3
CVE 653	Highway Bridges and Culverts	3
	Total	**15 Units**

COURSE DESCRIPTION FOR HIGHWAY ENGINEERING

CVE 656 Site Characterization and Instrumentation (3 Units)

Introduction to site characterization. 2. Concept of site characterization. 3. Site characterization methods. 4. Site investigation using non-destructive Tests. 5. Site investigation using in site testing. 6. Sampling. 7. Laboratory testing for site characterization. 8. Numerical methods. 9. Geotechnical and Geo-environmental case studies. 10. Seismic site classification. 11. Instrumentation.

CVE 654 Pavement Design and Analysis (3 units)

Principles of pavement design. 2. Traffic considerations in pavement design. 3. Pavement material characterization. 4. Analysis of flexible pavements. 5. Flexible pavement design methods. 6. Analysis of concrete pavements. 7 Concrete pavement design methods. 8 Pavement evaluation techniques. 9. Pavement overlay design methods.

CVE 655 Geo-Informatics in Transportation Engineering (3 Units)

1. Concepts of geo informatics. Data, and database: (a) Concept of geo-informatics. (b) Land use and transportation data for GIS and c. Data Base development.

Transport Network and Maps: a). Map generation and analysis b). Transportation Network Development and Algorithm.
GIS applications in Transportation a). Transportation models and their applications using GIS b) GIS-T applications c). Intelligent Transport Systems d). Case Studies.

CVE 650 Geometric and Formation Design of Highway (3 Units)
Road classification, design speed, road cross-section elements, sight distance. Vertical and horizontal alignments Route location earth work calculation, cost analysis of earthwork. Review of Federal Highway Code.

CVE 651 Traffic Studies (3 Units)
Highway capacity studies, intersections and interchange, inter-section design, delay studies, accident studies and traffic control systems.

CVE 652 Drainage and Maintenance of Highway (3 Units)
Types of drainage. Storm water drainage design hydrologic analysis and hydraulic design. Drainage conduits: channels, ditches, pipes and culverts, subsurface drainage. Maintenance of highway: maintenance criteria, maintenance of paved and unpaved roads.

CVE 653 Highway Bridges and Culverts (3 Units)
Bridge location surveys, types of highway bridges and culverts. Selection of appropriate bridge/culvert structure. Design and evaluation.

Environmental Engineering Option

First Semester

Course No	Title	Units
PGC 601	Research Methodology and ICT in Engineering	3
CVE 601	Computational Methods in Civil Engineering	3
CVE 622	Unit Processes for Water and Wastewater Treatment	3
CVE 647	Soil Erosion	3
CVE 661	Environmental Impact Assessment and Economic Analysis	3
CVE 662	Industrial Waste Engineering	3
CVE 663	Solid Waste Engineering	3
	Total	**21 Units**

Second Semester

CVE 624	Contaminant transport and Water Quality Control	3
CVE 690	Project	6

Elective Courses (Candidates should select any two)

CVE 626	Water Resources Planning and Management	2

CVE	664	Pollution Prevention and Control	2
CVE	665	Bioremediation	2
		Total	**13 Units**

COURSE DESCRIPTION FOR ENVIRONMENTAL ENGINEERING

CVE 660 Environmental Health Engineering (3 Units)

Industrial waste and control: theory and design of industrial unit operation. Waste minimization. Air pollution: types of contaminants, prevention and control. Dispersion. Transboundary pollution. Models, solid waste management; management practices and recycling. Oil pollution: dispersion of crude oil in aquatic environment, effects of oil pollution, prevention and control.

CVE 661 Environmental Impact Assessment and Economic Analysis (3 Units)

Environmental Impact Assessment concept, objectives, methodologies, preparation of Impact Statements. Evaluation and Interpretation of Impacts. Case studies in water resources, manufacturing industries etc. Risk assessment, ethics/health and safety. Economic analysis: environment and material economy, environmental cost accounting, cost benefit analysis. Welfare environmental economics. Other applications of economic principles to pollution control projects.

CVE 662 Industrial Waste Engineering (2 Units)

Industrial waste and control: theory and design of Unit operation and processes for industrial waste treatment. Oil pollution of rivers and seas. Effects on aquatic organisms, land, vegetation and water sources. Prevention and control of oil pollution. Remediation of contaminated soils. Air pollution prevention and control strategies. Source of noise, measurement and standards. Noise control devices. Industrial hazards and safety.

CVE 663 Solid Wastage Engineering (3 Units)

Generation, collection, transportation and disposal methods. Processing of wastes: special kinds of wastes hazardous, hospital, nuclear, demolition wastes. Separation, treatment and disposal systems and designs. Material recovery strategies. Energy recovery systems. Biogas production principles and design. Software for solid waste management. Application of operations research.

CVE 664 Pollution Prevention and Control (3 Units)

Pollution types and sources, control and prevention strategies. Legislation; environmental laws, international and national regulation, conservation laws, institution arrangements, economic tools, waste minimization. Clean production; concepts, process auditing and integration, input/output analysis, risk benefit assessment, process involvement and life cycle analyses. Global and industrial case studies, environmentally sound energy systems. Recycling of gaseous, liquid and solid wastes;

production of useful materials from wastes. Applications of operations research in waste management

CVE 665 Bioremediation (3 Units)

Bioremediation – on site and off-site. Kinetics of bioremediation. Application to oil removal from aquatic environment and soils. Groundwater bioremediation. Enhanced bioremediation through genetic engineering.

CVE 690 M.ENG/M.Sc Project Report 6Units)

A comprehensive project report on the candidate's specific area of specialization is required. An in-depth study of a chosen topic involving the scientific process of research must be approved by the Department. The work must be properly written, demonstrate deep understanding of the relevant disciplines and must make a valuable contribution to knowledge.

DOCTOR OF PHILOSOPHY

COMPULSORY COURSES

Course Code	Course Title	Units
CVE 711	Basic & Advanced Modeling	3
CVE 712	Applied Modeling	3
CVE 713	Advanced Civil Engineering Software	3
	Total	**9 Units**
RESEARCH		
PGC 701	Synopsis& Research Grant Writing	3
CVE 702	Ph.D Seminar I	3
CVE 703	Ph.D. Seminar II	3
	Thesis	12
	Total	**21 Units**

DOCTOR OF PHILOSOPHY COURSE DESCRIPTION

CVE 711 Basic & Advanced Modeling 3 Units

Modeling and solution of real Civil Engineering problems, solution techniques for model equations, model calibration and verification.

CVE 712 Applied Modeling 3Units

Application of models to existing problems. Model critique, troubleshooting and modification.

CVE 713 Advanced Civil Engineering Software 3Units

Application of Engineering software as research aids. Software to include MATLAB, SPSS, Minitab, Excel, Arc GLS, Mathematica, etc.

CVE 701 Ph.D. Thesis and Technical Report Writing (12 Units)

The Ph.D. student is expected to select an interesting topic from his/her area of specialization with the guidance of his/her supervisor. Successful study should make original contributions to knowledge and should contain at least three articles publishable in reputable journals, have extensive and up-to-date literature review, and demonstrate full understanding of the subject matter and answer all the questions satisfactorily during oral presentation. At least two seminars based on the thesis should be presented to the departmental Postgraduate Board by each candidate before final examination. Choice of broad research area with considerations of interdisciplinary topics, Identification of research/ knowledge gaps and research objectives. Role of technical reports in engineering projects. Fundamental principles of technical writing. Format of different types of reports, outlines, purpose and scope, technical discussion details, role of appendix, function of figures, equation editors, tables and illustration. Literature search, references (citing and listings). Nature of recommendations and conclusions. Guides for writing memoranda, business letters. Oral presentation of technical reports and thesis. Synopsis writing.

PGC 701 Synopsis & Research Grant Writing (3 Units)

Developing long-term research plan; identification of potential funding agencies and their requirements. Research objectives in relation to interests of the funding agencies. Estimating research timelines, Budget preparation, manpower requirements and availability, research facilities, legal issues, etc.

CVE 702/703 Seminars (6 Units)

Each doctoral candidate shall present at least three seminars on his/her research project before graduation. At least, one seminar shall be presented at faculty level before graduation.