Faculty of Engineering and Architecture [Civil Engineering]

VISION AND MISSION

The VISION of the Civil Engineering Department is to be recognized locally and regionally as a leading department providing high quality education, research and services.

The MISSION is to provide students with the highest level of theoretical and practical education that leads them to successful careers. The department programs prepare graduates to acquire effective and interactive skills to face new challenges as high caliber Civil Engineers to enable them to contribute effectively and professionally to society.

ENTRANCE REQUIREMENTS

A student interested in joining the Faculty of Engineering, has to:

1. Obtain pass mark in seven subjects including: Arabic language, religious studies, English language, mathematics, physics, chemistry, computer or engineering sciences. International students who have not studied Arabic and religious studies may have more alternative subjects from an approved list of subjects published in the webpage of Ministry of Higher Education.
2. Achieve the percentage in Sudan School Certificate announced every year (International students may have 10% less in the School Certificate scores.
3. Apply electronically though the website of the Admission and Accreditation Office, Ministry of Higher Education, or apply directly in Admission Office in the National University, and pass the health examination, aptitude tests and interview at the Faculty of Engineering-.Pay the published fees: 30,000 SDG or US $ 3,500 [international students] (2018).

CAREER ADVICE:

Civil Engineering is the oldest and one of the most important branches of engineering profession all over the world as civil engineering is related to almost all aspects of civilization. Many of the important things in our lives that we take for granted are the product of civil engineering. Civil engineer deals with a wide variety of engineering aspects such as designing, construction, and maintenance of different structure (buildings, embankments, storage tanks, dams, roads, water and wastewater networks, irrigation and drainage networks, etc..), solving execution problems, managing engineering and construction projects, and it just does not end there. Civil engineer also has a significant role in planning and managing transportation systems, terrific safety, conservation and development of water resources, treatment and reuse of wastewater, and the list extends. The civil engineering curriculum in National University - Sudan is set to serve the broad range activities of the profession. It is designed to fulfill the student's need of sufficient and balanced content of different civil engineering topics. The graduate can go in any one of the above areas, and be immediately enrolled in jobs. A graduate may, also, choose to obtain masters or PhD in the subspecialties of civil engineering. International students are allowed to take engineering jobs in Sudan.

FACULTY OBJECTIVES

The objectives of the National University Faculty of Engineering -Civil Engineering Department are to:

1. Ensure that graduates will have a mastery of fundamental knowledge, problem solving skills, engineering experimental abilities, and design capabilities necessary for entering civil engineering career and/or higher studies.
2. Produce graduates that have the knowledge and skills necessary for identifying and assessing design alternatives and the related social, economic, environmental, and public safety impacts.
3. Produce graduates who have verbal and written communication skills necessary for successful professional practice.
4. Prepare graduates to function effectively on teams.
5. Prepare graduates to deal with ethical and professional issues, taking into account the broader societal implications of civil engineering.
6. Prepare graduates for professional careers, leadership roles and life-long learning.

Curriculum Objectives [Characteristics of the civil engineering graduate

A graduate of the National University Civil Engineering Curriculum should be able to:

1. Show ability to apply knowledge of mathematics, science, and engineering.
2. Demonstrate the skills to design and conduct experiments, as well as to analyze and interpret data.

3. Show ability to design a system, component, or process to meet desired needs.
4. Present attitudes to function on multi-disciplinary teams.
5. Identify, formulate and solve engineering problems.
6. Show understanding of professional and ethical responsibility.
7. Communicate effectively.
8. Discuss the impact of engineering solutions in a global and societal context.
9. Recognize the need for, and an ability to engage in life-long learning
10. Show awareness of contemporary issues.
11. Use, skillfully the techniques, skills, and modern engineering tools necessary for engineering practice.
12. Plan, design, construct, maintain, and operate of large and permanent engineering projects of our civilization. Civil engineers are in demand wherever there are people.
13. Discuss the major subdivisions of civil engineering, structural, geotechnical, environmental, sanitary, water resources, and transportation engineering.
14. Outline the components of projects as bridges and large buildings, dams, and other river and harbor work, municipal water supply and sanitation facilities, streets, highways, and other transportation facilities.

Feedback to students after mid-course and end of course assessment is an essential part of the civil engineering programme

PLAN TIMETABLE

The student has to earn 186 credit hours to obtain a B.Sc. degree in Civil engineering. The study program distributed over 10 semesters as follows:

Semester 1 [22 CHs - 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Physics I	PHY111	2	1	2	5	3
Chemistry	CHM 111	2		3	5	3
Calculus I	MAT111	2	2		4	3
Linear Algebra	MAT 112	2	2	-	4	3
Engineering Mechanics I (Statics)	MAT 113	2	2		4	3
English Language I	ENL111	3	-	-	3	3
Engineering Drawing I	GEN 121	1	3		4	2
Sudanese Culture	SCL111	2	-	-	2	2
		16	10	5	31	22

Semester 2 [21 CHs - 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Physics II	PHY 121	2	1	2	5	3
Calculus II	MAT 121	2	2	-	4	3
Analytic Geometry	MAT 122	2	2	-	4	3
Engineering Mechanics II (Dynamics)	MAT 123	2	2	-	4	3
Introduction to Computer	COM121	1	-	2	3	2
English Language II	ENL121	2	2	-	4	3
Engineering Drawing II	GEN121	1	3		4	2
Fundamental of Engineering	GEN122	2	-	-	2	2
		14	12	4	30	21

Semester 3 [20 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Technical English for Engineering	ENL 211	2	2		4	3
Engineering Geology	CEN 213	3			3	3
Differential Equations	MAT 211	2	2		4	3
Computer Programming	COM 221	2		3	5	3
Mechanics of Materials I	GEN 212	2	2		4	3
Introduction to Civil Engineering	CEN 211	2	-		2	2
Surveying	CEN 212	2		3	5	3
		15	6	6	27	20

Semester 4 [20 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Numerical Methods	MAT 222	2	2	1	5	3
Vector Analysis	MAT 221	2	2		4	3
Introduction to Mechanical Engineering	GEN 221	2	1		3	2
Advance Surveying	CEN 221	2		3	5	3
Civil Engineering Drawing	CEN222	1	3		4	2
Material science	GEN 223	2	-		2	2
Occupational and Environmental Safety	GEN 222	2			2	2
Introduction to Electrical Engineering	GEN 224	2	1	2	5	3
		15	9	6	30	20

Semester 5 [19 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Complex Functions	MAT 311	2	2	-	4	3
Structural Analysis I	CEN 311	2	2		4	3
Fluid Mechanics	CEN 312	2	1	2	5	3
Concrete Technology	CEN 313	2	-	3	5	3
Construction Engineering	CEN 314	2	-	-	2	2
Mechanics of Materials II	CEN 315	2	2	-	4	3
Engineering Properties of Soils	CEN 316	2	-	1	3	2
		14	7	6	27	19

Semester 6 [16 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Ethics and Profession practice	CEN 325	2	-	-	2	2
Hydraulics	CEN 322	2	1	2	5	3
Remote Sensing and GIS	CEN 321	3	-	1	4	3
Statistics and Probability	MAT 321	2	2	1	5	3
Quantity Surveying	CEN 323	2	1	-	3	2
Reinforced Concrete Design I	CEN 324	2	2	-	4	3
		13	6	4	23	16

- **Surveying camp 2 Weeks. 120 Hours equivalent to 8 practical hours.**

Semester 7 [18 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Water Supply Engineering	CEN 411	2	1	2	5	3
Structural Analysis II	CEN 412	2	2		4	3
Hydrology	CEN 413	3	1		4	3
Design of Steel Structures	CEN 414	2	2		4	3
Soil Mechanics	CEN 415	2	1	2	5	3
Engineering Economics	GEN 411	2	2		4	3
		13	9	4	26	18

Semester 8 [17 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Reinforced Concrete Design II	CEN 421	2	2		4	3
Waste Water Engineering	CEN 422	3	1		4	3
Highway and Transportation Engineering	CEN 423	2	1	3	6	3
Groundwater Engineering	CEN 424	2	1		3	2
Structural Analysis III	CEN 425	3	1		4	3
Construction Management	CEN 426	2	2		4	3
		14	8	3	25	17

Semester 9 [15 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Foundation Engineering	CEN 511	3	1		4	3
Highway construction and Design	CEN 512	3	1		4	3
Dynamics of Structures	CEN 513	3	1		4	3
Hydraulic Structures	CEN 514	3	1		4	3
Elective 1	CEN 52	3	1		4	3
Graduation Project	CEN 590		6		6	-
		15	11	0	26	15

Semester 10 [15 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th	Tut	Lab	Total	
Improvement of Geotechnical Materials	CEN 521	3	-	-	3	3
Computer Applications	CEN 522	2	-	3	5	3
Bridge Design	CEN 523	3	1	-	4	3
Elective 2	CEN 52	3	1	-	4	3
Graduation Project	CEN 590	0	12	-	12	6
		11	14	3	28	15

COURSE OUTLINES:

Title	*Code*	*Semester/Duration*	*Credits*
PHYSICS I	PHY 111	1/Longitudinal	2,1,2

Vectors, particle kinematics and dynamics, work, energy, momentum, angular momentum, conservation laws, rigid bodies, oscillations, temperature, properties of matter. Mechanisms of heat transfer, introduction to kinetic theory of matter. Physical optics: theories of light; diffraction of light; polarization; Waves and oscillations.

.*Title*	*Code*	*Semester/Duration*	*Credits*
CALCULUS I	MAT111	1/Longitudinal	2,2,0

Functions, limits, continuity, differentiation and integration of polynomials, exponential, logarithmic and trigonometric functions, product, quotient and chain rules applications of differentiation to graphing, series, maximum-minimum problems and related rate problems, definite and indefinite integrals, and the fundamental theorem of calculus. Surfaces of revolution, parametric equations, polar coordinates, sequences and series, and Taylor series.

Title	*Code*	*Semester/Duration*	*Credits*
PHYSICS II	PHY121	2/Longitudinal	3,1,2

Electricity and magnetism: Coulomb's law, Gauss's law and its application, Ohm's law, Kirchoff's law; Faradays law of electromagnetic induction, Modern physics: Galilean transformation, special theory of relativity and its consequences; quantum theory of radiation; photo-electric effect, Compton effect, wave particle duality, interpretation of Bohr's postulates, radioactive disintegration, properties of nucleus, nuclear reactions, fission, fusion, chain reaction, nuclear reactor.

Title	*Code*	*Semester/Duration*	*Credits*
GENERAL CHEMISTRY	CHM 111	2/Longitudinal	2,0,3

Atomic law, quantum mechanics and Bohor hydrogen atom, wave mechanics atomic model, periodic table, periodic properties of elements and its relation to electronic structure, chemical and physical bonding: types and properties, electronic bonding and particle structure, bonding forces; Spectroscopy.

Title	*Code*	*Semester/Duration*	*Credits*
Linear Algebra	MAT 112	2/Longitudinal	2,2,0

Geometric vectors in three dimensions, dot product, cross product, lines and planes, complex numbers, systems of linear equations, existence and nonexistence of solutions, matrix algebra: matrix inverse, determinants, Cramer's rule, introduction to vector spaces, linear independence and bases, rank, linear transformations, matrix-matrix Transformation: rotation of sxes, orthogonality and applications, Gram-Schmidt algorithm, Eigen values and eigenvectors.

Title	*Code*	*Semester/Duration*	*Credits*
Calculus II	MAT 121	2/Longitudinal	2,2,0

Applications of integration including areas, volumes, moments, pressure and work, techniques of integration, length of curves, surfaces of revolution, parametric equations, functions of several variables, partial derivatives, implicit functions, multiple integrals, line, surface, and volume integrals, change of variables in multiple integrals .Polar coordinates: polar curves, standard polar curves

Title	*Code*	*Semester/Duration*	*Credits*
Analytic Geometry	MAT 122	2/Longitudinal	2,2,0

Introduction Coordinates. Vector form of a straight line, parametric equations of a straight line, Planes: Equation of a plane, Cylindrical and spherical coordinate: Introduction to cylindrical and spherical Coordinates, Surfaces: Quadratic surfaces, Cylinder and cone: Cylinder, directrix of cylinder, right cylinder, The conic sections, General equation of sphere, great circle.

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Mechanics I (Statics)	MAT 113	2/Longitudinal	2,2,0

Vector operations. Equilibrium of a particle. Free body diagram. Moment of forces about a point and about an axis. Equivalent systems. Equilibrium of a rigid body in two dimensions. Trusses (method of Joints and sections) .Bullys. Friction.

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Mechanics II (Dynamics)	MAT 123	2/Longitudinal	2,2,0

Displacement, velocity and acceleration (and their angular counterparts) - basic dynamics concepts – force, momentum, work and energy - Newton’s laws of motion - basic dynamics concepts - the Work-Energy principle, Impulse-Momentum principle

Title	Code	Semester/Duration	Credits
DIFFERENTIAL EQUATIONS	MAT 211	3/Longitudinal	2,2,0

Ordinary differential equation: formation of differential equations; solution of first order differential equations by various methods; solution of differential equation of first order but higher degrees; solution of general linear equations of second and higher orders with constant co-efficient; solution of Euler's homogeneous linear differential equations.

Partial differential equation: introduction, linear and non-linear first order differential equations; standard forms; linear equations of higher order; equations of the second order with variable coefficients.

Title	Code	Semester/Duration	Credits
INTRODUCTION TO CIVIL ENGINEERING	CEN 211	3/Longitudinal	2,0,0

Civil engineering profession. Civil engineering disciplines. Infrastructures. Building Constructions and management. Remote sensing & GIS. Environmental Engineering. Road Engineering. Bridges. Dams and Irrigation. Site visits..

Title	Code	Semester/Duration	Credits
MECHANICS OF MATERIAL 1	GEN 213	3/Longitudinal	2,2,0

Concepts of stress and strain, constitutive relationships; deformations due to tension, compression and temperature change; beam statics: reactions, axial force, shear force and bending moments; axial force, shear force and bending moment diagrams using method of section and summation approach; elastic analysis of circular shafts, solid noncircular and thin walled tubular members subjected to torsion; flexural and shear stresses in beams; shear centre; thin walled pressure vessels. Tension, direct shear and impact tests of mild steel specimen

Title	Code	Semester/Duration	Credits
ENGINNERING DRAWING	GEN211	3/Longitudinal	1,3,0

Lines and lettering; plane geometry: drawing of linear and curved geometric figures, e.g. pentagon, hexagon, octagon, ellipse, parabola, hyperbola; solid geometry: concept of isometric view and oblique view, theory of projections; drawing of isometric view of 3d objects such as cube, prism, pyramid, cone and cylinder; projections of cube, prism, cone, cylinder; developments

Title	Code	Semester/Duration	Credits
COMPUTER PROGRAMMING	COM 221		2,0,2

Computer organization and hierarchy of programming language, high-level language, arithmetic computations, algorithm design Flowcharts, selection statements, repetition statements, debugging and testing of programmed, logical and character data type, data files and formatted outputs, array processing, Applications.

Title	Code	Semester/Duration	Credits
ENGINEERING GEOLOGY	CEN 213	3/Longitudinal	2,0,0

Introduction. Process of external and internal origin (Volcanic, Metamorphic, Sedimentary), Physical properties and identification of common rock forming minerals, Weathering and Erosion, Discontinuity classification: Joints, faults and other fractures, Folds, unconformities.

Brief Introduction to structural Geology: Seismic Waves, Classification of Earthquakes, Earthquake Geology of Aquifers, Wells, Springs and Ground Water Conditions, Role of geology in selection of sites for civil engineering structures, Brief introduction of local geology

Title	Code	Semester/Duration	Credits
SURVEYING	CEN 212	3/Longitudinal	2,0,3

Distance measurement techniques, Leveling and Contouring: Reduction of levels, adjustments of levels, precise leveling. Theodolite and its Types, Traversing and Triangulation, Tachometry, Plane Table Surveying. Horizontal

control techniques. Survey markers, Observations on Polaris, Computation technique for azimuth determination and Gyro-theodolite. Total Stations.

Title	*Code*	*Semester/Duration*	*Credits*
NUMERICAL METHODS	MAT221	4/Longitudinal	2,2,0

Errors and Approximation. Bisection method, Newton's method, Secant method, Method of false position. Newton's and Gauss interpolating techniques, Simple theorems on divided differences, Lagrange's formula of interpolation, Numerical differentiation. Numerical Integration: Trapezoidal and Simson's rule numerical integration techniques. Solution of differential equations, Euler and modified Euler methods, RungeKutta and KuttaMerson methods.

Title	*Code*	*Semester/Duration*	*Credits*
VECTOR ANALYSIS	MAT 222	4/Longitudinal	2,2,0

Vectors: addition, subtraction, multiplications, vectors products. space curves, arc length, curvature, scalar and vector fields, gradient, divergence and curl. Theorem: the divergence Theorem, Green's theorem in a Plane, Stokes' theorem. Derivation of Gauss's Law, the Heat equation and Navier-Stokes equations.

Title	*Code*	*Semester/Duration*	*Credits*
CIVIL ENGINEERING DRAWING	CEN 221	4/Longitudinal	1,3,0

An introduction in graphical engineering which cover graphical technique and technical drawing principle in order preparing civil engineering drawing. Computer usage in drawing and detailing, Basic CAD practices, Basic AutoCAD usage.

Title	*Code*	*Semester/Duration*	*Credits*
INTRODUCTION TO MECHNICAL ENGINEERING	GEN 221	4/Longitudinal	2,1,2

Basic Concepts: Fundamentals of Heat Transfer, Conduction, Convection, Radiation, Thermal Conductivity, Overall Heat Transfer Coefficients, Practical Equations, Laws of Thermodynamics, Internal Combustion Engines.

Heating Ventilation and Air Conditioning (HVAC): Introduction to HVAC components. Heating and cooling load and its calculations; Comfort charts; Outline of A.C. systems; Consideration for air-conditioning in buildings; natural Ventilations; Insulating materials.

Title	*Code*	*Semester/Duration*	*Credits*
INTRODUCTION TO ELECTRICAL ENGINEERING	GEN 222	4/Longitudinal	2,1,2

Electrical Elements and Circuits: Electric current, voltage, power and energy, Ohm's law, inductance, capacitance, Kirchoff's laws. Introduction to node voltage and loop current methods, AC single and poly-phase system, DC machines, AC Synchronous Machines, AC Induction Machines, Transformers, Converting Machines. Power Plant Installations and Distribution System: Power Systems layout, generation, transmission, distribution and utilization of electric power, Introduction to domestic electrification. Electronics: Diode. Transistor and simple rectifier circuit. Principles of House wiring and Industrial wiring, Illumination. Electrical know how related to experimental design instrumentations like corrosion rate measurements, strain guages, LDT's, LVDT's. etc.

Title	*Code*	*Semester/Duration*	*Credits*
Material Science	GEN 223	4/Longitudinal	2,0,0

Classification of materials. Atomic structure: atomic structure and Inter-atomic bonding., ceramics and polymers. Imperfections in solids. Mechanical properties of materials: Response to Stress, Shear and Torsion. Phase diagrams and transformation in metals. Metal Alloys, Ceramics, and Polymers. Corrosion and degradation of materials.Electrical, Optical ,thermal and magnetic properties: Material selection and design considerations. Economical, environmental and social issues in materials science.

Title	Code	Semester/Duration	Credits
Occupational and Environmental Safety	GEN 224	4/Longitudinal	2,0,0

Methods of toxicology and risk assessment of workplace, hazards, contemporary issues on chemical hazards in the workplace, physical hazards in the workplace, ergonomics, occupational epidemiology, and national, regional and international guidelines, standards and regulations.

Environmental hazards, indoor air quality, ambient air quality, water pollution, solid waste disposal and mining pollution, environmental noise, environmental auditing and impact assessments

Title	Code	Semester/Duration	Credits
Advanced Surveying	CEN 221	4/Longitudinal	2,0,3

Control Surveys: Geodesy, Coordinate Systems and Datum, Modern Methods in Surveying. Computation of areas by various methods, Computation of and volumes by various methods. Height of points from a Digital Terrain Model. Mass-Hall Diagram. Horizontal and vertical curves.

Title	Code	Semester/Duration	Credits
STRUCTURAL ANALYSIS I	CEN 311	5/Longitudinal	2,2,0

Basic principles. Analysis of statically determinate trusses, beams, frames, arches, suspension cables. Influence lines for statically determinate structures. Deflection of structures. Buckling of columns.

Title	Code	Semester/Duration	Credits
ENGINEERING PROPERTIES OF SOIL & MEASUREMENTS	CEN 316	5/Longitudinal	2,0,1

Laboratory Measurements of: Moisture density relationship, Classification and identification of soil, Grain size analysis, Compaction characteristics, Permeability, Consolidation, Shear strength. Associated laboratory experiments.

Title	Code	Semester/Duration	Credits
CONSTRUCTION ENGINEERING	CEN 314	5/Longitudinal	2,0,0

General, Construction Environment. Site work, construction equipment, Substructure, Superstructure, Internal Construction and finishing, Domestic Services.

Title	Code	Semester/Duration	Credits
CONCRETE TECHNOLOGY	CEN 313	5/Longitudinal	2,0,3

Introduction to concrete; component materials for concrete (cement, aggregates, water, chemical admixtures, mineral admixtures); properties of materials, tests on materials; production processes of concrete, tests on fresh concrete; concrete mix design; tests on hardened concrete, properties of hardened concrete, strength, deformation, durability.

Title	Code	Semester/Duration	Credits
FLUID MECHANICS	CEN 312	5/Longitudinal	2,1,2

Introduction to fluid properties and characteristics, static fluid, fluid kinematics, continuity equation, momentum equation and, Bernoulli and energy equation, flow measurement, boundary layers, lift and drag forces. Related laboratory experiments.

Title	Code	Semester/Duration	Credits
MECHANICS OF MATERIAL II	CEN 315	5/Longitudinal	2,2,0

Symmetric and unsymmetric bending of beams; stress transformation, failure criteria; beam deflection by direct integration and moment area method; buckling of columns; elastic strain energy and external work; cable and cable supported structures; bolted, riveted and welded joints.

Title	*Code*	*Semester/Duration*	*Credits*
REINFORCED CONCRETE DESIGN I	CEN 324	6/Longitudinal	2,2,0

Introduction to properties of concrete and reinforcing steel. Behaviour of reinforced concrete under flexure and shear. Introduction to Code of Design. Types of loads and their factors. Ultimate strength method of design. Analysis and design of singly and doubly reinforced sections. Analysis and design of T-section. Design of beams against shear forces. Design of one-way slab and stairways. Development length. Design of isolated, combined and wall footings.

Title	*Code*	*Semester/Duration*	*Credits*
HYDRAULICS	CEN 322	6/Longitudinal	2,1,2

Pipe flow analysis and design. Steady flow in closed conduits and networks. Steady uniform flow in open channels. Non-uniform flows in open channels. Flow measurements. Hydraulic machinery (Pumps and Turbines), Related laboratory experiments.

Title	*Code*	*Semester/Duration*	*Credits*
Statistics and Probability	MAT 322	6/Longitudinal	2,2,0

measures of central tendency and standard deviation; moments, skewness and kurtosis; elementary probability theory and discontinuous probability distribution; continuous probability distributions, e.g. normal and exponential distribution.

Title	*Code*	*Semester/Duration*	*Credits*
REMOTE SENSING AND GIS	CEN 321	6/Longitudinal	3,0,1

Introduction to the basic for GPS and GIS applications; Geodesy: introduction, the ellipsoid and geoids, geodetic position , geoids undulation ,deflection of the vertical, geodetic coordinate system ; Map Projection : projections used in state plane coordinate systems, UTM projection; GPS : overview of GPS, differential GPS, GPS static survey, GPS kinematic survey; GIS: introduction to GIS, GIS data sources and data format, creating GIS databases, GIS applications, use of surveying software such as GeoMedia and Leica Geo Office).
Surveying camp 2 Weeks. 120 Hours equivalent to 8 practical hours.

Title	*Code*	*Semester/Duration*	*Credits*
QUANTITY SURVEYING	CEN 323	6/Longitudinal	2,1,0

Specification of construction items. Bill of Quantities (B.O.Q) & Measurement Book (M.B): Types and methods of estimates, Working out quantities, rates and cost. schedule of rates and specifications; Rate analysis;

Title	*Code*	*Semester/Duration*	*Credits*
STRUCTURAL ANALYSIS II	CEN 412	7/Longitudinal	2,2,0

Analysis of statically indeterminate structures by method of consistent deformations. Method of slope-deflection and moment distribution. Influence lines for statically indeterminate structures. Approximate methods of analyze of multi-sections forms.

Title	*Code*	*Semester/Duration*	*Credits*
Ethics and Professional Practice	CEN 427	7/Longitudinal	2,0,0

Engineering ethics: meaning of ethics, importance of ethics, principles of ethics, required ethical behaviour, code of engineering ethics, responsibilities of professional engineer, professional behaviour. Basics of law for engineers: introduction to Sudanese legal system, law of contract, industrial law, intellectual property law .etc.

Title	***Code***	***Semester/Duration***	***Credits***
SOIL MECHANICS	CEN 415	7/Longitudinal	2,1,2

Seepage theory, soil stresses using elastic theory, Immediate settlement, Total and effective stress principle, consolidation settlement and its rate, Shear strength, Lateral earth pressure, Slope stability, Excavation and bracing. . Associated laboratory experiments.

Title	***Code***	***Semester/Duration***	***Credits***
ENGINEERING ECONOMICS	GEN 411	7/Longitudinal	2,0,0

Economics and engineering; microeconomics and macroeconomics; theory of demand and supply and their elasticity; demand estimation; price determination;, depreciation; Time value of money; cost-benefit analysis; pay-back period, NPV, IRR, inflation; economic feasibility of engineering undertakings.

Title	***Code***	***Semester/Duration***	***Credits***
HYDROLOGY	CEN 413	7/Longitudinal	3,1,0

Principles of Hydrology and Water Resources Engineering. Hydrologic cycle. Measurement of precipitation, evaporation, infiltration and stream flows. Hydrographs. Flood Routing. Reservoir Sedimentation.

Title	***Code***	***Semester/Duration***	***Credits***
DESIGN OF STEEL STRUCTURES	CEN 414	7/Longitudinal	2,2,0

Design of steel structures. Material properties of steel. Allowable stress design approach. Introduction to codes. Connections, tension members, compression members, beam-columns. Beams and girders. Design of frames, trusses and industrial buildings.

Title	***Code***	***Semester/Duration***	***Credits***
Water Supply Engineering	CEN 411	7/Longitudinal	2,2,0

Sources of water and demand requirements, Water quality parameters, Water treatment operations, Water distribution networks, Laboratory Experiments

Title	***Code***	***Semester/Duration***	***Credits***
REINFORCED CONCRETE DESIGN II	CEN 421	8/Longitudinal	2,2,0

Review ACI/Euro- Code provisions. Design of Continuous Beams and Frames: Continuity of reinforced concrete structures, load combinations. Design of Two-way slabs: Edge supported vs. column supported slab systems. Design of rectangular and circular Reinforced Concrete Columns. Axially and eccentrically loaded columns. interaction diagrams. Slender columns and biaxial bending.

Title	***Code***	***Semester/Duration***	***Credits***
TRANSPORTATION ENGINEERING	CEN 423	8/Longitudinal	3,1,2

Transportation as a system; human and vehicle characteristics; traffic flow characteristics; highway capacity analysis; highway control devices; public transportation; urban transportation planning; parking facilities; transportation safety; intelligent transportation system and computer applications; introduction to railway, waterway, airport and pipeline.

Title	*Code*	*Semester/Duration*	*Credits*
WASTEWATER ENGINEERING	CEN 422	8/Longitudinal	3,1,0

Composition of sewage and solid wastes, characterization of sewage, B.O.D. Removal kinetic, Sanitation in developing countries, Wastewater collection: Sanitary sewers systems, Storm water collection, Preliminary, primary and secondary treatment, tertiary & advanced treatment, sludge management and waste stabilization ponds system, Introduction to industrial wastes.

Title	*Code*	*Semester/Duration*	*Credits*
STRUCTURAL ANALYSIS III	CEN 425	8/Longitudinal	3,1,0

Energy methods. Matrix method of structural analysis. Flexibility and stiffness methods. Elastic instability. Limit state analysis of frames.

Title	*Code*	*Semester/Duration*	*Credits*
GROUND WATER ENGINEERING	CEN 424	8/Longitudinal	2,1,0

Groundwater in hydrologic cycle and its occurrence. Physical properties and principles of groundwater movement. Groundwater and well hydraulics. Groundwater resource evaluation. Groundwater levels and environmental influences. Water mining and land subsidence. Groundwater pollution and contaminant transport. Recharge of groundwater. Saline water intrusion in aquifers. Groundwater management

Title	*Code*	*Semester/Duration*	*Credits*
CONSTRUCTION MANAGEMENT	CEN 426	8/Longitudinal	3,1,0

Construction planning, scheduling, and control. Use of computer-based information systems for project management. Value engineering. Critical path method and PERT scheduling techniques. Computer drawn scheduling networks. Schedule compression. Resource allocation leveling and optimization. Project organization and financial control. Decision making.

Title	*Code*	*Semester/Duration*	*Credits*
FOUNDATION ENGINEERING	CEN 511	8/Longitudinal	3,1,0

Application of soil mechanics and other related techniques to design of foundations. Methods of site and soil exploration; bearing capacity and settlements; shallow and deep foundations; bracing and retaining structures. Case studies

Title	*Code*	*Semester/Duration*	*Credits*
HIGHWAY DESIGN AND CONSTRUCTION	CEN 512	9/Longitudinal	3,1,0

Characteristics of driver, pedestrian vehicle, and traffic flow affecting highway design; Geometric design of highways; Layouts of intersections, interchanges and terminals; Highway drainage; Review of highway paving materials; Design of asphalt paving mixtures; Pavement design; Highway construction and supervision; categorization of common pavement surface distress and associated correction activities; Introduction to maintenance management system;

Title	*Code*	*Semester/Duration*	*Credits*
DYNAMICS OF STRUCTURE	CEN 513	9/Longitudinal	3,1,0

Single degree of freedom system, formulation of equation of motion; free vibration response; response to harmonic, impulse and general dynamic loading; vibration analysis by Rayleigh's method; response spectra; two degrees of freedom system.

Title	*Code*	*Semester/Duration*	*Credits*
HYDRAULIC STRUCTURES	CEN 514	9/Longitudinal	3,1,0

Types and functions of hydraulic structures. Gravity Dams. Earth dams. Over weirs and spillways. Energy dissipation hydraulic structures. Hydropower Plants. Hydraulic design of culverts.

Title	*Code*	*Semester/Duration*	*Credits*
ELECTIVE I: FROM CE DEPARTMENT	CEN 55-	9/Longitudinal	3,1,0

Title	*Code*	*Semester/Duration*	*Credits*
GRADUATION PROJECT I	CEN 590	9/Longitudinal	0,3,0

This is the first phase of the capstone project that is a continual project over two semesters, and involves number of students working as one team tackling different aspects of the civil engineering works, which may involve research and development work, engineering design, literature survey, experimental work, theoretical work, computational studies, simulation, and implementation. Students will be assigned an research and development project, and all work conducted during the semester must be compiled in a final report and orally presented to the examining committee at the end of Semester 2.

Title	*Code*	*Semester/Duration*	*Credits*
IMPROVEMENT OF GEOTECHNICAL MATERIALS	CEN 521	10/Longitudinal	3,0,0

Improving performance of soils for engineering applications. Analysis of methods of stabilizing soils and rocks including topics on: Mechanical and chemical stabilization and earth reinforcement. Site Reports

Title	*Code*	*Semester/Duration*	*Credits*
COMPUTER APPLICATIONS	CEN 522	10/Longitudinal	2,0,3

Computers in Engineering. Computer programming methods. Matrix algebra language and co aided design of slabs beams and columns

Title	*Code*	*Semester/Duration*	*Credits*
BRIDGE DESIGN	CEN 523	10/Longitudinal	3,1,0

Superstructure and substructure design. Design of simple span and continuous span bridges, including slab, beam and truss types. Introduction to orthotropic steel plate deck bridges. Suspension bridges.

Title	*Code*	*Semester/Duration*	*Credits*
ELECTIVE II: FROM CE DEPARTMENT	CEN 55-	10/Longitudinal	3,1,0

Title	*Code*	*Semester/Duration*	*Credits*
GRADUATION PROJECT II	CEN 590	10/Longitudinal	0,3,0

This is the implementation phase of the capstone project that is a continual project over two semesters, and involves number of students working as one team tackling different aspects of the civil engineering works, which may involve research and development work, engineering design, literature survey, experimental work, theoretical work, computational studies, simulation, and implementation. Students will be assigned an research and development project, and all work conducted during the semester must be compiled in a final report and orally presented to the examining committee at the end of the Semester.

List of Elective Courses

Title	*Code*	*Semester/Duration*	*Credits*
Introduction to Finite Element Methods	CEN 551	10/Longitudinal	3,1,0

Principles of Finite Element Method of analysis. Definitions and mathematical analysis. Application of principles of Finite Element Methods to the design and analysis of civil engineering structures.

Title	Code	Semester/Duration	Credits
Plastic Analysis	CEN 552	10/Longitudinal	3,1,0

Yield line theory of slabs, yield line, virtual work criterion, application to slabs of different geometry and support condition. Plastic analysis of beams and frames, upper and lower bound theory. Mechanism and static method of analysis. Instantaneous centric plastic moment distribution. Application to beams frames.

Title	Code	Semester/Duration	Credits
Irrigation Engineering	CEN 553	10/Longitudinal	3,1,0

Soil-water relationship as related to application to irrigation water, Irrigation scheduling for crops, Operation of irrigation projects, Design of canals and drains, Irrigation methods, Layout of canalization and drainage systems for agricultural schemes

Title	Code	Semester/Duration	Credits
Pavement Design	CEN 554	10/Longitudinal	3,1,0

Road pavement: flexible & rigid pavement, Pavement structural design, Pavement materials & testing: granular materials, bituminous materials & Asphalt Concrete Mixture, Pavement Construction: construction equipment & construction stages, Highway drainage, Highway maintenance.

Faculty of Engineering and Architecture [Electrical and Electronics Engineering]

VISION AND MISSION

The VISION of this Department is to provide education leading to becoming a highly competent professional in Electrical & Electronics Engineering who will excel in meeting the challenges to serve the society.

The MISSION is to enhance the position of the EEE Department as one of the top teaching and research departments in Sudan by providing the highest quality teaching and learning environment for the students and thus producing competent and compassionate EEE graduates fully equipped to achieve the highest personal and professional standards for the overall development of the university and of the country. Moreover, the Department is dedicated to attracting and sustaining a cluster of faculty members who are, through their quality teaching, research and service, devoted to the development of compassionate EEE graduates.

ENTRANCE REQUIREMENTS

A student interested in joining the Faculty of Engineering, has to:

1. Obtain pass mark in seven subjects including: Arabic language, religious studies, English language, mathematics, physics, chemistry, and computer or engineering sciences. International students who have not studied Arabic and religious studies may have more alternative subjects from an approved list of subjects published in the webpage of Ministry of Higher Education.
2. Achieve the percentage in Sudan School Certificate announced every year (International students may have 10% less in the School Certificate scores.
3. Apply electronically though the website of the Admission and Accreditation Office, Ministry of Higher Education, or apply directly in Admission Office in the National University, and pass the health examination, aptitude tests and interview at the Faculty of Engineering-.
4. Pay the published fees: 30,000 SDG or US $ 3,500 [international students] (2018).

CAREER ADVICE

Graduate from the Faculty of Engineering with B.Sc (EEE) acquires a unique mix of electrical, electronics and computer related courses enabling the students to take-up a professional career / higher studies in any of these areas. Broad range of topics covered includes Electrical Circuits, Electrical Machines, Control Systems, Measurements & Instrumentation, Power Generation, Distribution & Transmission, Analog &Digital System Design, Power Electronics, Microprocessors, Computer Architecture, Data Structures, Digital Signal Processing, Communication Systems, Renewable Energy Systems and Illumination Technology etc. The curriculum will be updated periodically to reflect changes in the Electrical & Electronic Engineering profession in consultation with experts from industries and other renowned academic institutions. The graduate can go in any one of the above

areas, and be immediately enrolled in jobs. A graduate may choose to obtain masters or PhD in the subspecialties of civil engineering. International students are allowed to take engineering jobs in Sudan

FACULTY OBJECTIVES

The objectives of the National University Faculty of Engineering - Electric and Electronic Department are to:

1. Ensure that graduates will have a mastery of fundamental knowledge, problem solving skills, engineering experimental abilities, and design capabilities necessary for entering EE engineering career and/or higher studies.
2. Produce graduates that have the knowledge and skills necessary for identifying and assessing design alternatives and the related social, economic, environmental, and public safety impacts.
3. Produce graduates who have verbal and written communication skills necessary for successful professional practice.
4. Prepare graduates to function effectively on teams.
5. Prepare graduates to deal with ethical and professional issues, taking into account the broader societal implications of Electric and Electronic engineering.
6. Prepare graduates for professional careers, leadership roles and life-long learning.

Curriculum Objectives [Characteristics of the Electrical and Electronic engineering graduate A graduate of the National University- EEE Curriculum should be able to:

1. Show ability to apply knowledge of mathematics and science fundamentals in EE engineering.
2. Act as competent professional with good communication skills and a desire with good knowledge in Electrical & Electronics Engineering.
3. Demonstrate the skills to design and conduct experiments, as well as to analyze and interpret data.
4. Show ability to design a system, component, or process to meet desired needs.
5. Present attitudes to function on multi-disciplinary teams.
6. Identify, formulate and solve engineering problems.
7. Show understanding of professional and ethical responsibility.
8. Communicate effectively.
9. Discuss the impact of EE engineering solutions in a global and societal context.
10. Recognize the need for, and an ability to engage in life-long learning
11. Show awareness of contemporary issues.
12. Use, skillfully the techniques, skills, and modern engineering tools necessary for EE engineering practice.
13. Plan, design, construct, maintain, and operate of large and permanent engineering projects of our civilization
14. Design, develop, test, and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems, and power generation equipment.
15. Design and develop electronic equipment, such as broadcast and communications systems from portable music players to global positioning systems (GPS).
16. Engage in postgraduate studies and research to contribute to knowledge expansion.

Feedback to students after mid-course and end of course assessment is an essential part of the electrical and electronic engineering program

Electrical & Electronics Engineering Study Program

The student has to earn 190 - 194 credit hours to obtain a B.Sc. degree in Electrical & Electronics engineering. The study program me for B.Sc. students distributed over 10 semesters. At the starting of semester 6 each student has to select one of the three specializations:

- Electrical Power engineering (190 credit hours)
- Control Engineering (190 credit hours)
- Communication and Networks Engineering (194 credit hours)

Semester 1 [22 CHs - 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Physics I	PHY111	2	1	2	5	3
Chemistry	CHM 111	2		3	5	3
Calculus I	MAT111	2	2		4	3
Linear Algebra	MAT 112	2	2	-	4	3
Engineering Mechanics I (Statics)	MAT 113	2	2		4	3
English Language I	ENL111	3	-	-	3	3
Engineering Drawing I	GEN 121	1	3		4	2
Sudanese Culture	SCL111	2	-	-	2	2
		16	10	5	31	22

Semester 2 [20 CHs - 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Physics II	PHY 121	2	1	2	5	3
Calculus II	MAT 121	2	2	-	4	3
Analytic Geometry	MAT 122	2	2	-	4	3
Engineering Mechanics II (Dynamics)	MAT 123	2	2	-	4	3
Introduction to Computer	COM121	1	-	2	3	2
English Language II	ENL121	2	2	-	4	2
Engineering Drawing II	GEN121	1	3		4	2
Fundamental of Engineering	GEN122	2	-	-	2	2
		14	12	4	30	21

Semester 3 [20 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Complex Functions	MAT212	2	2	-	4	3
Differential Equations	MAT211	2	2	-	4	3
Structural Programming	COM211	2	-	3	5	3
Material Science and Characteristics	GEN211	2	1	-	3	2
Mechanical Engineering Principles	GEN212	2	2	-	4	3
Electrical Circuits Principles	EEE211	2	1	2	5	3
Technical English for Engineering	ENL211	2	2	-	4	3
		14	10	5	29	20

Semester 4 [19 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Vector Analysis	MAT221	2	2		4	3
Data Structures and Algorithms	COM221	2		3	5	2
Mechanics of Materials	GEN221	2	2	1	5	3
Occupational and Environmental Safety	GEN222	2			2	2
Electrical Circuits Theory	EEE221	2	1	2	5	3
Digital Electronics Systems	EEE222	2	1	2	5	3
Analog Electronics Fundamentals	EEE223	2	1	2	5	3
		14	7	10	31	20

Semester 5 [19 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Communication Skills	CSK311	2			2	2
Statistics and Probability	MAT311	2	2		4	3
Digital Electronics Design	EEE311	2		2	4	3
Electrical and Electronic Drawing	EEE312	1	2		3	2
Electrical Circuits Analysis	EEE313	2	1	2	5	3
Measurements and Instrumentations	EEE314	2	1	2	5	3
Communications Principles	EEE315	2	1	2	5	3
		13	7	8	28	19

Semester 6 (Control & Power) [20 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Numerical Methods	MAT321	2	2		4	3
Computer Aided Design	COM321	1		3	4	2
Analog Electronics Circuits	EEE321	2	1	2	5	3
Control Theory	EEE322	2	2		4	3
Electromagnetic Fields Theory	EEE323	2	2		4	3
Elements of Power Systems	CPE321	2	2		4	3
Electromechanical Conversion	CPE322	2	1	2	5	3
		13	10	7	30	20

Semester 6 (Communications & Networks) [20 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Numerical Methods	MAT321	2	2		4	3
Computer Aided Design	COM321	1		3	4	2
Analog Electronics Circuits	EEE321	2	1	2	5	3
Control Theory	EEE322	2	2		4	3
Electromagnetic Fields Theory	EEE323	2	2		4	3
Objected Oriented Programming	CNE321	2	1	2	5	3
Digital Communications	CNE322	2	1	2	5	3
		13	8	9	30	20

Semester 7(Control)[17 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Engineering Economics	GEN411	2		-	2	2
Sensors and Transducers	EEE411	2	1	2	5	3
Microprocessors and Applications	EEE412	2	1	2	5	3
Electrical Power Utilization	CPE411	2	1	-	3	2
Optimization Techniques	CPE412	2	1		3	2
Electrical Machines	CPE413	2	1	2	5	3
Signals and Systems Analysis	CCN411	2	1		3	2
		14	6	6	26	17

Semester 7(Power) [17 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Engineering Economics	GEN411	2		-	2	2
Sensors and Transducers	EEE411	2	1	2	5	3
Microprocessors and Applications	EEE412	2	1	2	5	3
Electrical Power Utilization	CPE411	2	1	-	3	2
Optimization Techniques	CPE412	2	1		3	2
Electrical Machines	CPE413	2	1	2	5	3
Electrical Power Systems	PRE411	2	1	-	3	2
		14	6	6	26	17

Semester 7 (Communication & Networks) [19 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Engineering Economics	GEN411	2		-	2	2
Sensors and Transducers	EEE411	2	1	2	5	3
Microprocessors and Applications	EEE412	2	1	2	5	3
Computer Networks	CNE411	2	1	2	5	3
Antennas Systems	CPE412	2	1	2	5	3
Software Engineering	CNE413	2	1	2	5	3
Signals and System Analysis	CCN411	2	1	-	3	2
		14	6	10	30	19

Semester 8 (Control) [17 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Engineering Projects Management	GEN421	2			2	2
Research Methodology	GEN422	2		-	2	2
Power Electronics	CPE421	2	1	2	5	3
Digital Signal Processing	CCN421	2	1		3	2
Industrial Control Systems	CPE422	2		2	4	3
Control Systems	COE421	2	1	2	5	3
Instruments Systems and Signals	COE422	2	1		3	2
		14	4	6	24	17

Semester 8 (Power) [17 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Engineering Projects Management	GEN421	2	-	-	2	2
Research Methodology	GEN422	2	-	-	2	2
Power Electronics	CPE421	2	1	2	5	3
Industrial Control Systems	CPE422	2	-	2	4	3
Thermodynamics	PRE421	2	1		3	2
Power Plants Engineering	PRE422	2	1	2	5	3
Power Systems Analysis I	PRE423	2	1	-	3	2
		14	4	6	24	17

Semester 8 (Communication & Networks)[17 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Engineering Projects Management	GEN421	2	-	-	2	2
Research Methodology	GEN422	2		-	2	2
Digital Signal Processing	CCN421	2	1		3	2
Computer Networks Engineering	CNE421	2	1	2	5	3
Satellite Communications	CNE422	2	-	3	5	3
Multimedia Technology	CNE423	2	1	2	5	3
Information Theory and Coding	CNE424	2	-	-	2	2
		14	3	7	24	17

Semester 9 (Control)[18 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Values and Ethics in Profession	GEN511	2	-	-	2	2
Artificial Neural Networks	CCN511	2	2	-	4	3
Multivariable Control Systems	COE511	2	2	-	4	3
Optimal Control Theory	COE512	2	2	-	4	3
Control Systems Analysis	COE513	1	-	3	4	2
Graduation Project I	COE514	-	-	6	6	-
Elective Course 1	COE515	2	2	-	4	3
		11	8	9	28	16

Semester 9(Power)[18 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Values and Ethics in Profession	GEN511	2	-	-	2	2
Power Systems Protection	PRE511	2	1	2	5	3
Electrical Machines Dynamics	PRE512	2	2	-	4	3
Power System Planning	PRE513	2	2	-	4	3
Power System Analysis II	PRE514	1	-	3	4	2
Graduation Project I	PRE515	-	-	6	6	-
Elective Course 1	PRE516	2	2	-	4	3
		11	7	11	29	16

Semester 9(Communication & Networks) [18 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Values and Ethics in Profession	GEN511	2	-	-	2	2
Artificial Neural Networks	CCN511	2	2	-	4	3
Optical Fiber Communications	CNE511	2	1	2	5	3
Cellular and Mobile Communications	CNE512	2	1	2	5	3
Networks Security	CNE513	2	1	-	3	2
Graduation Project I	CNE514	-	-	6	6	-
Elective Course 1	CNE515	2	2	-	4	3
		12	7	10	29	16

Semester 10 (Control)[16 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Microcontroller and Embedded Systems	COE521	2	1	2	5	3
Digital Control Systems	COE522	2	2	--	4	3
Graduation Project II	COE524	--		12	12	6
Elective Course 2	COE525	2	2	-	4	3
Elective Course 3	COE526	2	2	-	4	3
		8	7	14	29	18

Semester 10 (Power)[16 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Power Systems dynamics and Control	PRE521	2	2	-	4	3
Computer Aided Designs of Electrical Machines	PRE522	2	2	-	4	3
Graduation Project II	PRE524	-	-	12	12	6
Elective Course 2	PRE525	2	2	-	4	3
Elective Course 3	PRE526	2	2	-	4	3
		8	8	12	28	18

Semester10 (Communications & Networks) [18 CHs-18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Communications Network Management	**CNE521**	**2**	**1**	**2**	**5**	**3**
Distributed Systems	**CNE522**	**2**	**1**	**2**	**5**	**3**
Communications system Analysis	**CNE523**	**1**	**-**	**3**	**4**	**2**
Graduation Project II	**CNE524**	**-**	**-**	**12**	**12**	**6**
Elective Course 2	**CNE525**	**2**	**2**	**-**	**4**	**3**
Elective Course 3	**CNE526**	**2**	**2**	**-**	**4**	**3**
		9	**6**	**19**	**34**	**20**

Elective Courses for Control

1- Fuzzy Control Systems
2- Nonlinear Control Systems
3- Robust Control Theory
4- Adaptive Control Systems

Elective Courses for Power

1- Special Electrical Machines
2- Power Generation Economics
3- High Voltage Engineering
4- Renewable & Alternative Energy Source

Elective Courses for Communications & Networks

1- Broad Band Wireless Networks
2- Grid Computing
3- Computer Architecture & Organization
4- Network Operating Systems
5- Network and System Administration.

COURSE OUTLINES

Title	*Code*	*Semester/Duration*	*Credits*
Sudanese Studies	**SDS211**	**3/Longitudinal**	**2,0,0**

Sudan: Earth and humans - historical background, cultural Sudan - Sudanese studies on the question of identity in Sudan – the concept of culture applied on the Sudanese Studies - culture characteristics with reference to the Sudanese society - Sudanese heritage, pluralism and diversity - outs Sudanese culture and specificities and its alternatives - curriculum evolutionary - trickle-down approach - descriptive approach - the theory of cultural worlds - the archaeological method - field trips: the national archaeological. Museum, the natural History Museum of ethnography.

Title	*Code*	*Semester/Duration*	*Credits*
Communication Skills	CSK311	5/Longitudinal	**2,0,0**

Review of sentence elements, basic sentence patterns.

Introduction to Communication: Meaning of communication and business communication, nature scope purpose, principles functions and importance, communication model.

Media of Communication: Introduction, written communication, oral communication, face-to-face communication, visual communication, audio-visual communication. Advantages and disadvantages of different media.

Types of Communication: External and internal, formal and informal, downward communication, upward communication, horizontal communication, grapevine, merits and demerits, Media used in different types of communication. Barrier to effective communication and improvement of communication.

Written communication: Letters, memos, reports, writing good business letters, style and structure, pattern and writing techniques

of various business letters, important commercial terms used in office correspondence.

Office memos: Meaning, function and format.

Oral Communication: Speeches, interviews, meetings, conferences, telephonic conversation, techniques, advantages and disadvantages of different oral communication.

On verbal Communication: Symbols gestures, body language, etc. Visual aid in communication. Fundamentals of Report

Writing: Basics of report writing, report structure, the shorter form, long format reports.

Comprehension and Precise Writing: Passage or paragraph related to business management, decision making, developing

business relations. Entering into business deals, import quotations, bids.

Art of Addressing, Meeting and Conference: Preparingand presenting seminar papers.

Technology of Business Communication: Early development of communication technology, changes resulting from new technology. A look of the future.

Use of Computer in Business Communication: Advantages and limitations.

Title	***Code***	***Semester/Duration***	***Credits***
Calculus I	MAT111	1/Longitudinal	**2,2,0**

Introduction to Functions: Mathematical and physical meaning of functions, graphs of various functions. Hyperbolic functions.

Introduction to Limits: Theorems of limits and their applications to functions. Some useful limits, right hand and left hand limits, Continuous and discontinuous functions and their applications.

Derivatives: Introduction to derivatives. Geometrical and physical meaning of derivatives. Partial derivatives and their geometrical significance. Application problems (rate of change, marginal analysis)

Higher derivatives: Leibnitz theorem, Rolles theorem, Mean value theorem. Taylor's and Maclaurin's series.

Applications of derivatives: Asymptotes, tangents and normals, curvature and radius of curvature, maxima and minima of a function

of a single variable (applied problems) differentials with applications.

Applications of Partial Derivatives: Euler's theorem, total differentials, maxima and manima of two variables.

Title	*Code*	*Semester/Duration*	*Credits*
Linear Algebra	**MAT121**	**2/Longitudinal**	**2,2,0**

Introduction to matrices, elementary row operations and vector spaces: Brief introduction to matrices. Symmetric and Hermitian matrices, Introduction to elementary row operations, Echelon form and reduced echelon form. Rank of a matrix. Inverse of a matrix by using elementary row operations. Vector spaces. Vector subspaces. Linear combination, Linear dependence and basis, linear

transformation.

System of Linear equations: System of non-homogeneous and homogeneous linear equations, Gaussian elimination method, Gauss Jardon method, Consistency criterion for solution of homogeneous and non-homogeneous system of linear equations. Applications of system of linear equations.

Determinants: Introduction to determinants, Properties of determinants of order n, Axiomatic definition of a determinant. Applications of determinants (Cramer's Rule).

Title	*Code*	*Semester/Duration*	*Credits*
Calculus- II	**MAT122**	**2/Longitudinal**	**2,2,0**

Integral calculus: Methods of integration by substitutions and by parts. Integration of rational and irrational algebraic functions. Definite integrals, improper integrals, Gamma and Beta functions, reduction formulae.
Applications of integral calculus: Cost function from marginal cost, rocket flights, area under curve.
Vector algebra: Introduction to vectors, Scalar and vector product of three and four vectors. Volume of parallelepiped andtetrahedron.
Vector calculus: Vector differentiation, vector integration and their applications. Operator, gradient, divergence and curl with their
applications.

Title	*Code*	*Semester/Duration*	*Credits*
Analytical Geometry	**MAT123**	**2/Longitudinal**	**2,2,0**

Analytic Geometry of 3-dimensions: Introduction Coordinates of a point dividing a line segment in a given ratio. Vector form of a straight line, parametric equations of a straight line, equation of a straight line in symmetric form, direction ratios and direction cosines, angle between two straight lines, distance of a point from a line, Planes: Equation of a plane, angle between two planes, intersection of two planes, a plane and a straight line, skew lines, Cylindrical and spherical coordinate: Introduction to cylindrical and spherical Coordinates, Surfaces: Quadratic surfaces, degenerate surfaces, symmetry, traces, intercepts of the surfaces, surface of revolution, Cylinder and cone: Cylinder, directrix of cylinder, right cylinder, The cone, Sphere: General equation of sphere, great circle..

Title	*Code*	*Semester/Duration*	*Credits*
Complex Functions	**MAT211**	**3/Longitudinal**	**2,2,0**

Complex numbers system and complex variable theory: Introduction to complex number systems, Argand's diagram, modulus and argument of a complex number, polar form of a complex number. DeMoivre's theorem and its applications, Complex functions, analytical functions, harmonic and conjugate, harmonic functions, cauchy-Rehmunn equations (in Cartesian and polar coordinates). Line integrals, Green's theorem, Cauchy's theorem, Chauchy's integral formula, singularities, poles, residues and contour integration and applications.

Title	*Code*	*Semester/Duration*	*Credits*
Differential Equations	**MAT212**	**3/Longitudinal**	**2,2,0**

Ordinary differential equation: formation of differential equations; solution of first order differential equations by various methods; solution of differential equation of first order but higher degrees; solution of general linear equations of second and higher orders with constant co-efficient; solution of Euler's homogeneous linear differential equations. Partial differential equation: introduction, linear and non-linear first order differential equations; standard forms; linear equations of higher order; equations of the second order with variable coefficients..

Title	*Code*	*Semester/Duration*	*Credits*
Vector Analysis	**MAT221**	**4/Longitudinal**	**2,0,0**

Vector Analysis: Vectors and Scalars, Algebra of vectors, Vector differentiation and vector integration, Gradient, Divergence and Curl. Physical significance of Gradient, Divergence and Curl. Green theorem, Divergence theorem, Gauss and Stoke's theorem and their applications and curvilinear coordinate systems..

Title	*Code*	*Semester/Duration*	*Credits*
Statistics and Probability	**MAT311**	**5/Longitudinal**	**2,2,0**

Mean, Median, Mode and Standard Deviation; Samples Space; Definition of Probability; Conditional Probability; General Multiplication Theorem; Independent Events; Bayes' Theorem; Random Variable; Discrete and Continuous Probability Distributions - Probability mass function; Probability density function; Distribution Function; Expectation; Variance; Probability Distribution—Binomial, Poisson and Normal. Correlation and Regression; Method of Least Squares; Linear Curve Fitting..

Title	*Code*	*Semester/Duration*	*Credits*
Numerical Methods	**MAT321**	**6/Longitudinal**	**2,2,0**

Approximation in numerical computation, Truncation and rounding errors; Interpolation: Lagrange's Interpolation, Newton forward & backward differences Interpolation, Newton divided difference; Numerical Integration: Trapezoidal, Rule, Simson's 1/3 Rule, Weddle' Rule;

Numerical Solution of a system of linear equation Gauss elimination method, Matrix Inversion, LU Factorization method, Gauss Jacobi method, Gauss Seidel method; Algebraic Equation: Bisection method, Secant method, Regular-Falsi method, Newton-Raphson method; Numerical solution of ordinary differential equation: Taylor's series method, Euler's method, Runge-kutta method, and Predictor-Corrector method..

Title	*Code*	*Semester/Duration*	*Credits*
Physics I	**PHY111**	**1/Longitudinal**	**2,1,2**

Physical optics: theories of light; Young's double slit experiment, displacement of fringes and its uses, Fresnel bi-prism, interference at wedge shaped films, Newton's rings, interferometers; diffraction of light; Fresnel and Fraunhoffer diffraction, diffraction by single slit, diffraction from a circular aperture, resolving power of optical instruments, diffraction at double slit and n-slits-diffraction grating; polarization; production and analysis of polarized light, Brewster's law, Malus law, polarization by double refraction, retardation plates, nicol prism, optical activity, polarimeters, polaroid. Waves and oscillations: differential equation of a simple harmonic oscillator, total energy and average energy, combination of simple harmonic oscillations, Lissajous figures, spring-mass system, calculation of time period of torsional pendulum, damped oscillation, determination of damping co-efficient; forced oscillation, resonance, two-body oscillations, reduced mass, differential equation of a progressive wave, power and intensity of wave motion, stationary wave, group velocity and phase velocity, architectural acoustics, reverberation and Sabine's formula. Heat and thermodynamics: principle of temperature measurements: platinum resistance thermometer, thermo-electric thermometer, pyrometer; kinetic theory of gases: Maxwell's distribution of molecular speeds, mean free path, equi-partition of energy, Brownian motion, Vander Waal's equation of state, review of the first law of thermodynamics and its application, reversible and irreversible processes, second law of thermodynamics, Carnot cycle; efficiency of heat engines, Carnots theorem, entropy and disorder, thermodynamic functions, Maxwell relations, Clausius-Clapeyron equation, Gibbs phase rule, third law of thermodynamics.

Title	*Code*	*Semester/Duration*	*Credits*
Physics II	**PHY121**	**2/Longitudinal**	**2,1,2**

Structure of matter : crystalline and non-crystalline solids, single crystal and polycrystal solids, unit cell, crystal systems, coordinations number, crystal planes and directions, NaCl and CsCl structure, packing factor, Miller indices, relation between interplanar spacing and Miller indices, Bragg's law, methods of determination of interplanar spacing from diffraction patterns;
defects in solids*:* point defects, line defects, bonds in solids, interatomic distances, calculation of cohesive and bonding energy; introduction to band theory: distinction between metal, semiconductor and insulator. **Electricity and magnetism**: Coulomb's law, electric field (E), Gauss's law and its application, electric potential (V), capacitors and capacitance, capacitors with dielectric, dielectric and atomic view, charging and discharging of a capacitor, Ohm's law, Kirchoff's law; magnetic field: magnetic induction, magnetic force on a current carrying conductor, torque on a current carrying loop, Hall effect, Faradays law of electromagnetic induction, Lenz's law, self induction, mutual induction; magnetic properties of matter; hysteresis curve; electromagnetic oscillation: L-C oscillations and its analogy to simple harmonic motion. Modern physics: Michelson-Morley's experiment, Galilean transformation, special theory of relativity and its consequences; quantum theory of radiation; photo-electric effect, Compton effect, wave particle duality, interpretation of Bohr's postulates, radioactive disintegration, properties of nucleus, nuclear reactions, fission, fusion, chain reaction, nuclear reactor.

Title	*Code*	*Semester/Duration*	*Credits*
General Chemistry	**CHM121**	**2/Longitudinal**	**2,0,3**

Quantum theory; atomic structure, Bohr's theory, Heisenberg's uncertainty principle, Schrödinger's wave equation, electronic configurations and properties of atoms; electronic configurations and properties of molecules: chemical bond, valence bond theory molecular orbital theory, shape of molecules, bond length, bond energy;

Electrochemistry and battery technology: voltaic cells, electrolytic cells, fuel cells, primary, secondary and reserve batteries.
Characteristics - cell potential, current, capacity, electricity storage density, energy efficiency, cycle life and shelf life. Construction, working and applications of Zinc- Air, Nickel- metal hydride batteries. Lithium batteries: Introduction, construction, working and applications of Li-MnO_2 and Li-ion batteries.
Photochemistry; Photochemistry: Laws of photochemistry - Grotthuss–Draper law, Stark–Einstein law and Lambert-Beer Law. Photoprocesses - Internal Conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-sensitisation.Spectroscopy; Electromagnetic spectrum - Absorption of radiation – Electronic, Vibrational and rotational transitions. Width and intensities of spectral lines. Spectrophotometric estimation of iron. UV-visible and IR spectroscopy – principles, instrumentation (Block diagram) and applications.
Polymer chemistry: Introduction: Classification of polymers – Natural and Synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerisation. Types and mechanism of polymerisation: Addition, condensation and copolymerisation. Properties of polymers: Tg, Tacticity, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerisation: Bulk, emulsion, solution and suspension.
Nanochemistry: Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: Nanocluster, nanorod, nanotube and nanowire. Synthesis: Precipitation, thermolysis, hydrothermal, solvothermal, electrodeposition, chemical vapour deposition Composites - Introduction- definition - constitution- classification- applications of composite materials-fiber reinforced composites-Important types and failures of fiber reinforced composites, Advantages and applications of composites, properties of reinforced composite.

Title	*Code*	*Semester/Duration*	*Credits*
Introduction to Computing	**COM111**	**1/Longitudinal**	**1,0,2**

Introduction to Computer: Overview of Computer organization and historical perspective computer applications in various fields of science and management.

Data representation: Number systems, character representation codes, Binary, hex, octal codes and their inter conversions. Binary arithmetic, Floating-point arithmetic, signed and unsigned numbers.

Introduction to OS and Office Automation: Concept of computing, Introduction to Operating Systems such as DOS, windows2000/Xp, UNIX, Client Server Technology, etc. (only brief user level description). Introduction to World Processing, Spread Sheet & Presentation software e.g. MS-Word, MS-Excel, MS-Power Point.

Introduction to Auto CAD: Coordinate System, 2D drafting: lines, circles, arc, polygon, etc., Editing, 3D, Solid modeling, Rendering, Use of Auto CAD for engineering drawing practices.

Web Technologies: Introduction to World Wide Web, Search engines, e-mail, news, gopher, Audio & Video Conferencing, Internet Protocols: FTP, telnet, TCP/IP, SMTP, HTTP, Languages used for WEB **Technology: HTM**L, practical examples using DHTML and Static HTML.

Title	*Code*	*Semester/Duration*	*Credits*
Structural programming	**COM 211**	**3/Longitudinal**	**1,0,3**

Concept of programming language and its classification, Programming algorithm and flow chart construction. Writing structured programs using C language: data types, constants, variables, operators and expressions, assignments and type conversion in assignments, control flow, functions and program structure, pointers and arrays, strings, advanced data types, pointer to

functions, user defined data types, advanced operators, records, input/ output, dynamic variables, and linked lists,file management, recursion and graphics programming.

Title	*Code*	*Semester/Duration*	*Credits*
Data Structure and Algorithms	**COM221**	**4/Longitudinal**	**1,0,3**

Data structure: Introduction to the data structure, advanced data types, static data types, and dynamic data types, linked lists, operations on linked list, stack, operations on stack, queues, operations on queue trees, operations on trees **Algorithms:** Introduction to sorting algorithms, bubble sorting algorithm, insertion sorting algorithms, introduction to searching algorithm, sequential searching algorithm, binary search algorithm, jump search algorithm, exponential searching algorithm..etc

Title	*Code*	*Semester/Duration*	*Credits*
Occupational and Environmental Safety	**GEN222**	**4/Longitudinal**	**2,0,0**

Occupational Safety: Develop a deep understanding the concepts of occupational safety and hygiene. For example, OSH professionals and the resources available to assist them, contemporary methods of toxicology and risk assessment of workplace hazards, contemporary issues on chemical hazards in the workplace, measurement of chemical hazards in the workplace,

measurement of physical hazards in the workplace, ergonomics, occupational epidemiology, and national, regional and international guidelines, standards and regulations.

Environmental Safety: Understanding the concepts and issues of environmental health, including environmental toxicology and risk

assessment, population dynamics and geographical information systems, environmental hazards, indoor air quality, ambient air

quality, soil pollution, water pollution, sanitation and wastewater treatment, solid waste disposal and mining pollution, environmental noise, emissions control technologies for air, environmental auditing and impact assessments, environmental impact of tourism, national and regional guidelines, standards and regulations, and International guidelines, standards and regulations.

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Economics	**GEN411**	**7/Longitudinal**	**2,0,0**

1. Economic Decisions Making – Overview, Problems, Role, Decision making process.

2. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.

3. Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest.

4. Present Worth Analysis: End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.

5. Cash Flow & Rate Of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost

Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.

6: Uncertainty In Future Events - Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options.

7. Depreciation - Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.

8. Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems.

9. Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.

10. Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Projects Management	**GEN421**	**8/Longitudinal**	**2,0,0**

The Basic Concepts of Management, Process of planning. Project Planning. Financial Management. PERT, CPM. Managerial decision making and its impact on society: with emphasis on the selection of corporate goals, measures of corporate performance and concepts of industrial regulations and legal aspects.
Organization Theory and Process – Leadership – Motivation – Communication – Conflict Management in Organization.
Plant Location – Plant Layout – Production Planning and Control – Product Design and Development – Channels of Distribution. Materials Management – Inventory Control.
Industrial Disputes and their Settlement – Provision of Factories Act and Industrial Disputes Act. Recent Trends in Contemporary Business Environment.

Title	*Code*	*Semester/Duration*	*Credits*
Research Methodology	**GEN422**	**8/Longitudinal**	**2,0,0**

Problem Selection and Information Collection Definition, Objective, Motivation, Types of Research, Significance, Criteria of Good Research. Defining the Research Problem: Definition of Research Problem, Selection of Problem, Necessity of defining the Problems, Techniques involves in defining the problem.

Research Design: Meaning of Research Design, Need for research Design, Features of a Good Design, Different Design Approach.

Sampling and Measuring information Sampling Design: Census And Sample Survey, Implications of A Sample Design, Steps In Sample Design, Criteria of Selecting A Sampling Procedure, Different Types of Sample Designs, How to Select A Random Sample, Random Sample From An Infinite Universe, Complex Random Sampling Designs. Measuring and Scaling Techniques: Measurement in Research, Measurement Scales, Sources of Error In Measurement, Tests of Sound Measurement, Technique of Developing Measurement Tools, Scaling, Scale Classification Bases.

Methods of Data Collection: Collection of Primary Data, Observation Method, Interview Method, Collection of Data, Collection of Secondary Data.

Processing and Analysis of Data Processing Operations, Some Problems In Processing, Elements/Types of Analysis, Statistics In Research, Measures of Central Tendency, Measures of Dispersion, Measures of Relationship, Regression Analysis.

Sampling Fundamentals: Need For Sampling, Important Sampling Distributions, Central Limit Theorem, Sampling Theory, Concept of Standard Error, Estimation, Estimating The Population Mean (M),Estimating Population Proportion, Sample SizeAnd Its Determination

Testing Hypothesis -Basic Concepts Concerning Testing of Hypotheses, Procedure For Hypothesis Testing, Measuring The Power of A Hypothesis Test, Tests of Hypotheses Analysis of Variance and Co-variance : Analysis of Variance (Anova), The Basic Principle of Anova, Anova Technique, Setting up Analysis of Variance Table, Coding Method. Interpretation and Report Writing Meaning of Interpretation, Technique of Interpretation, Precautions in Interpretation, Different Steps in Writing Report, Types of Reports, Precautions for Writing Research Reports

.

Title	*Code*	*Semester/Duration*	*Credits*
Values and Ethics in Profession	**GEN511**	**9/Longitudinal**	**2,0,0**

Science, Technology and Engineering as knowledge and as Social and Professional Activities.

Effects of Technological Growth: Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development

Energy Crisis: Renewable Energy Resources Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics. Appropriate Technology Movement of Schumacher; later developments. Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis.Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology..

Ethics of Profession:

Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.

Profession and Human Values: Values Crisis in contemporary society Nature of values: Value Spectrum of a good life Psychological values: Integrated personality; mental health Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Sudanese Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity.

Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

Basic Engineering Sciences (All Disciplines)

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Mechanics I (Statics)	GEN121	2/Longitudinal	2,2,0

Statics of particles: forces in plane, forces in space, equilibrium, moment of a force, moment of a couple, equivalent systems of forces on rigid bodies, equilibrium in two dimensions, equilibrium in three dimensions, distributed forces: centroids and center of gravity, analysis of structures: trusses, frames and machines, internal forces in beams and cables, friction, moments of inertia of areas, moments of inertia of masses, method of virtual work..

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Mechanics II (Dynamics)	GEN122	2/Longitudinal	2,2,0

Fundamentals of dynamics. Dynamics of particles and rigid body including kinematics and kinetics. Applications of ewton's second law of motion. Analysis of motion in two dimensional and three dimensional spaces. Methods of nergy and momentum. Applications of Dynamics to the engineering concepts..

Title	*Code*	*Semester/Duration*	*Credits*
Workshops Practice	**GEN112**	**2/Longitudinal**	**0,0,6**

Safety Precautions: The use and care of tools and measuring instruments.
Electrical Shop: Electric shock and its treatment, use of megger, wire-guage, phase tester and other electrician's tools, Cables, their sizes, current rating and jointing. Solders and soldering. Main features of domestic installations and appliances, e.g. D.B. system, fluorescent lamps, fans etc. Necessity and methods of earthing, faults and remedies, in wiring circuits. Winding practice of machine coils.
Elementary Machine Shop: Detailed study of center lathe and accessories. Plain and taper turning, simple screw cutting. Cutting tools and their grinding. Introduction of shaper, slotter, planner, pillar and radial drilling machines.
Fitting Shop: The use and care of fitter's tools. Marking out of jobs. Practice in metal filing, sawing, drilling, Die Sinking, tapping and reaming. Introduction and use of power jack saw and arbor press.
Smithy Shop: The use and care of forging tools and blacksmith tools. Open hearth forge, practice in upsetting, drawing out spreading, bending, cutting and punching, hardening and tempering of small cutting tools. Soldering, brazing, electric and gas welding.
Carpentry Shop: The use and care of timber, its defects and preservation methods. Practice in planning and sawing. Different types of wood joints. Study of sawing, planning, turning and turning machines, pattern making.
Foundry & Pattern Shop: Casting and pattern making.

Title	*Code*	*Semester/Duration*	*Credits*
Electrical and Electronics Workshop	**GEN112**	**2/Longitudinal**	**0,0,6**

1.a. Familiarization of wiring tools, lighting and wiring accessories, various types ofwiring systems
b. Wiring of one lamp controlled by one switch.
2. a. Study of Electric shock phenomenon, precautions, preventions; Earthing
b. Wiring of one lamp controlled by two SPDT Switches and one 3 pin plug socketindependently
3. a. Familiarization of types of Fuse, MCB, ELCB etc.
b. Wiring of fluorescent lamp controlled by one switch from panel with ELCB & MCB.
4. a. Study of estimation and costing of wiring
b. Domestic appliance – Wiring, Control and maintenance: Mixer machine, ElectricIron, fan motor, pump motor, Battery etc
5. a. Familiarization of electronic components colour code, multimeters.
b. Bread board assembling - Common emitter amplifier.
6. a. Study of soldering components, solders, tools, heat sink.
b. Soldering practice.

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Drawing I	**GEN124**	**2/Longitudinal**	**0,0,6**

Introduction: Graphics as a tool to communicate ideas, lettering and dimensioning. Construction of geometrical figures like pentagon and hexagon.
Orthographic Projection: Principles of orthographic projection, principal and auxiliary planes, First and third angle projections. Projection of points, pictorial view. Projections of lines parallel to both the plane. Parallel to one and inclined to other, inclined to both the Planes Application to practical problems. Projection of sqlid 1h simple position , Axis or slant edge inclined to one and parallel to other plane, Solids lying on a face or generator on a

plane. Sectioning of solids lying in various positions, true shape of the section. Development of lateral surfaces, sheets metal drawing.
Isometric Projection: Principles of isometric projection, Isometric projection using box and Offset methods.

Title	*Code*	*Semester/Duration*	*Credits*
Material Science and Characteristics	**GEN211**	**3/Longitudinal**	**2,1,0**

Introduction: Classification of materials; Structure-property Relations; Metals & Alloys, Ceramics, Polymers, Composites and Semiconductors. Atomic Structure & Inter atomic Bonding; Fundamentals of Atomic Structure and Chemical Bonding; Atomic

Bonding in Solids. Phase Diagrams: Phase Rules; Single component and Binary Phase diagrams; The Level Rule; Hume-Rothery rules of alloying.

Diffusion in solids: Fick's Laws of Diffusion; The Atomic Model of Diffusion Phase. **Transformations**: Nucleation and Growth, Recovery, Re crystallization and Grain Growth. Environmental Degradation of materials: Oxidation and Corrosion; Thermal and Photo Degradation; Chemical Degradation; Radiation Damage. Structure of solids: Crystalline and Non-crystalline states; Crystallographic directions and phases; Determination of crystal structures.

Defects and imperfections in solids: Point, Line and Planer defects; Interfacial defects and volume defects; impurities in solids. Elastic, Plastic and Viscoelastic Behavior of materials: Stress-strain relationship; relaxation and creep; strengthening mechanism

and fracture. Thermal properties of materials: Heat capacity; Thermal expansion and thermal conductivity.

Electrical properties: Electronic and Ionic conduction; Energy Band structures in solids; Electron Mobility; Temperature variation of conductivity.

Dielectric behavior: Capacitance; Types of polarization; Frequency dependence of dielectric constant; Ferroelectricity and Piezoelectricity in materials.

Magnetic properties: Diamagnetic; Ferromagnetic, antiferromagnetic and Ferrimagnetic behavior of materials; soft and hard magnetic materials; superconductivity.

Optimal properties: Light interaction with solids; Absorption, Transmission and Reflection; Luminescence; Photoconductivity; Lasers. Materials selection: Material properties and Engineering Design parameters; General effects of processing on parameters; selection of structural; Electronic and Magnetic Materials – case studies..

Title	*Code*	*Semester/Duration*	*Credits*
Mechanical Engineering Principles	**GEN212**	**3/Longitudinal**	**2,1,0**

Basic Concepts: Fundamentals of Heat Transfer, Conduction, Convection, Radiation, Thermal Conductivity, Overall Heat Transfer Coefficients, Practical Equations, Laws of Thermodynamics, Internal Combustion Engines. Heating Ventilation and Air Conditioning (HVAC): Introduction to HVAC components. Heating and cooling load and its calculations;
Comfort charts; Outline of A.C. systems; Consideration for air-conditioning in buildings; natural Ventilations; Insulating materials..

Title	*Code*	*Semester/Duration*	*Credits*
Engineering Drawing II	**GEN213**	**3/Longitudinal**	**1,3,0**

Introduction: Graphic language, Classification of drawings, principles of drawing: IS codes for Machine Drawing, lines, Scales, Sections, Dimensioning, Standard abbreviations.

Orthographic Projections: Principles of first and third angle projections, drawing and sketching of machine elements in Orthographic projections, spacing of views.

Screwed (Threaded) Fasteners: Introduction, Screw thread nomenclature, forms of threads, Thread series, Thread Designation. Representation of threads, Bolted Joints, Locking arrangements, Foundation Bolts. Keys and Cotters: Keys, Cotter Joints.

Shaft Couplings: Introduction, Rigid and flexible coupling.

Riveted Joints: introduction, Rivets and riveting, Rivet heads Classification of riveted

Assembly drawing: Introduction, Engine parts, Stuffing box etc. Free hand sketching: Introduction, Need for freehand sketching, Free hand of Sketching of some threaded fasteners and simple machine Components..

Title	*Code*	*Semester/Duration*	*Credits*
Electrical Circuits Principles	**EEE211**	**3/Longitudinal**	**2,1,2**

Electrical Elements and Circuits: Energy and Energy transfer, Electric charge, electric current, potential difference & voltage, Electric power & energy, Electric circuits, sources, resistance, specific resistance temperature coefficient of resistance, Ohm's law, Fundamental circuit laws, Kirchoff's laws, Direct applications of fundamental laws to simple resistive networks, Introduction to node voltage and loop current methods.

Capacitance: permittivity expression for capacitance, Charging and discharging, series and parallel connection of capacitors.

Title	*Code*	*Semester/Duration*	*Credits*
Electrical Circuits Theory	**EEE221**	**4/Longitudinal**	**2,1,2**

Generation of alternating e.m.f, introduction to periodic functions, RMS or effective, Average and maximum values of current & voltage for sinusoidal signal wave forms. Introduction to phasor representation of alternating current. Power and A.C. circuit, active power, reactive power apparent power and power factor..

Title	*Code*	*Semester/Duration*	*Credits*
Digital Electronics Systems	EEE222	4/Longitudinal	2,1,2

Introductory Concepts: Number Systems, Base Conversion Methods, Complements of Numbers, Codes, Error detecting and Error Correcting Codes.
Minimization of Boolean Functions: Standard forms of Boolean Functions, Simplification of Functions – Karnaugh map and QuineMcClusky methods, multiple output functions.
Logic Gates: Symbols and Truth Tables of Gates – AND, OR, NOT, NAND, NOR, XOR, Multiplexers, Demutiplexers, Encoders, Decoders.
Combinational Logic: Logic Design of Combinational circuits – Binary addition, Subtraction, Code Conversion, Priority Encoders, Decoders, Seven segment Displays, Comparators, PLAs.

Title	*Code*	*Semester/Duration*	*Credits*
Electrical and Electronic Drawing	EEE312	5/Longitudinal	1,2,0

Electrical and Electronic Symbols: Electrical and Electronic symbols use in Electrical and Electronic installations like light, power, alarm and control circuits etc. Simple Light Circuits: Schematic and wiring diagrams for the following circuits:

- Light and fan points controlled by individual switches

- Fluorescent tube controlled from one switch

- One lamp controlled by two switches (stair case circuit)

- Two lamps controlled by three switches (Double staircase circuit)

Simple Alarm Circuits Without and With Relays Schematic and wiring diagrams for the following circuits:

- One bell controlled by one push button

- Two ordinary bells (for day and night) used at a Doctor's residence.

- Bell response circuit using one bell and a relay

- Bell response circuit of an office (for three rooms)

- Traffic control light system for two road crossing

- A light circuit which gets automatically connected to DC supply in case of power failure

House Wiring: Installation plan, single line wiring diagram, selection and rating of necessary equipment and to prepare a list of material required for electrical wiring of a small house (In batten/concealed conduit system). Determination of sizes of distribution boards for multistoried buildings. Introduction to concept of rate schedules

Service Line Connection: Layout diagram (from supply pole to building) and to prepare a list of material required for giving service line connection (For single phase and three phase small loads) Power **Wiring For a Small Workshop**: Installation plan, single line wiring diagram, selection and rating of necessary equipment and to prepare a list of material required for a small workshop. Determination of sizes of panels for given loads. Introduction to concept of rate schedule.

Title	***Code***	***Semester/Duration***	***Credits***
Digital Electronics Design	EEE311	5/Longitudinal	2,0,2

Sequential Machine Fundamentals: The Flip-flop – RS, JK and D Flip-flops, the Design of Clocked Flip-flop, Flipflop conversion from one type to another. Counters and Registers.
Traditional Approaches to Sequential Analysis and Design: Analysis and Design of Finite State Machines, State Reduction, Design of Flipflops, Counters and Shift Registers.
Asynchronous Finite State Machines: Analysis and Design of Asynchronous Machines, Cycles, Races and Hazards.

Title	***Code***	***Semester/Duration***	***Credits***
Analog Electronics Fundamentals	**EEE223**	**4/Longitudinal**	**2,1,2**

Energy Band Theory of Solids: Intrinsic and Extrinsic Semiconductors Doping, Doping Materials, Carrier Mobility, Conductivity, Diffusion and continuity equation, Hall – Effect and its Application.

Semiconductor Diodes: Band structure of PN Junction, Quantitative Theory of PN Diode, Volt – Amp. Characteristics, Temperature Dependence, Transition and Diffusion Capacitance of PN Junction, Zener and Avalanche Breakdowns, Tunnel Diode, LED, Schottky Barrier Diode, Varactor Diode, Photo Diode, PIN Diode, Point Contact Diode.

Diode Rectifiers: Half-wave, Full-wave and Bridge Rectifiers with and without Filters, Ripple Factor and Regulation Characteristics.

Bipolar Junction Transistor: NPN and PNP junction Transistor, Characteristics of Current Flow across the Base Regions, Minority and Majority Carrier Profiles, CB, CE and CC Configurations and their Input and Output Characteristics. Comparison of CE, CB and CC Configurations. Junction Biasing for Saturation, Cutoff and Active Region, Ș and ș Parameters and the relation between them.

JFET: JFET and its characteristics, Pinch off Voltage, Drain Saturation Current, MOSFET – Enhancement and Depletion Modes, Small signal models of FET.

Transistor Biasing Circuits: Various Biasing Circuits and Stabilization, Thermal Runaway, Thermal Stability, Biasing of FETs. Small Signal – Low Frequency Transistor Biasing Circuits: Transistor as an Amplifier, h – parameter model, Analysis of Transistor Amplifier Circuits using h – parameters. CB, CE and CC Amplifier configurations and performance factors. Analysis of Single Stage Amplifier, RC Coupled Amplifiers. Effects of Bypass and Coupling Capacitors. Frequency Response of CE Amplifier, Emitter – Follower, Cascaded Amplifier, High Frequency model of Transistor.

Title	*Code*	*Semester/Duration*	*Credits*
Electrical Circuits Analysis	**EEE313**	**5/Longitudinal**	**2,1,2**

Network Theorems: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, star delta transformation for D.C and A.C circuits. Single-phase and three phase circuit analysis.

Two port network: Introduction, characterization of linear time-invarient, two ports by six sets of parameters. Relationship among parameter sets. Inter connection of two ports.

Title	*Code*	*Semester/Duration*	*Credits*
Measurements and Instrumentations	**EEE314**	**5/Longitudinal**	**2,1,2**

Measurements: Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors, loading effect due to shunt and series connected instruments.

Analog meters: General features, Construction, Principle of operation and torque equation of Moving coil, Moving iron, Electrodynamometer, Induction instruments, Principle of operation of the Electrostatic, Thermoelectric, Rectifier type instruments, Extension of instrument ranges and multipliers.

Instrument transformer: Disadvantage of shunt and multipliers, Advantage of Instrument transformers, Principle of operation of Current& Potential transformer, errors.

Measurement of Power: Principle of operation of Electrodynamic& Induction type wattmeter. Wattmeter errors.

Measurement of resistance: Measurement of medium, low and high resistances, Megger.

Measurement of Energy: Construction, theory and application of AC energy meter, testing of energy meters.

Potentiometer: Principle of operation and application of Crompton's DC potentiometer, Polar and Co-ordinate type AC potentiometer. Application.

AC Bridges: Measurement of Inductance, Capacitance and frequency by AC bridges.

Cathode ray oscilloscope (CRO): Measurement of voltage, current, frequency & phase by oscilloscope. Frequency limitation of CRO. Sampling and storage oscilloscope, Double beam CRO.

Electronic Instruments: Advantages of digital meter over analog meters, Digital voltmeter, Resolution and sensitivity of digital meters, Digital multimeter, Digital frequency meter, Signal generator.

Title	*Code*	*Semester/Duration*	*Credits*
Communications Principles	**EEE315**	**5/Longitudinal**	**2,1,2**

Linear Modulation Systems: Need for Modulation, Frequency Translation, Method of Frequency Translation, Amplitude Modulation, Modulation Index, Spectrum of AM Signal, Modulators and Demodulators (Diode detector), DSB-SC Signal and its Spectrum, Balanced Modulator, Synchronous Detectors, SSB Signal, SSB Generation Methods, Power Calculations in AM Systems, Application of AM Systems.

Angle Modulation Systems: Angle Modulation, Phase and Frequency Modulation and their Relationship, Phase and Frequency Deviation, Spectrum of an FM Signal, Bandwidth of Sinusoidally Modulated FM Signal, Effect of the Modulation Index on Bandwidth, Spectrum of Constant Bandwidth FM, Phasor Diagram for FM Signals,

FM Generation: Parameter variation method, Indirect method of Frequency Modulation (Armstrong Method), Frequency Multiplication, PLL FM Demodulator, Pre – emphasis and De – emphasis, Comparison of FM and AM.Noise In AM and FM Systems: Sources of Noise, Resistor Noise, Shot Noise, Calculation of Noise in a Linear System, Noise in AM Systems, Noise in Angle Modulation Systems, Comparison between AM and FM with respect to Noise, Threshold Improvement in Discriminators, Comparisons between AM and FM.

Radio Transmitters: Classification of Radio Transmitters, AM and FM Transmitters, Radio Telegraph and Telephone Transmitters, SSB Transmitters.

Radio Receivers: Radio receiver Types, AM Receivers – RF Section, Frequency Changing and Tracking, Intermediate Frequency and IF Amplifiers, Automatic Gain Control (AGC); FM Receivers – Amplitude Limiting, FM Demodulators, Ratio Detectors, ISB Receiver, Comparison with AM Receivers.

Communication Receivers: Extensions of the Super-heterodyne Principles, Additional Circuits..

Title	*Code*	*Semester/Duration*	*Credits*
Analog Electronics Circuits	**EEE321**	**6/Longitudinal**	**2,1,2**

Multistage Amplifiers: BJT and FET RC Coupled Amplifiers – Frequency Response. Cascaded Amplifiers. Calculation of Band Width of Single and Multistage Amplifiers. Concept of Gain Bandwidth Product.

Feed back Amplifiers: Concept of Feedback Amplifiers – Effect of Negative feedback on the amplifier Characteristics. Four Feedback Amplifier Topologies. Method of Analysis of Voltage Series, Current Series, Voltage Shunt and Current Shunt feedback Amplifiers.

Sinusoidal Oscillators: Condition for oscillations –LC Oscillators – Hartley, Colpitts, Clapp and Tuned Collector Oscillators –Frequency and amplitude Stability of Oscillators – Crystal Oscillators – RC Oscillators -- RC Phase Shift and Wein bridge Oscillators.

Power Amplifiers: Classification of Power Amplifiers – Class A, Class B and Class AB power Amplifiers. Series Fed, Single Ended Transformer Coupled and Push Pull Class A and Class B Power Amplifiers. Cross-over Distortion in Pure Class B Power Amplifier, Class AB Power Amplifier – Complementary Push Pull Amplifier with trickle Bias, Derating Factor – Heat Sinks.

Tuned Voltage Amplifiers: Single Tuned and Stagger Tuned Amplifiers – Analysis – Double Tuned Amplifier – BandwidthCalculation.

Operational Amplifiers: Concept of Direct Coupled Amplifiers. Ideal Characteristics of an operational Amplifier – Differential Amplifier - Calculation of common mode Rejection ratio – Differential Amplifier supplied with a constant current – Normalized Transfer Characteristics of a differential Amplifier – Applications of OP-Amp as an Inverting and Non-Inverting Amplifier, Integrator, Differentiator Summing and Subtracting Amplifier and Logarithmic Amplifier. Parameters of an Op-Amp, Measurement of OP-Amp Parameters.

Title	*Code*	*Semester/Duration*	*Credits*
Control Theory	**EEE322**	**6/Longitudinal**	**2,2,0**

Input / Output Relationship: Introduction to open loop and closed loop control systems, mathematical modeling and representation of physical systems (Electrical, Mechanical and Thermal), derivation of transfer function for different of types of systems, block diagram & signal flow graph, Reduction techniques, Mason's Gain formula.

Time – Domain Analysis: Time domain performance criteria, transient response of first, second & higher order systems, steady state errors and static error constants in unity feedback control systems, error criteria, generalized error constants, performance indices, response with P, PI and PID controllers.

Frequency Domain Analysis: Polar and inverse polar plots, frequency domain specifications, Logarithmic plots (Bode plots), gain and phase margins, relative stability. Correlation with time domain, constant M & N circles, close loop frequency responses, from open loop response.

Concept of Stability: Asymptotic stability and conditional stability, Routh – Hurwitz criterion, Nyquist stability criterion, Root locus plots and their applications.

Title	*Code*	*Semester/Duration*	*Credits*
Electromagnetic Fields Theory	**EEE323**	**6/Longitudinal**	**2,2,0**

Electrostatics: Coulomb‟s law, force, electric field intensity, flux density, Gauss‟s law and its application, electrostatic potential, boundary conditions, method of images, Laplace‟s and Poisson ‟s equations, energy of an electrostatic system, conductors and
dielectrics.

Magnetostatics: Concepts of magnetic field, Ampere‟s law, Biot-Savart‟s law, vector magnetic potential, energy of magnetostatic system, mechanical forces and torques in electric and magnetic fields. Curvilinear co-ordinates, rectangular, cylindrical and spherical coordinates, solutions to static field problems. Graphical field mapping with applications, solution to Laplace equations, rectangular, cylindrical and spherical harmonics with applications.

Maxwell‟s equations: their derivatives, continuity of charges, concepts of displacement currents. Boundary conditions for timevarying systems. Potentials used with varying charges and currents. Maxwell‟s equations in different coordinate systems.

Title	*Code*	*Semester/Duration*	*Credits*
Sensors and Transducers	**EEE411**	**7/Longitudinal**	**2,1,2**

Mechanical and Electromechanical sensor: Definition, principle of sensing & transduction, classification.

Resistive (potentiometric type): Forms, material, resolution, accuracy, sensitivity.

Strain gauge: Theory, type, materials, design consideration, sensitivity, gauge factor, variation with temperature, adhesive, rosettes.

Inductive sensor: common types- Reluctance change type, Mutual inductance change type, transformer action type, Magnetostrictive type, brief discussion with respect to material, construction and input output variable, Ferromagnetic plunger type, short analysis.

LVDT: Construction, material, output input relationship, I/O curve, discussion.

Proximity sensor

Capacitive sensors: Variable distance-parallel plate type, variable area- parallel plate, serrated plate/teeth type and cylindrical type, variable dielectric constant type, calculation of sensitivity. Stretched diaphragm type: microphone, response characteristics.

Piezoelectric element: piezoelectric effect, charge and voltage co-efficient, crystal model, materials, natural & synthetic type, their comparison, force & stress sensing, ultrasonic sensors.

Thermal sensors: Material expansion type: solid, liquid, gas & vapor

Resistance change type: RTD materials, tip sensitive & stem sensitive type, Thermister material, shape, ranges and accuracy specification.
Thermo emf sensor: types, thermoelectric power, general consideration,Junction semiconductor type IC and PTAT type.
Radiation sensors: types, characteristics and comparison. Pyroelectric type.
Magnetic sensors: Sensor based on Villari effect for assessment of force, torque, proximity, Wiedemann effect for yoke coil
sensors, Thomson effect, Hall effect, and Hall drive, performance characteristics.
Radiation sensors: LDR, Photovoltaic cells, photodiodes, photo emissive cell types, materials, construction, response. Geiger counters, Scintillation detectors, Introduction to smart sensors.

Title	*Code*	*Semester/Duration*	*Credits*
Microprocessors and Applications	**EEE412**	**7/Longitudinal**	**2,1,2**

Internal Architecture and Functional Description of INTEL 8085, Microprocessor Interrupt Structure of 8085, Instruction Set and Timing Diagrams.
Programming The 8085: Introduction to 8085 Assembly Language Programming, Sample Programs - Stack and Subroutines.
Interfacing Semiconductor Memory Devices To 8085: Classification and Internal Organization of Semiconductor Memory Devices, Interfacing of SRAMs, DRAMs and EPROMs. Interfacing I/O Devices to 8085: Parallel I/O (8255A), Timer/Counter (8253), Serial I/O (8251A), Keyboard/Display Interface.
Data Converters: ADC, DAC, and their Interfacing to 8085. Elementary Concepts of 16Bit and 32Bit Microprocessors, like INTEL 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro..

Title	*Code*	*Semester/Duration*	*Credits*
Computer Aided Design	**COM321**	**6/Longitudinal**	**1,0,3**

MATLAB basics: The MATLAB environment - Basic computer programming - Variables and constants, operators and simple calculations - Formulas and functions - MATLAB toolboxes.

Matrices and vectors: Matrix and linear algebra review - Vectors and matrices in MATLAB - Matrix operations and functions in MATLAB.

Computer programming: Algorithms and structures - MATLAB scripts and functions (m-files) - Simple sequential algorithms - Control structures (if…then, loops).

MATLAB programming: Reading and writing data, file handling - Personalized functions - Toolbox structure - MATLAB graphic functions.

Numerical simulations: Numerical methods and simulations - Random number generation - Montecarlo methods.

Hands-on session: Interactive hands-on-session where the whole class will develop one or more MATLAB scripts that solve an assigned problem.

Applied Sciences (Control)

Title	*Code*	*Semester/Duration*	*Credits*
Elements of Power Systems	**CPE321**	**6/Longitudinal**	**2,2,0**

General layout of a power system and its components, generation, transmission, distribution, utilization, control, thermal generation and its different types, hydro-electric generation, renewable energies, comparison of methods of generation.

Overhead transmission line: Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phase symmetrical and unsymmetrical configurations. Bundle conductors. Transposition. Concept of GMD and GMR. Influence of earth on conductor capacitance.

Overhead line construction: Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers.

Insulators: Types, Voltage distribution across a suspension insulator string, String efficiency, Arching shield & rings, Methods of

improving voltage distribution across Insulator strings, Electrical tests on line Insulators.

Corona: Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.

Cables: Types of cables, cable components, capacitance of single core & 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.

Characteristics and Performance of transmission lines: Short, medium (nominal, T) and long lines and their representation.A.B.C.D constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.

Tariff: Guiding principle of Tariff, different types of tariff.

Sudanese Electricity Rule: General Introduction..

Title	*Code*	*Semester/Duration*	*Credits*
Electromechanical Conversion	**CPE322**	**6/Longitudinal**	**2,1,2**

Electromechanical Energy Conversion: Forces and torques in magnetic field systems. Energy balance. Singly excited system. Coenergy. Multiply excited system. Dynamic equations.

D.C. Machines Fundamentals: Simple linear machine. A loop rotating between pole faces. Communication. Armature construction. Armature reaction. Induced voltage and torque equation. Construction. Power flow and losses.

D.C. Generators: Equivalent circuit Magnetization curve. Separately existed; shunt, series and compounded generators. Paralleloperation.

D.C. Motors: Equivalent circuit. Separately excited; Shunt, permanent magnet, series and compounded motors.

Speed control of DC motors: Starters, speed control methods for series, shunt and compound motors, series parallel control for traction motor, multivoltage control, plugging, Dynamic braking, testing efficiency and temperature rise, determination of losses,

divert and indirect test, estimation of temperature rise of armature, commutator and field winding, Efficiency. **Transformers**: Transformer Fundamentals, Importance of transformers. Types and construction. Ideal transformer. Theory andoperation of real Single-phase transformers phasor diagrams. Leakage reactance. Losses. Equivalent circuit parameters. No load and short circuit test per Unit systems. Voltage regulation and efficiency. Autotransformers. Tapping. Parallel operation and load division. Inrush current. Exciting current. Three phase transformer. Per unit system. Three phase connections and harmonic Suppression. Vector groups. Three phase transformation using two transformers.

Title	*Code*	*Semester/Duration*	*Credits*
Electrical Power Utilization	**CPE411**	**7/Longitudinal**	**2,1,0**

Radiation and vision: Physics of light-wave theory, quantum theory, unified theory, photon generation, visible wavelength range, standard observer curve, different forms of energy converted to visible radiation, spectral power distribution curve. Quantities, units, standards and measurement:

Luminous energy, luminous flux, spectral radiant flux, solid angle, luminous intensity, luminance, illuminance, luminous efficacy. Colour temperature, colour rendering index, reflectance, diffuser, etc. Lambert's cosine law, inverse square law and cosine law of illumination. Polar curve, Roussea's diagram, illuminance (flux) meter, bench photometer (intensity measurement), integrating sphere (flux measurement).Optical system of human eye.

Sources of light: Construction and electrical circuits of different sources of light, filament lamps, halogen temps, discharge lamps -sodium and mercury high pressure discharge lamps, tube and CFL lamps.

Lighting calculations for indoor and outdoor applications: Shop lighting, factory lighting, street lighting, flood lighting. Electric heating, welding and electroplating: Induction heating—principle of operation, scope of high frequency and low frequency heating, induction heating, power supplies at different frequencies.Induction heating furnaces—coreless and core types.

Arc heating: AC arc heating—different arc electrodes, direct and indirect arc furnace and their power supply systems, electrode regulators, condition for maximum output, necessity of reactor in arc furnace, general arc furnace transformer construction, energy balance in arc furnace, advantages of direct arc furnaces. DC arc furnace supply system, different bottom electrodes, twin shell DC EAF (electrode arc furnace) system, advantages of DC archeating.

Dielectric heating: Principle of operation, choice of voltage and frequency, electrode configuration.

Resistance heating: Different resistance heating materials and their properties, causes of failures. Direct and indirect resistance heating furnace. Design of resistance elements.

Electric welding: Resistance and arc welding and equipment for such welding.

Electrolysis: Application of electrolysis, electro deposition, electro extraction, electrorefining.

Title	***Code***	***Semester/Duration***	***Credits***
Optimization Techniques	CPE412	7/Longitudinal	2,1,0

Linear Programming:- Introduction-Formulation of LP, Solution to LP-Graphical method. Simplex method-Big M method-Two phase method. Dual Simplex method-Revised simplex method, Duality. Transportation models, Assignment models.

Dynamic Programming:- Introduction-Formulation of DP, Principle of optimality, System reliability, Solution of LPP by DP. Application of DP in shortest route-cargo handling-allocation-scheduling problem. Network models: - CPM and PERT.

Nonlinear programming:- Introduction-Formulation of NLP, local and global optimum, concave and convex functions, types of NLP. Unconstrained one –d optimization: - Necessary and sufficient conditions, unrestricted search methods-Region elimination methods-Dichotomous search-Interval halving method, Fibonacci method-Golden section method, Gradient search methods-Bisection method-Secant method-Newton Raphson method-Quadratic interpolation method.

Multivariable NLP without constraints:- Classical methods-limitations, Numerical methods Univariant method-Conjugate direction method-Steepest descend method-Newtons method. Multivariable NLP with constraints:-Necessary and sufficient conditions-Equality and inequality constraints, Kuhn Tucker conditions, Gradient projection method-cutting plane method-penalty function method.

Title	***Code***	***Semester/Duration***	***Credits***
Electrical Machines	**CPE413**	**7/Longitudinal**	**2,1,2**

Induction machines: Construction, Double revolving field theory, Cross field theory, Starting methods, Speed-Torque characteristics, Phasor diagram, Condition of Maximum torque, Determination of equivalent circuit parameters, Testing of Single phase motors, Applications. Single phase AC series motor, Compensated and uncompensated motors.

3-Phase Induction machine: Induction motor as a Transformer, Flux and MMF phasors in Induction motors, Equivalent circuit, Performance equations, Induction motor phasor diagram· Toque-slip characteristic, Power slip characteristic, Determination of equivalent circuit parameters. Methods of

starting of squirrel Cage and Wound rotor Motors. Speed control of Induction motor· Polarity Test, Application of Polyphase Induction motor.

Synchronous Machines: Construction, Types, Excitation systems, Generator & Motor modes, Armature reaction, Theory for salient pole machine, Two reaction theory, Voltage regulation (EMF,MMF, ZPF). Operating characteristics of Alternators and their rating. Power angle characteristics of Synchronous machines.

Parallel operation of Alternators, Synchronous machine connected to infinite bus, effect of change of excitation and speed of prime mover. Starting of Synchronous motor, V-curve. Damper winding, Hunting. Short circuit transients. Applications.

Title	*Code*	*Semester/Duration*	*Credits*
Power Electronics	**CPE421**	**8/Longitudinal**	**2,1,2**

Introduction: Concept of power electronics, application of power electronics, uncontrolled converters, advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS,IGBT and GTO.

PNPN devices: Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.

Phase controlled converters: Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of free wheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters.

DC-DC converters: Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers and switching mode regulators.

Inverters: Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. Brief idea of Resonant Pulse inverters.

AC controllers: Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads. Principle of operation of cycloconverters, circulating and non circulating mode of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconvetter.

Applications: Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS, static VAR controller.).

Title	*Code*	*Semester/Duration*	*Credits*
Industrial Control Systems	**CPE422**	**8/Longitudinal**	**2,0,2**

Introduction to Programmable Logic Controllers: Overview, Functions & Features , Typical areas of Application , PLC vsPersonal Computers , PLC vs Dedicated Controllers , Logic Contact Symbology , Binary & Hexadecimal conversions , Input / output addressing .

PLC Hardware: Backplane & Rack , Power Supply Module , Programmable Controller , Discrete Input / output Modules , Analog Input / output Modules , Special Function Input / output Modules , Network Interface Modules , Serial Communication Interface , Memory modules , Proprietary Cables & accessories , Redundancy - overview , Introduction to Remote Input / outputs.

System Configuration: Finalization of Input / output Module count ,Rack Configuration , Power Supply Limits , Communication Limits , Input / Output allotment & addressing , Finalization of Derived Function Blocks.

Fundamentals of PLC Programming: Configuration , Ladder Logic (LD) , Function Block Diagram (FBD) , Instruction List (IL) ,Structured Text (ST) , Sequential Function Chart (SFC) , Arithmetic Functions , Logic Functions , Timers and Counters ,Communication Instructions , Data Transfer Instructions , System Bits and Words , Function Blocks , Derived Function Blocks , PID Function Blocks.

PLC Programming – Implementation: Configuration of Rack , Configuration of Controller , Configuration of Network Modules ,Configuration of Input Output Modules , Structuring a program , Creation of database , Programmer's console , Downloading / Uploading Projects , PLC Modes (RUN, STANDBY, MONITOR) , Simulation & Testing , Loop tuning & Parameter setting, On line Monitoring / debugging , Diagnostic features.

Distributed Control System (DCS): Concept of DCS , Data Acquisition Basics , Data Control Basics , DCS Architecture ,Proprietary Networks , Advantages & Limitations , Overview of configuration & programming.

Supervisory Control & Data Acquisition (SCADA): Introduction to SCADA , SCADA Architecture , Communication table for signal exchange , Introduction to communication protocols ,Creation of Database , Interfacing with PLC , Operating Screens , Applicationprogramming , Simulation / RUN time , Alarms, Trends & Bar graphs , Historical Data Management.

Title	*Code*	*Semester/Duration*	*Credits*
Signals and Systems Analysis	CCN411	7/Longitudinal	2,1,0

Signals, Transformations of Independent Variables, Basic Continuous Time Signals, Basic Discrete Time Signals, Systems, Properties of Systems, Linear Time – invariant Systems.

Linear Time – Invariant (LTI) Systems: Representation of Signals in terms of Impulses, Discrete Time LTI Systems, the Convolution Sum, Continuous Time LTI Systems, the Convolution Integral. Properties of LTI Systems, Systems Described by Differential and Difference Equations. Block Diagram Representation of LTI Systems Described by Differential Equations and, Singularity Functions. Analogy between Vectors and Signals, Orthogonal Vector and Signal Spaces. Approximation of a Function by a Set of Mutually Orthogonal Functions, Fourier Analysis of Continuous Time Signals and Systems. The Response of Continuous Time LTI Systems to Complex Exponentials, the Continuous Time Fourier series. Convergence of Fourier series, A-periodic Signals and Continuous Fourier Transform. Periodic Signals and Continuous Fourier Transform. Convolution and Modulation Property. Polar Representation of Continuous Fourier Transform. Frequency Response Characterized by Linear Constant Coefficient Differential Equations. First-order and Second-order Systems.Fourier Analysis of Discrete Time Signals and Systems Response of Discrete Time LTI Systems to Complex Exponential. Fourier Series, DTFT, Periodic Signals and DTFT, Properties of DTFT, Convolution, Modulation and Duality Property. Polar Representation of DTFT, First-order and Second-order Systems.

Concept of Z: Sampling Theorem, Reconstruction of a Signal from Samples, the Effect of Under sampling, Discrete Time Processing of Continuous Time Signals. Sampling in Frequency Domain, Sampling of Discrete Time Signals. Z-transform of a Discrete Sequence, Region of Convergence for the Z-transform. Inverse Z-transform, Properties of Z-transform, Relation Between Z and Fourier Transform..

Title	*Code*	*Semester/Duration*	*Credits*
Digital Signal Processing	**CCN421**	**8/Longitudinal**	**2,1,0**

Discrete-time signals: Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp & complex exponentials, arithmetic operations on sequences.

LTI systems: Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution

supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.
Discrete Time Fourier Transform (DTFT): Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain.
Z- Transforms: Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Perseval's relation, inverse Z-transform by contour integration, power series & partial-fraction expansions with examples and exercises.
Discrete Fourier Transform: Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences- Overlap-Save and Overlap-Add methods with examples and exercises.
Fast Fourier Transforms: Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.
Filter design: Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.
Digital Signal Processor: Elementary idea about the architecture and important instruction sets of TMS320C 5416/6713 processor, writing of small programs in assembly Language.
FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP alrorithms onto FPGA.

Title	*Code*	*Semester/Duration*	*Credits*
Artificial Neural Networks	CCN511	9/Longitudinal	2,2,0

Machine Learning& AI - Introduction, hierarchical perspective and foundations. Rote Learning, Learning by advice, Learning in problem solving inductive learning, explanation based learning, learning from observation and discovery, learning by analogy, introduction to formal learning theory. Biological neurons and brain, models of biological neurons, artificial neurons and neural networks, Early adaptive nets Hopfield nets, back error propagation competitive learning lateral inhibition and feature maps, Stability - Plasticity and noise saturation dilemma,

ART nets, cognition and recognition. Neural nets as massively parallel, connectionist architecture, Application in solving problems from various are as e.g., AI, Computer Hardware, networks, pattern recognition sensing and control etc..

Title	*Code*	*Semester/Duration*	*Credits*
Control Systems	**COE421**	**8/Longitudinal**	**2,1,2**

Correlation between Time and Frequency Responses – Polar Plots – Bode Plots – Log Magnitude versus Phase Plots – All Passand Minimum Phase Systems – Nyquist Stability Criterion – Assessment of Relative Stability – Constant M and N Circles.

Compensation Techniques: Concept of compensation, Lag, Lead and Lag-Lead networks, design of closed loop systems using compensation techniques, feedback compensation using P, PI, PID controllers..

Title	*Code*	*Semester/Duration*	*Credits*
Instruments systems and Signals	**COE422**	**8/Longitudinal**	**2,1,0**

General measurement systems: specifications of instruments, their static and dynamic Characteristics. Active and passive transducers and their classification. Transducers: Resistance type - potentiometer, strain gauge; Inductive type – LVDT, RVDT

Sensing elements: Temperature sensing elements – RTD, thermistor, thermocouple, semiconductor IC sensors; Pressure sensing elements – manometers, elastic elements, Bourdon tube, diaphragm, bellows; Electrical type - McLeod gauge, Pirani gauge; Flow sensing transducers. Velocity measurement. Electromagnetic flow meter, Coriolis flow meter, Ultrasonic flow meter; capacitive

sensors. Photo conductive sensors – Capacitive sensors- Variable area – Variable distance – Variable dielectric type sensors.Analytical sensors – pH measurement. Hall effect transducer. **Feedback transducer systems, data display and recording systems**: Self balancing systems, servo operated system, data-loggers, analog and digital data acquisition systems, Analog and magnetic tape recorders, digital input-output devices. MEMS- principle of operation, materials, basic process, manufacturing technology.

Telemetry: Data transmission – methods of data transmission, current, voltage, and position telemetry systems. Modulation

techniques: FM, AM, ASK, FSK, Time division and frequency division multiplexing, applications, signal isolation techniques (MCT2E). Digital methods of frequency, phase and time period measurements.

Optical instruments: Eye, telescopes, microscopes, photographic lenses, optical projection systems, cameras, Abbe's refractromete, monochromatic. Thermal detectors and Quantum detectors, bolo meter, Photodiodes- PIN and avalanche photodiodes, phototransistors, photo multipliers, IR detectors. CCD devices – principle and operation.

Title	*Code*	*Semester/Duration*	*Credits*
Multivariable Control Systems	**COE511**	**9/Longitudinal**	**2,2,0**

Introduction: Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality. State Space **Approach of Control System Analysis**: Modern Vs conventional control theory, concept of state, state variable state vector, state space, state space equations, Writing state space equations of mechanical, Electrical systems, Analogous systems. State Space Representation using physical and phase variables, comparison form of system representation. Block diagram representation of state model. Signal flow graph representation. State space representation using canonical variables. Diagonal matrix. Jordan canonical form, Derivation of transfer functions from state-model.

Solution of State Equations: Eigenvalues and Eigen vectors. Matrix, Exponential, State transition matrix, Properties of state transition matrix. Computation of State transition matrix concepts of controllability & observability, Pole placement by state feedback.

Title	*Code*	*Semester/Duration*	*Credits*
Optimal Control Theory	**COE512**	**9/Longitudinal**	**2,2,0**

Introduction: Optimal control problem. Problem Formulation. Performance measures for various types of optimal control problems -Minimum time problem- Minimum fuel problem- Minimum energy problem- Tracking problem- Regulator problem—selection of a performance measure-Example..

Dynamic programming: The optimal control law- principle of optimality-Recurrence relation of dynamic programming- computational procedure for solving optimal control problems-Characteristics of Dynamic programming solution-Discrete linear regulator problem-Hamilton Jacobi Bellman equation-Continuous linear regulator problem.

Calculus of variations: Fundamental concepts . Functional of single function- Euler - equation-General variation of a functional-Functionals of several independent functions- Boundary conditions. Piecewise smooth extremals. Constrained extremisation of functional s-Point constraints-differential equation constraints-isoperimetric constraints.

Variational approach to optimal control problems: Necessary conditions for optimal control - Boundary conditions in optimal control problem. Linear regulator problem . Linear Tracking problem. Pontryagin.s minimum principle- State inequality constraints -Minimum time problems Minimum control effort problems.

Title	*Code*	*Semester/Duration*	*Credits*
Control Systems Analysis	**COE513**	**9/Longitudinal**	**1,0,3**

Introduction to Computer Aided Control System Analysis. Main principles of control: Feedforward and feedback control; advantages and limitations of feedback and feedforward control; structure of feedback systems.

Mathematical preliminaries: Review of LTI systems description in both time and frequency domains; linearization; block diagrams and signal flow graph manipulations

Mathematical modelling: First-principle and phenomenological modeling; models of sensors, actuators, and standard controllers

Stability of control systems: Input-output and internal stability; Routh-Hurwits criterion.

Analysis of control systems in the time domain: Steady state response, error coefficients and system type; transient response characteristics; relation between pole/zero configuration and transient response.

Root-locus technique: Rules for root-locus sketching; root contours and applications

Design of control systems in the time domain: Design specifications in the time domain; design of P, PI, PD, and PID controllers; design of lead, lag, and lead-lag compensators

Analysis of control systems in the frequency domain: Characteristics of stationary response in the frequency domain; stability analysis in the frequency domain (Nyquist stability criterion)

Design of control systems in the frequency domain: Design specifications in the frequency domain: design of P, PI, PD, and PID controllers; design of lead, lag, and lead-lag compensators

Title	*Code*	*Semester/Duration*	*Credits*
Graduation Project I	**CPE514**	**9/Longitudinal**	**0,0,6**

Project work is for duration of two semesters and is expected to be completed in the tenth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work

may be undertaken in electrical power systems / machines / control / electronics / communications / computer / instrumentation / engineering or any allied area and must have relevance in electrical or electronics engineering. Project evaluation committee consisting of the guide and three/four faculty members specialised in the above field shall perform the screening and evaluation of

the projects by end of semester ten. Each project group should submit project synopsis within three weeks from start of ninth semester. Project evaluation committee shall study the feasibility of each

project work before giving consent. Literature survey and 30% of the work has to be completed in the ninth semester.

Title	*Code*	*Semester/Duration*	*Credits*
Microcontroller and Embedded Systems	**COE521**	**10/Longitudinal**	**2,1,2**

Introduction to Embedded Systems: Characteristics of Embedded Systems, Microprocessor basics, **Microprocessor architectures**: CISC and RISC- Von Neumann and Harvard- Instruction pipelining, Microcontroller: characteristics, Classification.

Hardware Design(with PIC16F84 example):PIC16F84-Architecture, Instruction set, Programming model, Interfacing with peripherals, Interrupts, Parallel I/O ports-Simple Interfacing, Timers and counters, Watchdog timer, Power supply and reset, Clock oscillator.

Hardware Design: Memory for embedded systems: Introduction, Volatile memories, Non volatile memories, Microcontroller memory implementation. DACs-stand alone converter-PWM, Data acquisition systems- Sensors-temperature sensors-light sensors, ADCs.

Buses and Protocols: Processor memory bus- peripheral buses-parallel vs serial buses. Serial communication- types-features-bus arbitration, serial standards and protocols, serial ports.

Software Design: Preliminary programming: Assembly language programming Systematic software: Developing program structure, Choice between assemblers and high level languages. Operating system concepts: Embedded operating systems, Network operating systems, Layers of an OS, Components of an OS, Kernel, Tasks, Scheduling algorithms, Threads, Interrupt handling, IPC,

Task synchronisation, Semaphores. **Real Time operating System**: Real time tasks, Real time systems, Types of real time tasks, Real time operating systems, Real timescheduling algorithms, Rate monotonic algorithm, Earlist deadline fast algorithm, Qualities of a good RTOS.

Title	*Code*	*Semester/Duration*	*Credits*
Digital Control Systems	**COE522**	**10/Longitudinal**	**2,2,0**

Introduction to discrete time control system: Block diagram of a digital control system- Review of z- transforms and inverse z- transforms- solution of difference equations- pulse transfer function pulse transfer function with dead time- system time response- Realization of pulse transfer functions (Digital Controllers)- Direct Programming- Standard Programming- Series programming-parallel programming- ladder programming.

Review of stability analysis in z- plane: Jury's stability test –Bilinear transformation and extension of Routh's stability criterion to discrete systems- Transient and Steady state response analysis- transient response specifications- steady state error analysis- effect of sampling period on transient response - frequency response specifications- Nyquist stability criterion in the z- plane- Digital Controllers- PI, PD & PID Controllers- Lag, lead, and lag-lead compensators- Design of lag compensator and lead compensator based on root locus and Bode plot approaches.

State Space analysis of digital control systems: state space representation of discrete time systems Transfer function from state model- Controllable, Observable, Diagonal/ Jordan Canonical forms from transfer function- Solution of linear time invariant discrete time state equations discretization of continuous time space equation- representing state models in DCF/ JCF using transformation matrix .Concept of controllability and observability for a linear time invariant discrete time control system- condition for controllability and observability - state feedback- design via pole placement state observers- design of full order state observer.

Title	*Code*	*Semester/Duration*	*Credits*
Graduation Project II	**COE524**	**10/Longitudinal**	**0,0,12**

This project work is the continuation of the project initiated in ninth semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation supervisor through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. There shall be at least an Interim Evaluation and a final evaluation of the project in the 10^{th} semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Each project group should complete the project work in the 10^{th} semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide and three/four faculty members specialized in electrical power systems / machines / control / electronics / communications / computer / instrumentation / engineering.

Electives

Title	*Code*	*Semester/Duration*	*Credits*
Non-Linear Control Systems	**COE513**	**9/Longitudinal**	**2,2,0**

Introduction and classical techniques- Characteristics of nonlinear systems - classification of equilibrium points - limit cycles -analysis of systems with piecewise constant inputs using phase plane analysis . perturbation techniques- periodic orbits -stability of periodic solutions - singular perturbation model - slow and fast manifolds. Stability of Nonlinear Systems - Lyapunov stability - local stability - local linearization and stability in the small- Direct method of Lyapunov - generation of Lyapunov function for linear and nonlinear systems - variable gradient method - Centre manifold theorem - region of attraction - Invariance theorems - Input output stability - L stability - L stability of state models. Feedback Control and Feedback Stabilisation- Analysis of feedback systems- Circle Criterion - Popov Criterion– Concepts of Inverse control-Feedback linearization- Model predictive control-Simultaneous Feedback control- Design via linearization-

stabilization - regulation via integral control- gain scheduling - Exact Feedback Linearization - Input state linearization - input/output linearization - state feedback control - stabilization - tracking - integral control.

Applied Sciences (Power)

Title	*Code*	*Semester/Duration*	*Credits*
Electrical Power Systems	**PRE411**	**7/Longitudinal**	**2,1,0**

Per unit system, power systems matrices, symmetrical components, study of power systems faults, symmetrical and non-symmetrical short circuit faults, short circuit analysis, function of the Z matrix, choice of circuit breakers, study of load flow (power flow), Guass-Seidal, Newton-Raphson, fast decoupled techniques, optimal load flow, DC load flow.

Title	*Code*	*Semester/Duration*	*Credits*
Thermodynamics	**PRE421**	**8/Longitudinal**	**2,1,0**

Basic concepts and definitions, Processes & Cycles, concept of Thermodynamic Property and definition of State; First Law of Thermodynamics, Work & Heat as energies in transition, Interchange-ability of Energy States, Working Fluids and Steady / Unsteady Flow Energy Equations, Perfect and Real Gases; Second Law of Thermodynamics, Reversible and Irreversible Processes, Entropy & Carnot Efficiency, concept of Available Energy.

Title	*Code*	*Semester/Duration*	*Credits*
Power Plants Engineering	**PRE422**	**8/Longitudinal**	**2,2,0**

Power plant economics and selection: Effect of plant type on costs, rates, fixed elements, energy elements, customer elements and investor's profit; depreciation and replacement, theory of rates. Economics of plant selection, other considerations in plant selection.

Steam power plant: General layout of steam power plant, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Dust collection system, Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.

Diesel power plant: General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.

Gas turbine power plant: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant .

Nuclear power plant: Principles of nuclear energy, Lay out of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants.

Hydro electric station Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, run off size of plant and choice of units, operation
and maintenance, hydro systems, interconnected systems.

Electrical system: Generators and their cooling, transformers and their cooling. Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms. Pollution due to power generation.

Title	*Code*	*Semester/Duration*	*Credits*
Power Systems Analysis I	**PRE423**	**8/Longitudinal**	**2,1,0**

Travelling Waves; Resistive, inductive and capacitive terminations, Bewelly lattice diagram. HVDC: Advantage of D.C transmission over A.C, construction of D.C transmission system, main uses of D.C transmission, economic factors, future prospects, converters & inverters, Control of HVDC and limitations. Thermal Rating of power system equipment, cooling techniques, causes of over voltages & insulation coordination, breakdown mechanism.

Title	*Code*	*Semester/Duration*	*Credits*
Power Systems Protection	**PRE511**	**9/Longitudinal**	**2,1,2**

Power system protection: Protective zones, Relaying elements and quantities. Protective relays, basic requirements and type of protection, phase and amplitude comparator, grading (time & current), classification of Electromagnetic relays, Directional relay, Distant relay, Differential relay, basic aspects of static and digital relays, relay protection scheme for transformer, feeder, generators and motors. Circuit breakers, circuit breaking transients, transient recovery voltage, current chopping and resistance switching, circuit breaker rating, arc and arc extinction, circuit breaker types, oil circuit breaker, vacuum circuit breaker, air blast circuit breaker, SF6 circuit breaker and operating mechanism, advantages and disadvantages of different types.

Title	*Code*	*Semester/Duration*	*Credits*
Electrical Machines Dynamics	**PRE512**	**9/Longitudinal**	**2,2,0**

MODELING CONCEPTS: Basic Two-pole machine representation of commutator machines, 3-ph synchronous machine with and without damper bars and 3-ph induction machine, Kron's primitive machine-voltage, current and torque equations. Real time model of a two phase induction machine-

transformation to obtain constant matrices-thee phase to two phase transformation- power equivalence.

MODELING OF THREE PHASE INDUCTION MACHINE: Generalized model in arbitrary reference frame- Electromagnetic torque –Derivation of commonly used induction machine models- Stator reference frame model Rotor reference frame model- Synchronously rotating frame model- Equations in flux linkages - per unit model-Dynamic Simulation- Small signal equations of induction machine.

SYMMETRICAL AND UNSYMMETRICAL 2 PHASE INDUCTION MACHINE: Analysis of symmetrical 2 phase induction machine-voltage and torque equations for unsymmetrical 2 phase induction machine voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine-analysis of steady state operation of unsymmetrical 2 phase induction machine-single phase induction motor - Cross field theory of single-phase induction machine.

SYNCHRONOUS MACHINE MODELING: Mathematical model of a sep. excited DC motor- steady state and transient analysis - Transfer function of a sep. excited DC motor – Mathematical model of a DC series motor, shunt motor linearization techniques for small perturbations. Synchronous machine inductances – voltage equations in the rotor's DQ0 reference frame- electromagnetic torque-current in terms of linkages.

DYNAMIC ANALYSIS OF SYNCHRONOUS MACHINE: Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria- simulation of three phase synchronous machine – modelling of PMSM.

Title	*Code*	*Semester/Duration*	*Credits*
Power Systems Planning	**PRE513**	**9/Longitudinal**	**2,2,0**

Introduction of power planning, National and Regional Planning, structure of P.S., planning tools. Electricity Regulation, Electrical Forecasting, forecasting techniques modeling. Generation planning, Integrated power generation cogeneration/captive power, Power pooling and power trading. Transmission and distribution planning. Power system Economics. Power sector finance, financial planning, private participation Rural Electrification investment, concept of Rational tariffs.

Power supply Reliability, Reliability planning. System operation planning, load management, load prediction, reactive power balance Online power flow studies, state estimation, computerized management, power system simulator. Computer aided planning, wheeling.

Environmental effects, the greenhouse effect Technological impacts. Insulation coordination. Reactive compensation.

Optimal power system expansion planning : Formulation of least cost optimization problem incorporating the capital, Operating and maintenance cost of candidate plants of different types (Thermal, Hydro, Nuclear, Non-conventional etc.) and minimum assured reliability constraint – optimization techniques for solution by programming.

Title	*Code*	*Semester/Duration*	*Credits*
Power Systems Analysis II	**PRE514**	**9/Longitudinal**	**2,2,0**

Introduction to Computer Aided Power System Analysis, Modelling of Power System Components, formulation and Z-bus and Y-bus, LU Factorization Algorithm. Introduction to fault analysis and types of faults in power systems, development of different algorithms for analysis of symmetrical and asymmetrical faults using sequence networks, Short Circuit Calculation algorithm. Newton-Raphson Power Flow Algorithm, Decoupled and Fast Decoupled Power Flow Solution Methods, DC Power Flow Algorithm.

Introduction: Load flow analysis - iterative methods of load flow solution; Numerical solution of large sparse systems, State Estimation, least squares estimation - Basic solution and sequential form of solution.

Static state estimation, treatment of bad data, Different load forecasting techniques.

Automatic Generation Control - Single and multi-area systems. Optimal control. Decentralized control. Control of load frequency (LF) controller. Power system optimization, unit commitment, economic despatch. Active and reactive power optimization, Hydro-thermal scheduling.
Real time computer control of Power system, configuration, security, monitoring and state estimation, Economic despatch and LF control.

Title	*Code*	*Semester/Duration*	*Credits*
Computer Aided Power Systems Analysis	**PRE514**	**9/Longitudinal**	**1,0,3**

Introduction to Computer Aided Power System Analysis, Modelling of Power System Components, formulation and Z-bus and Y-bus, LU Factorization Algorithm. Introduction to fault analysis and types of faults in power systems, development of different algorithms for analysis of symmetrical and asymmetrical faults using sequence networks, Short Circuit Calculation algorithm. Newton-Raphson

Power Flow Algorithm, Decoupled and Fast Decoupled Power Flow Solution Methods, DC Power Flow Algorithm.

Introduction: Load flow analysis - iterative methods of load flow solution; Numerical solution of large sparse systems, State Estimation, least squares estimation - Basic solution and sequential form of solution. Static state estimation, treatment of bad data, Different load forecasting techniques.

Automatic Generation Control - Single and multi-area systems. Optimal control. Decentralized control. Control of load frequency (LF) controller. Power system optimization, unit commitment, economic dispatch. Active and reactive power optimization, Hydro-thermal scheduling.

Real time computer control of Power system, configuration, security, monitoring and state estimation,

Economic dispatch and LF control. Data Acquisition system; man-machine interface.

Title	*Code*	*Semester/Duration*	*Credits*
Graduation Project I	**PRE515**	**9/Longitudinal**	**0,0,6**

Project work is for duration of two semesters and is expected to be completed in the tenth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work

may be undertaken in electrical power systems/ machines/ control/ electronics/ communications / computer / instrumentation / engineering or any allied area and must have relevance in electrical or electronics engineering. Project evaluation committee consisting of the guide and three/four faculty members specialized in the above field shall perform the screening and evaluation of the projects by end of semester ten.

Title	*Code*	*Semester/Duration*	*Credits*
Power systems dynamics and control	**PRE521**	**10/Longitudinal**	**2,2,0**

Electrical power systems stability, generators modelling, steady steady-state stability, transient stability computer analysis of transient stability, multi-machine stability, effect of control equipments in improving stability.

Automatic Generation Control: Concept of AVR and ALFC Loops, Significance of Double Loop in ALFC; Exciter and VAR Control; Single Area Load Frequency Control; Two Area Load Frequency Control; Frequency Response.

Compensation in Power System: Reactive Power Sensitivity and Voltage Control; Load Compensation with Capacitor Banks; Line Compensation with Reactors; Shunt and Series Compensation; Fixed Series Capacitors; Thyristor Controlled Series Capacitors; Introduction to SVC and STATCOM.

Voltage stability: comparison between angle and voltage stability, reactive power flow and voltage collapse, mathematical formulation of voltage stability, voltage stability analysis (PV and QV curves), Prevention of voltage collapse.

Title	*Code*	*Semester/Duration*	*Credits*
Computer Aided Design of Electrical Machines	**PRE522**	**10/Longitudinal**	**2,2,0**

Industrial standardization. National and international standards, codes and testing laboratories. Manufacturing and operating systems, Design considerations for electrical machines, Properties and applications of materials for magnetic machine insulation system and its design considerations, Thermal time constant. Cooling systems of transformers and rotating machines. Duty cycles. Ratings and temperature-rise. Mechanical design considerations. Specific loading and output equations of power transformer and induction motor. Design of transformer or induction motor. Introduction to computer Aided Design (CAD) and, computer aided manufacturing (CAM).

Title	*Code*	*Semester/Duration*	*Credits*
Graduation Project II	**PRE524**	**10/Longitudinal**	**0,0,12**

This project work is the continuation of the project initiated in ninth semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation supervisor through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. There shall be at least an Interim Evaluation and a final evaluation of the project in the 10^{th} semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Each project group should complete the project work in the 10^{th} semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide and three/four faculty members specialized in electrical power systems / machines / control / electronics / communications / computer / instrumentation / engineering.

Electives

Title	*Code*	*Semester/Duration*	*Credits*
High Voltage Engineering	**PRE525**	**10/Longitudinal**	**2,1,2**

Breakdown phenomena: Breakdown of Gases: Mechanism of Break down of gases, Charge multiplication, Secondary emission, Townsend Theory, Streamer Theory, Paschen's Law, Determination of Minimum breakdown voltage, Breakdown in non uniform field, Effect of polarity on corona inception and break down voltage.

Partial Discharge: definition and development in solid dielectric.

Break Down of Solids: Intrinsic breakdown, Electromechanical break down, Thermal breakdown, Streamer Breakdown.

Breakdown of Liquid: Intrinsic Break down, Cavitation Theory, Suspended particle Theory.

Breakdown in Vacuum: Non metallic electron emission mechanism, Clump mechanism, Effect of pressure on breakdown voltage.

Generation of High Voltage: Generation of high AC voltages: Testing transformer, Cascaded transformer, Series resonant circuit, single stage and multi stage. Advantages of Series Resonant Circuit in testing of cables. Generation of DC high voltage: Cockcroft Walton doubler and multistage circuit.

Electrostatic generator: Definition of Impulse Voltage as per Indian Standard Specification, Wave front and wave tail time ,Generation of Impulse Voltage, Multistage Impulse generator, triggering of Impulse Generator.

Measurement of High Voltage: Sphere gap voltmeter, AC , DC and impulse high voltage measurement as per Indian Standard Specifications. Resistance and Capacitance Potential dividers, Peak voltmeters for measurement of high AC voltage in conjunction with capacitance dividers. Capacitance Voltage Transformer, Rotating Voltmeter for the measurement of DC high voltage, Electrostatic Voltmeter

Transient in power systems: Lightning Phenomena, Electrification of cloud, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke. Protection of Electrical Apparatus against over voltage, Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Ground wires. Insulation Co ordination, Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.

High Voltage Testing: High Voltage testing, Power frequency withstand, induced over voltage and impulse test on transformers, Power frequency wet withstand test and impulse test on insulators.

Title	*Code*	*Semester/Duration*	*Credits*
Power Generation and Economics	**PRE526**	**10/Longitudinal**	**2,2,0**

Renewable and non-renewable energy resources, cost of electrical energy production, power system investment, alternative generating projects, constant load factor method, net effective cost method, economic operation of power systems, distribution of load between units, transmission loss, distribution of load between plants.

Unit Commitment: Constraints in Unit Commitment, Spinning reserve, Thermal unit constraints, Hydro constraints, Must run, Fuel constraints. Unit commitment solution methods. State Estimation and load forecasting in power system: Introduction, state estimation methods, concept of load forecasting, load forecasting technique and application in power system.

Title	*Code*	*Semester/Duration*	*Credits*
Renewable and Alternative Energy Sources	**PRE525**	**10/Longitudinal**	**2,1,2**

Introduction to Energy sources: Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energysources. Impact of renewable energy generation on environment, Kyoto Protocol.

Solar Energy: Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still,

solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems.

Wind Energy: Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations

Energy from Biomass: Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration,

filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas.

Geothermal Energy: Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages disadvantages and application of geothermal energy, prospects of geothermal energy in Sudan.

Magneto Hydrodynamic power generation: Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.

Hydrogen Energy: Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.

Fuel cell: Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cell

Title	*Code*	*Semester/Duration*	*Credits*
Special Electrical Machines	**PRE516**	**9/Longitudinal**	**2,2,0**

Stepper Motors: Construction of single stack and three stack variable reluctance, permanent magnet and hybrid stepper motors and their modes of operation (1-Phase on, 2- Phase on and half step modes)- Torque equation – static and dynamic characteristics-definition and explanation of the terms (step single, resolution, positional error, pull in torque, pull out torque, detent torque, mid frequency resonance, response range, slew range- closed loop control of stepper motors – Microprocessor based control of stepper motor,(block diagram, interface and flow chart of open loop control)- comparison of the above mentioned stepper motors –Applications Switched Reluctance Motor(SRM)- constructional features- principle of operation-L-ș Profile constraints on pole arc and

tooth arc- torque equation- characteristics (Rotor position Vs Torque, inductance, flux linkage and current: torque Vs speed) – power converter circuits((n+1) switching devices and split link circuits)- sensor less control of SRM- Applications.

Synchronous Reluctance Motors (SyRM): Constructional features, working- Phasor diagram-. Torque equation, Characteristics –constant direct axis current control (block diagram and applications) Permanent Magnet Synchronous Motor(PMSM) constructional features- torque equation-Phasor diagram-circle diagrams- vector control of PMSM(Principle, block diagram and explanation)- Transfer function of PMSM.

Permanent Magnet Brushless DC Motors: Constructional features- electronic commutation - Comparison between mechanical and electronic commutation- analysis of BLDC square wave motor with 180 deg pole arc-self control and DSP based control of BLDC Motor(principle, block diagram, flow chart. AC servomotors-constructional features-working-Analysis based on symmetrical

components-transfer function- applications.

Single phase special machines: construction and working of AC series motor, repulsive motor and universal motor-phasor diagrams-applications. Linear induction motors(LIM)- Construction of double sided primary flat, tubular and transverse flux-LIMS- Thrust equation- Performance characteristics(SlipVs ȘPF and thrust)-output equation (no derivation),- choice of specific magnetic

and electric loading-applications Linear Synchronous Motor-(LSM) Construction of single sided, double sided and slotless LSMs Applications Linear Reluctance motor(LRM) Construction and principle of operation of LRM Linear Levitation Machine(LLM) Principle of levitation-construction and working of repulsion type and attraction type LLM. consistency and Munin. Case study-Other consistency models.

CORBA Case Study: Introduction-CORBA RMI-CORBA services.

Applied Sciences (Communications and Networks)

Title	*Code*	*Semester/Duration*	*Credits*
Object Oriented Programming	**CNE321**	**6/Longitudinal**	**2,1,2**

Object oriented Design: Concept of Object oriented programming language, Major and minor elements, Object, Class, relationship among objects, aggregation, links, relationship among classes association, aggregation using instantiation, meta-class, grouping constructs.

Object oriented concept: Difference between OOP and other conventional programming, advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism.

Basic concepts of Object oriented programming using Java: Class & Object properties: Basic concepts of Java programming-advantages of Java, byte code& JVM, data types, access specifiers, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, garbage collection, nested and inner classes, basic string handling concepts, -String (discuss char(), compare(), equals(), equalsIgnore case(), indexOf(), length(), substring(), to Char Array(),to LowercCase(), tostring(), methods), concept of mutable and immutable string, command line arguments, basics of I/O operations-keyboard input using Buffered Reader& Scanner classes.

Reusability properties: Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, use of abstract classes, & methods, interfaces. Creation of packages, importing packages, member access for packages.

Exception handling & Multithreading : Exception handling basics, different types ofexception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread synchronization, inter thread communication, deadlocks for threads, suspending & resuming threads.

Applet Programming (using swing): Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applet in applets, concept of delegation event model and listener, I/O in applets, use of repaint(), getDocumentBase(), getCodeBase() methods, layout manager (basic concept), creation of buttons (JButton class only) & text fields.

Title	*Code*	*Semester/Duration*	*Credits*
Digital Communications	**CNE322**	**6/Longitudinal**	**2,1,2**

Analog-to-Digital Conversion: Pulse modulation techniques, Sampling, Time Division Multiplexing, Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation, Digital **Modulation Techniques**: Pulse Code Modulation, Differential Pulse Code Modulation, Delta Modulation, Adaptive Delta Modulation, Continuously Variable Slope Delta Modulation, Companding, Noise in Pulse-Code and Delta-Modulation Systems. Binary Phase-Shift Keying, Differential Phase-Shift Keying, Differentially- Encoded PSK (DEPSK), Quadrature Phase-Shift Keying (QPSK), M-ary PSK, Quadrature Amplitude Shift Keying (QASK), Binary Frequency Shift-Keying, Similarity of BFSK and BPSK, M-ary FSK, Minimum Shift Keying (MSK), Duo-binary Encoding.

Mathematical Representation of Noise: Some Sources of Noise, Frequency- Domain Representation of Noise, The Effect of Filtering on the Probability Density of Gaussian Noise, Spectral Components of Noise Response of a Narrowband Filter to Noise, Effect of a Filter on the Power Spectral Density of Noise, Superposition of Noises, Mixing Involving Noise, Linear Filtering, Noise Bandwidth, Quadrature Components of Noise, Power Spectral Density of n(t) and n(t), Probability Density of n(t), n(t), and their Time Derivatives, Representation of Noise Using Orthonormal Coordinates, Irrelevant Noise Components

Data Transmission: A Base-band Signal Receiver, Probability of Error, The Optimum Filter, White Noise: The Matched Filter, Probability of Error of the Matched Filter, Coherent Reception: Correlation, Phase-Shift Keying, Frequency-Shift Keying, Non- coherent Detection of FSK, Differential PSK, Four Phase PSK (QPSK), Error Probability for QPSK, Probability of Error of Minimum Shift Keying (MSK), Comparison of Modulation Systems.

Spread Spectrum Modulation: Direct Sequence (DS) Spread Spectrum, Use of Spread Spectrum with Code Division, MultipleAccess (CDMA), Ranging using DS Spread Spectrum, Frequency Hopping (FH) Spread Spectrum, Generation and Characteristics of PN Sequences, Acquisition (Coarse Synchronization) of a FH Signal, Tracking (Fine Synchronization) of a FH Signal, Acquisition

(Coarse Synchronization) of a DS Signal, Tracking of a DS Signal.

Title	*Code*	*Semester/Duration*	*Credits*
Computer Networks	**CNE411**	**7/Longitudinal**	**2,1,2**

Introduction: Uses of Computer Networks, Network Structure, Architectures, Services, Standardization, Functions of Various Network Layers, Network examples.

Physical layer: Theoretical Basis for Data Communication, Transmission Media, Analog and Digital Transmission, Transmission and Switching ISDN.

Medium Access Sub-layer: LAN, MAN, Protocol, ALOHA, IEEE Standard for 802 for LANs, Fiber Optic Networks, Satellite Networks.

Data Link layer: Design Issues, Error Detection and Correction, Protocols and their Performance, Specifications and Examples.

Network layers: Design Considerations, Difference between Gateway, Ethernet Switch, Router, Hub, Repeater, Functions of Router, Congestion Control Internetworking and Examples, Details of IP addressing schemes, TCP/IP Protocol details.

Title	*Code*	*Semester/Duration*	*Credits*
Antennas Systems	**CNE412**	**7/Longitudinal**	**2,1,2**

Radiation and Antennas: Antenna definition, Functions of antennas , Network theorems, Properties of antennas, Antenna parameters , Polarization, Basic antenna elements , Radiation mechanism, Radiation fields of alternating current element, Radiated power and radiation resistance of current element, Radiation, induction and electrostatic fields, Hertzian dipole, Different current

distributions in linear antennas, Radiation from half-wave dipole, Radiation from quarter wave monopole , Radiation characteristics of dipoles.

Analysis of Linear Arrays: Directional characteristics of dipole antennas, Radiation pattern of alternating current element, Radiation pattern expressions of centre-fed vertical dipoles of finite length, Radiation patterns of centre-fed vertical dipoles, Radiation patterns of centrefed horizontal dipoles, Radiation patterns of vertical dipoles, Two-element uniform array, Uniform linear arrays, Field strength of a uniform linear array, First sidelobe ratio (SLR), Broadside and End-fire arrays, Patterns of array of non-isotropic radiators, Multiplication of patterns, Generalized expression for principle of pattern multiplication, Radiation pattern characteristics, Binomial arrays, Effect of earth on vertical patterns, Effect of earth on radiation resistance, Methods of excitation, Impedance matching techniques, Transmission loss between transmitting and receiving antennas - FRIIS formula, Antenna temperature and signal-to-noise ratio.

Array Synthesis: Introduction, Synthesis methods, Fourier transform method, Linear array design by Woodward-lawson method, Dolph-chebychev method (Tschebyscheff distribution), Taylor method, Laplace transform method, Standard amplitude distributions. HF, VHF and UHF Antennas: Introduction, Isotropic radiators, Directional antennas, Omni-directional antennas, Resonant antennas, Non-resonant antennas, LF antennas, Antennas for HF, VHF and UHF, Dipole arrays, Folded

dipole, V-Antennas, Inverted V-antennas, Rhombic antenna, Yagi-Uda antenna, Log-periodic antennas, Loop antenna, Helical antenna, Whip antenna, Ferrite rod antenna, Turnstile antennas, Discone antennas, Notch antenna.

Microwave Antennas: Introduction, Rod reflector, Plane reflector, Corner reflector, Parabolic reflector, Types of parabolic reflectors, Feed systems for parabolic reflectors, Shaped beam antennas, Horn antennas, Corrugated horns, Slot antennas, Impedance of a few typical dipoles, Slots in the walls of rectangular waveguides, Babinet's principle, Lens antennas, Microstrip antennas.

Antenna Measurements: Introduction, Drawbacks of measurements of antenna parameters, Methods to overcome drawbacks inmeasurements, Methods for accurate measurements, Measurement ranges, Indoor and outdoor ranges, Antenna impedance measurements, Measurement of radiation resistance, Gain measurements, Measurement of antenna bandwidth, Directivity measurement, Measurement of sidelobe ratio, Measurement of radiation efficiency, Measurement of antenna aperture efficiency, Measurement of polarization of antenna, Phase measurement.

Title	*Code*	*Semester/Duration*	*Credits*
Software Engineering	**CNE413**	**7/Longitudinal**	**2,1,2**

Overview of system analysis & design: Business system concept, System development life cycle, waterfall model, Spiral Model, Feasibility Analysis, Technical feasibility, Cost benefit Analysis, COCOMO model.

System design: Context diagram and DFD, Problem partitioning, Top down and bottom up design, decision tree, decision table and structured English, Functional Vs object oriented approach.

Testing: Levels of testing, Integration testing, Test case specification, Reliability assessment, Validation & Verification metrics, Monitoring & control.

System project management: Project scheduling, Staffing, software configuration management, Quality assurance, Project monitoring.

Fundamentals of Object oriented design in UML: Static and dynamic models, necessity of modeling, UML diagrams, Class diagrams, Interaction diagrams, Collaboration diagram, Sequence diagram, State chart diagram, Activity diagram, Implementation diagram.

Title	*Code*	*Semester/Duration*	*Credits*
Computer Networks Engineering	**CNE421**	**8/Longitudinal**	**2,1,2**

Data Communication Concepts and Terminology: Data Representation, Data Transmission, Modes of Data Transmission, Signal Encoding, Frequency Spectrum, Transmission Channel,

Data Communication Transmission Media: Transmission Line Characteristics, Transmission Line Characteristics in Time Domain, Cross talk, Metallic Transmission Media, Optical Fiber Base-band Transmission of Data Signals, Telephone Network, Long Distance Network

Modems and Data Multiplexers: Digital Modulation Methods, Multilevel Modulation, Differential PSK, Standard Modems, Limited Distance Modems and Line Drivers, Group Band Modems, Data Multiplexers, Statistical Time Division Multiplexers

Error Control: Transmission Errors, Coding for Error Detection and Correction, Error Detection Methods, Forward Error Correction Methods, Reverse Error Correction The Physical Layer,

The Data Link Layer: Need for Data Link Control, The Data Link Layer 196, Frame Design Considerations, Flow Control, Data Link Error Control, Data Link Management, HDLC-HIGH-LEVEL DATA LINK CONTROL

The Network Layer: The Sub network Connections, Circuit Switched Sub networks, Store and Forward Data Sub networks, Routing of Data Packets, Internetworking, Purpose of the Network Layer, Title of

X.25 Interface, Location of X.25 Interface, Addressing in X.25, Packet Assembler and Disassembler (PAD), Asynchronous Character Mode Terminal PAD

Local Area Networks: LAN Topologies, Media Access Control and Routing, MIEDIA ACCESS CONTROL IN LOCAL AREA NETWORKS, INTERNETWORKING, THE TRANSPORT AND UPPER OSI Layer, The Session Layer, The Presentation Layer, The

Application Layer.

Title	*Code*	*Semester/Duration*	*Credits*
Satellite Communications	**CNE422**	**8/Longitudinal**	**2,0,2**

Orbits & Lanunching Methods: Kepler laws – Orbital elements – Orbital perturbations – Apogee perigee heights – Inclines orbits –Sun synchronous orbits – Geo stationary orbits – Limits of visibility – Sun transit outage – polar Mount antenna – Antenna Look angles – launching orbits – Low earth orbits – medium orbits –constellation.

Space Link: EIRP – transmission losses – power budget equation – system Noise carrier to Noise ration – Uplink and downlink equations – Input and Output back Off - TWTA – Inter modulation Noise – C/No –G/T measurement.

Space & Earth Segment: Space segment – space subsystems payload – Bus – power supply – attitude control – station keeping – thermal control – TT & C Subsystem – Transponders – Antenna subsystem – Earth segment – cassegrain antenna –Noise temperature – Low Noise Amplifiers – Earth station subsystems –TVRO.

Multiplexing & Mulitple Access: Frequency Division multiplexing FDM/FM/FDMA – Single channel per carrier – MCPC –Combanded FDM/FM/FDMA – Time division multiplexing – T1 carrier – Time Division multiple, Access – Frame Burst structure, Frame efficiency, frame Acquisition and synchronization – SS TDMA – SPADE – Spread spectrum – direct sequence – CDMA.

Satellite Services: INTELSAT – INSAT Series – VSAT – Weather forecasting – Remote sensing – LANDSAT –Satellite Navigation – Mobile satellite Service – Direct to Home.

Title	*Code*	*Semester/Duration*	*Credits*
Multimedia Technology	**CNE423**	**8/Longitudinal**	**2,1,2**

Introduction to Multimedia: Overview, Importance, Components, Uses of multimedia, Future Hypertext and hypermedia, different media and channels and modes of communication.

Multimedia Resources: Data rate, cost effectiveness and production time considerations, Analog and digital representations, Image, Video and Audio Standards, Colour space and models, communication standards - ISDN, ATM.

Equipment and devices: Display screen, storage devices, communication and interactive peripherals.

Test: Attributes and guidelines, Text markup, HTML, models of hypertext document, XML

Digital Graphics: Vector and raster graphics, Graphics file formats, image manipulation.

Audio: Digital audio, MIDI, Processing sound, sampling, compression.

Video: MPEG Compression standards, Compression through Spatial and Temporal Redundancy, interframe and intra-frame Compression.

Animation: Types, techniques, key frame animation, utility, Morphing.

Compression techniques: Lossless and lossy compression, Simple compression techniques Interpolative, Predictive, Transform Coding, Discrete Cosine Transform, Statistical Coding - Huffman encoding. JPEG, MPEG

Design and development of multimedia: Tools to support multimedia development, Authoring Multimedia - different type of authoring environments, Media synchronization, Design process, development team Evaluation and Testing - Gagne events, Project management.

Human Computer Interaction (HCI): Objective, norms and guidelines, Shneiderman's rules for design, Norman's seven stages of action, Interaction Design & Notations - Meta notations and state transition graphs, Screen design norms and guidelines.

Multimedia information management application: Multimedia database and design consideration.

Intellectual property: Foundations of intellectual property, copyrights, issues regarding the use of intellectual property.

Future developments: Virtual reality, newer devices, performance support, knowledge management, interactive interfaces.

Title	*Code*	*Semester/Duration*	*Credits*
Information Theory and Coding	**CNE424**	**8/Longitudinal**	**2,0,0**

Basic concepts of information theory and its measurement, error coding in communication systems. Entropy, zero-memory information source, Markov information source. Adjoin source, language structure. Huffman codes, LZ, arithmetic codes. Introduction to rate distortion theory. Channel coding theorem, channel capacity, Shannon limit.

Block codes: characteristics of block codes, non-singular block codes, uniquely decodable codes, instantaneous codes, Kraft‟s inequality. Error detection, Burst error detecting and correcting codes, linear block codes, binary cyclic codes, Hamming codes, BCH codes, and Read-Solomon codes, encoding, Syndrome decoding and decoding algorithms. Introduction to convolution codes, code tree, trellis, state diagram, maximum likelihood decoding and the Viterbi algorithm. Trellis-coded modulation and Ungerboeck codes. Introduction to Turbo coding. Selection of coding scheme.

Title	*Code*	*Semester/Duration*	*Credits*
Optical Fiber Communications	**CNE511**	**9/Longitudinal**	**2,0,0**

Propagation in Fibers: Elementary discussion of propagation in fibers. Attenuation in Optical Fibers. E M wave propagation in step-Index Fibers. E M wave propagation in graded-Index Fibers.

Optical Fibers and Associated Components: Fiber Properties. Splices, connectors, Couplers, and Gratings.

Transmitting and Receiving Devices: Injection laser Characteristics. LED structures, Characteristics and modulation. Optical Transmitters, Receivers and Fiber-optic Link Design: Concepts of Fiber-Optic Networks and wavelength – Division Multiplexing:

Title	*Code*	*Semester/Duration*	*Credits*
Cellular and Mobile Communications	**CNE512**	**9/Longitudinal**	**2,1,2**

Introduction to Cellular Mobile Systems: A basic Cellular System, Performance Criteria, Uniqueness of Mobile Radio Environment, Operation of Cellular Systems, Planning and Cellular Systems, Analog & Digital Cellular Systems.

Elements of Cellular Radio System Design: General description of the problem, Concept of Frequency Channels, Co-channel interference Reduction factor, Desired C/I from a normal case in an Omnidirectional Antenna system, Cell splitting, consideration ofthe components of Cellular Systems.

Interference: Introduction to Co-channel interference, Real time Co-channel interference, Co-channel measurement, Design of Antenna system, Antenna parameters and their effects, Diversity Receiver,

Non Co-channel interference - different types. Cell Coverage for Signal and Traffic: General introduction, Obtaining the Mobile Point - to - Point model, Propagation over water or flat open area, Foliage loss, Propagation in near in distance, Long distance Propagation, Point - to - Point predication model - characteristics, Cell site, Antenna heights and signal coverage cells, Mobile - to - Mobile Propagation.

Cell Size Antennas and Mobile Antennas: Characteristics, Antennas at Cell site, Mobile Antennas.

Frequency Management and Channel Assignment: Frequency management, Fixed Channels assignment, Non Fixed Channel assignment, Traffic and Channel Assignment.

Hand Off, Dropped Calls: Why Hand-Off, Types of Hand-Off and their characteristics, Dropped call rates and their evaluation.

Operational Techniques: Parameters, Coverage hole filter, Leaky feeders, Cell Splitting and small cells, Narrow Beam concept.

Title	*Code*	*Semester/Duration*	*Credits*
Networks Security	**CNE513**	**9/Longitudinal**	**2,1,0**

State-of-the-art computer network security technologies, which are crucial to the success of any electronic commerce systems. The course covers fundamental techniques of cryptography, security threats and their possible countermeasures, secure protocols, and other network security schemes (authentication, key management, firewalls, intrusion detection, etc.).

Title	*Code*	*Semester/Duration*	*Credits*
Graduation Project I	**CNE424**	**8/Longitudinal**	**2,0,0**

Project work is for duration of two semesters and is expected to be completed in the tenth semester. Each student group consisting of not more than five members is expected to design and develop a complete system or make an investigative analysis of a technical problem in the relevant area. The project may be implemented using software, hardware, or a combination of both. The project work may be undertaken in electrical power systems / machines / control / electronics / communications / computer / instrumentation / engineering or any allied area and must have relevance in electrical or electronics engineering. Project evaluation committee consisting of the guide and three/four faculty members specialised in the above field shall perform the screening and evaluation of

the projects by end of semester ten.

Title	*Code*	*Semester/Duration*	*Credits*
Communications Network Management	**CNE521**	**10/Longitudinal**	**2,1,2**

DATA COMMUNICATION AND NETWORK MANAGEMENT OVERVIEW: Analogy of Telephone Network Management, Communications protocols and Standards, Case Histories of Networking and Management, Challenges of Information Technology Managers,

Network Management: Goals, Organization, and Functions, Network and System Management, Network Management System Platform, Current Status and future of Network Management.

SNMPV1 NETWORK MANAGEMENT MANAGED NETWORK: Organization and Information Models MANAGED NETWORK: Case Histories and Examples, The History of SNMP Management, The SNMP Model, The Organization Model, System Overview, The Information Model.

SNMPV1 NETWORK MANAGEMENT: Communication and Functional Models, The SNMP Communication Model, Functional model.

SNMP MANAGEMENT: SNMPv2 Major Changes in SNMPv2, SNMPv2 System architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base, SNMPv2 Protocol, Compatibility with SNMPv1.

SNMP MANAGEMENT: RMON : What is Remote Monitoring? , RMON SMI and MIB, RMON1, RMON2, ATM Remote Monitoring, A Case Study of Internet Traffic Using RMON **TELECOMMUNICATIONS MANAGEMENT NETWORK**: Why TMN? , Operations Systems, TMN Conceptual Model, TMN Standards, TMN Architecture, TMN Management Service Architecture, An Integrated View of TMN, Implementation Issues. Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Network Management

systems, Commercial Network management Systems, System Management, Enterprise Management Solutions.

WEB-BASED MANAGEMENT : NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, WBEM: Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network , Future Directions. Case Studies.

Title	*Code*	*Semester/Duration*	*Credits*
Distributed Systems	**CNE522**	**10/Longitudinal**	**2,1,2**

Characterization of Distributed Systems: Introduction-Examples-Resource Sharing and the Web-Challenges. System Models-Architectural-Fundamental.

Inter process Communication: Introduction-API for Internet protocols-External data representation and marshalling--Client-server communication-Group communication- Case study: Inter process Communication in UNIX.

Distributed Objects and Remote Invocation: Introduction-Communication between distributed objects-Remote procedure calls-Events and notifications-Case study: Java RMI.

Operating System Support: Introduction-OS layer-Protection-Processes and threads-Communication and invocation OS architecture.

Distributed File Systems: Introduction-File service architecture-Case Study: Sun Network File System-Enhancements and further developments.

Name Services: Introduction-Name Services and the Domain Name System-Directory Services-Case Study: Global Name Service.

Time and Global States: Introduction-Clocks, events and process states-Synchronizing physical clocks-Logical time and logical clocks-Global states-Distributed debugging.

Coordination and Agreement: Introduction-Distributed mutual exclusion-Elections- Multicast communication-Consensus and related problems.

Distributed Shared Memory: Introduction-Design and implementation issues-Sequential consistency and Ivy case study Release

Title	*Code*	*Semester/Duration*	*Credits*
Communications Systems Analysis	**CNE523**	**10/Longitudinal**	**1,0,3**

Simulation techniques for communication systems operating in random environments. Simulation models for stochastic signals and system components including coders, decoders, modulators, non-linear amplifiers, bit and carrier synchronizers, equalizers and receivers. Techniques for modeling time-varying channels. Monte Carlo simulation, semi-analytic simulation and variance reduction

techniques applied to the analysis, design and performance evaluation of communication systems.

Title	*Code*	*Semester/Duration*	*Credits*
Graduation Project II	**CNE524**	**10/Longitudinal**	**0,0,12**

This project work is the continuation of the project initiated in ninth semester. The performance of the students in the project work shall be assessed on a continuous basis by the project evaluation supervisor through progress seminars and demonstrations conducted during the semester. Each project group should maintain a log book of activities of the project. It should have entries related to the work done, problems faced, solution evolved etc. There shall be at least an Interim Evaluation and a final evaluation of the project in the 10^{th} semester. Each project group has to submit an interim report in the prescribed format for the interim evaluation. Each project group should complete the project work in the 10^{th} semester. Each student is expected to prepare a report in the prescribed format, based on the project work. Members of the group will present the relevance, design, implementation, and results of the project before the project evaluation committee comprising of the guide and three/four faculty members specialised in electrical power systems / machines / control / electronics / communications / computer / instrumentation / engineering.

Electives

Title	*Code*	*Semester/Duration*	*Credits*
Computer Architecture and Organization	**CNE525**	**10/Longitudinal**	**2,2,0**

Register Transfer and Micro operations: Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro operations, Logic Micro operations, Shift Micro operations, Arithmetic Logic Shift Unit.

Basic Computer Organization: Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory Reference Instructions, Input – Output and Interrupt, Complete Computer Description.Introduction, General Register Organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Program Control, Reduced Instruction Set Computer (RISC), Stack Organization.

Micro programmed Control: Control Memory, Address Sequencing, Microinstruction Formats, Micro program Example, Design of Control Unit.

Memory Organization: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory.

Input - Output Organization: Peripheral Devices, Input - Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, Direct Memory Access (DMA), Introduction to Multiprocessor System.

Title	*Code*	*Semester/Duration*	*Credits*
Broadband Wireless Networks	**CNE525**	**10/Longitudinal**	**2,0,0**

WiMAX Genesis and framework 802.16 standard, WiMAX forum, Other 802.16 standards, Protocol layer topologies - Layers of WiMAX, CS, MAC CPS, Security layer, Phy layer, Reference model, topology. Frequency utilization and system profiles: Cellular concept, Licensed and unlicensed frequencies, Fixed WiMAX system profiles, Mobile WiMAX profiles. WiMAX physical layer: OFDM transmission, SOFDMA, subcarrier permutation, 802.16 transmission chains, Channel coding, Turbo coding,Burst profile. WiMAX MAC and QoS: CS layer, MAC function and frames, Multiple access and burst profile, Uplink bandwidth allocation and request mechanisms, Network entry and QoS management. Radio engineering considerations: Radio resource management, Advance antenna technology in WiMAX, MBS. WiMAX architecture, Mobilityhandover and power save modes, Security.

Title	*Code*	*Semester/Duration*	*Credits*
Grid Computing	**CNE525**	**10/Longitudinal**	**2,0,0**

Grid Computing: Introduction - Definition and Scope of grid computing Grid Computing Initiatives: Grid Computing Organizations and their roles – Grid Computing analog –Grid Computing road map. Grid Computing Applications: Merging the Grid sources – Architecture with the Web Devices Technologies: OGSA – Sample use cases – OGSA platform components – OGSI – OGSA Basic Services. Grid Computing Tool Kits: Globus GT 3 Toolkit – Architecture, Programming model, High level services – OGSI .Net middle ware Solutions.

Title	*Code*	*Semester/Duration*	*Credits*
Network operating systems		**10/Longitudinal**	**2,2,0**

Introduction. Operating Systems: Introduction - Overview - Services . Protection: Processes - Program vs. Process - Representation - Management . Process Coordination: Communication - Synchronization (Semaphores, Message Passing) - Scheduling o Memory Management - Fixed Assignment - Dynamic Assignment - Virtual Memory . Networks and Distributed Systems: Introduction -

Benefits - Applications - Network Components - Types of Networks . Communication Basics: Protocols - Communication Software - Communication Hardware / Media - Synchronous vs. Asynchronous - RS-232 Interface . Network and Protocol Architectures: IEEE 802 LAN Standards - LAN Configurations - Ethernet - Token Ring - TCP/IP - OSI - ISDN, ATM . Transmission and Switching: Circuit Switching - Packet Switching . Client-Server Computing: Language Support - Socket Interface - RPC - Web Enabled Applications - Network Security.

Title	*Code*	*Semester/Duration*	*Credits*
network and system Administration		**10/Longitudinal**	**2,0,0**

Operating System Installation & Configuration - File System Organization - Network Services (HTTP, LPR, NFS, SMTP, SSH, etc.) - System Support and Maintenance - Application Installation & Configuration - Server Processes - Client Processes - Application Support & Maintenance - Server Administration & Management - User and Group Management - Backup & Disaster Recovery - Security Management - Job Scheduling & Automation - Resource and Site Management - Performance Monitoring - User Support and Education.

Faculty of Engineering and Architecture [Architecture]

VISION AND MISSION

The VISION of the department is to provide Excellence in architectural education and apply contemporary design innovations according to international standards of quality in the field of architecture and building technology. The MISSION is to improve the efficiency and effectiveness of architectural education to provide students with knowledge and experience to enable them to design architectural projects with emphasis on local and regional contemporary architectural styles.

ENTRANCE REQUIREMENTS

A student interested in joining the Faculty of Engineering, has to:

1 Obtain pass mark in seven subjects including: Arabic language, religious studies, English language, mathematics, physics, chemistry and computer or engineering sciences. International students who have not studied Arabic and religious studies may have more alternative subjects from an approved list of subjects published in the webpage of Ministry of Higher Education.

2 Achieve the percentage in Sudan School Certificate announced every year (International students may have 10% less in the School Certificate scores.

3 Apply electronically though the website of the Admission and Accreditation Office, Ministry of Higher Education, or apply directly in Admission Office in the National University, and pass the health examination, aptitude tests and interview at the Faculty of Engineering-.

4 Pay the published fees: 30,000 SDG or US $ 3,500 [international students] (2018).

CAREER ADVICE

Architecture arises from same origins as other universal manifestations of material culture. However, the artifacts designated as architecture possess a scale, permanence and a pervasive influence unique among human endeavors. These qualities give the discipline a cultural prominence that few other professions enjoy. Therefore, the study of architecture is concerned with complex, interdisciplinary issues. Some matters are primarily individual and practical: the basic human need for shelter and the desire to contrive efficient, adequate forms for the patterns of daily life. Architecture also serves a higher purpose, expressing the living values of a culture. It gives form, order and proportion to human activities. The practice of architecture today requires coordinated contributions from a variety of fields. Consequently, the study of architecture at National University, Sudan investigates principles and applications of technology, art, humanities, engineering, physical and social sciences, business and management. The Bachelor of Science degree in Architecture & Building Technology degree is intended for students seeking a professional career in architecture. The curriculum is designed to meet the requirements to prepare the graduate for professional practice. Sudanese and international graduates enjoy the availability of jobs in public and private companies or pursue their own business. They may continue postgraduate education in masters and PhDs to teach in colleges of Architecture.

FACULTY OBJECTIVES

The objectives of the National University Faculty of Engineering -Architecture and Building Technology (ABT) Department are to :

1 Ensure the ability to conceptualize and coordinate designs, addressing social, cultural, environmental and technological aspects of architecture

2 Ensure that graduates possess the ability to recognize the dialectic relationship between people and the built environment in the region

3 Apply and integrate computer technology in design processes and products

4 Utilize cutting edge building technology in design

5. Apply visual and verbal communication skills at various stages of architectural design and project delivery processes

6 Analyze critically building designs and conduct post occupancy evaluation studies

7 Employ architectural research methods including data collection and analysis to assess and propose improvements in existing built environments

8 Work collaboratively with teams of architects and various interdisciplinary design teams involved in the building industry

9 Recognize diversity of needs, values, behavioral norms, social patterns as they relate to the creation of the built environment

Curriculum Objectives [Characteristics of the Architecture and Building Technology graduate

A graduate of the National University- ABT curriculum should be able to:

1 Conceptualize and coordinate designs that address some of the most salient social, cultural, environmental, theoretical, economic, and technological aspects of architecture.

2 Recognize the dialectic relationship between people and the built environment in a region and apply principles of sustainable design.

3 Apply and integrate computer technology in design processes, documentation, and products of complete architectural drawings.

4 Utilize cutting-edge building technology in design and incorporate life safety systems.

5 Build abstract relationships, and to use visual and verbal communication skills throughout the project delivery process.

6 Analyze critically building designs, and to comprehend constructability.

7 Use a variety of analytical research methods when evaluating the building environment.

8 Work collaboratively with various design teams involved in the building industry, and to collaborate and negotiate with clients and consultants.

9 Recognize diversity of needs, values, behavioral norms, and social patterns as they relate to the creation of the building environment.

10 Get involved with designing new buildings, extensions or alterations to existing buildings, or advising on the restoration and conservation of old properties.

11 Work on individual buildings or on large redevelopment schemes, and can be responsible for the design of the surrounding landscape and spaces..

12 Work closely with clients and users to make sure that projected designs match their needs and are functional, safe and economical.

13 Control projects from start to finish and work with a number of construction professionals, including surveyors and engineers, producing drawings and specifications that the construction team works to.

Feedback to students after mid-course and end of course assessment is an essential part of the architecture program

Architecture Study Program

The student has to earn 188 credit hours to obtain a B.Sc. degree in Architecture. The study program for B.Sc. students in the Architecture Department distributed over 10 semesters as follows:

Semester 1 [19CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Computer Studies I	ARC111	2	-	3	5	3
Design Studio I	ARS111	2	8	-	10	6
History and Theory of Architecture I	ARH111	2	-	-	2	2
Mathematics I	ARM111	2	2	-	4	3
English Language I	ENL111	3	-	-	3	3
Sudanese Culture	SCL111	2	-	-	2	2
		13	10	3	26	19

Semester 2 [19 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Computer Studies II	ARC121	2	-	3	5	3
Design Studio II	ARS121	2	8	-	10	6
History and Theory of Architecture II	ARH121	2	-	-	2	2
Mathematics II	ARM121	2	2	-	4	3
English Language II	ENL121	3	-	-	3	3
Fundamentals of Engineering and Ethics	GEN122	2	-	-	2	2
		13	10	3	28	19

Semester 3 [21 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Design Studio III	ARS211	2	8	-	10	6
Construction Technology I	ART211	2	2	-	4	3
Structure I	ARR211	2	-	-	2	2
History and Theory of Architecture III	ARH211	2	-	-	2	2
Environmental Studies I	ARE211	2	-	3	5	3
Building Function I	ARF211	2	-	-	2	2
Computer Studies III	ARC 211	2		3	5	3
		14	10	6	30	21

Semester 4 [21 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Design Studio IV	ARS221	2	8	-	10	6
Construction Technology II	ART221	2	2	-	4	3
Structure II	ARR221	2	-	-	2	2
History And Theory Of Architecture IV	ARH221	2	-	-	2	2
Environmental Studies II	ARE221	2	-	3	5	3
Building Function II	ARF221	2	-	-	2	2
Computer Studies IV	ARC221	2		3	5	2
		14	10	6	30	21

Semester 5 [23 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Design Studio V	ARS311	4	12	-	16	10
Construction Technology III	ART311	2	2	-	4	3
Structure III	ARR311	2	1	-	3	2
History and Theory of Architecture V	ARH311	2	-	-	2	2
Building Services I	ARB311	2	-	-	2	2
Building Function III	ARF311	2	-	-	2	2

		14	15	-	29	21

Semester 6 [25 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Design Studio VI	ARS321	4	12	-	16	10
Construction Technology IV	ART321	2	2	-	4	3
Building Services II	ARB321	2	1	-	3	2
Urbanism I	ARU321	2	-	-	2	2
Construction Management I	ARO321	2	-	-	2	2
Building Function IV	ARF321	2	-	-	2	2
Structure IV	ARR321	2	1	-	3	2
		16	16	-	32	23

Semester 7 [24 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Design Studio VII	ARS411	4	12	-	16	10
Construction Technology V	ART411	2	1	-	3	2
Urbanism II	ARU411	2	-	-	2	2
Construction Management II	ARO411	2	-	-	2	2
Advanced computer studies	ARV411	1	3	-	4	2
Building Function V	ARF411	2	-	-	2	2
Building Services III	ARS411	2	-	-	2	2
		15	16	-	31	22

Semester 8 [24 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Design Studio VIII	ARS421	6	12	-	20	10
Construction Technology VI	ART421	2	2	-	4	3
Construction Management III	ARO421	2	-	-	2	2
Building Function VI	ARF421	2	-	-	2	2
Survey Engineering	SUR421	2	2	-	4	3
		14	16	-	32	20

Semester 9 [12 CHs-18 weeks]

Course Title	Code	Contact Hours				CH
		Th.	Tut	Lab	Total	
Graduation Project I	ARG511	-	20	-	20	10
Research method	ARR511	2	-	-	2	2
		2	20	-	22	12

Semester 10 [10 CHs- 18 weeks]

Course Title	Code	Contact Hours				CH
		Th	Tut	Lab	Total	
Graduation Project II	**ARG521**	**-**	**20**	**-**	**20**	**10**
		-3	**-**	**-**	**20**	**10**

COURSE OUTLINES

Title	*Code*	*Semester/duration*	*credits*
Design studio I	ARS 111	1/ Longitudinal	4,8,0

Students shall be trained in drafting draughting techniques and principles including use of drawing instruments and materials.

Training shall achieve knowledge of projections including perspectives, colour, rendering and shadow and shade principles.

Title	*Code*	*Semester/duration*	*credits*
Design studio II	ARS 121	2/ Longitudinal	4,8,0

Students shall learn the basics of architectural design and the development of form, space and function. They will be trained in the creative application of the vocabulary of form, space and relation: ties, edges, surfaces, volumes, enclosure, semi- enclosure, open, cluster, axis.

Title	*Code*	*Semester/duration*	*credits*
History and Theory of Architecture I	ARH 111	2/ Longitudinal	2,0,0

Students shall be exposed to contextual aspects of architecture.

They will learn about various and main world civilizations and civilizations components and characteristics. Coverage shall include classical as well as intermediary phases in civilization.

Title	*Code*	*Semester/duration*	*credits*
History and Theory of Architecture II	ARH 121	2/ Longitudinal	2,0,0

Students shall be exposed to contextual aspects of architecture, art and construction of classical civilizations in Europe and Middle East and successive phases up to Renaissance and the subsequent developments to the Modern era.

Title	*Code*	*Semester/duration*	*credits*
Mathematical I	ARM 111	2/ Longitudinal	2,2,0

Students shall learn some historical landmarks in the development of math with emphasis on geometry. Basic principles of geometric shapes and properties: dimension, area combination, subdivision. Rectangular, circular, triangular, hexagon, octagon, decagon.… etc. conical sections, with relevant software application.

Title	*Code*	*Semester/duration*	*credits*
Mathematical II	ARM 121	2/ Longitudinal	2,2,0

Students shall learn about solid geometric forms: pyramids, cubes, rectangular, blocks, conical, sphere, grid forms, lattice forms compositions and combinations of various forms. Measurements and dimensions, with relevant software application.

Title	***Code***	***Semester/duration***	***credits***
Computer Studies I	ARC 111	2/ Longitudinal	1,0,3

Introducing the students to the computer: basics of how to use software. Introduction to CAD: drawings and drawing setups for geometric shapes, lines, surfaces volumes, simple building plans.

Title	***Code***	***Semester/duration***	***credits***
Computer Studies II	ARC 121	2/ Longitudinal	1,0,3

Advanced CAD studies. Application and training on autocad, archicad, 3D, rendering, plans, sections elevations, dimensioning, labeling etc.

Title	***Code***	***Semester/duration***	***credits***
Design studio III	ARS 211	3/ Longitudinal	4,8,0

Students shall be trained in form and function through a complete design process utilizing modelling as a design technique. Presentations in models, drawings, photographs.

Design of a multi-cell building: brief formulation, analysis of requirements- examples search – spatial analysis and relations of functions. Form development.

Title	***Code***	***Semester/duration***	***credits***
Construction Technology I	ART 211	3/ Longitudinal	2,2,0

The students shall be introduced to construction technology: methods, materials and equipment's range.

Construction systems – Excavation – Foundations – Super structure – Roofing – Components – Opening – doors – windows.

Title	***Code***	***Semester/duration***	***credits***
Structure I	ARR 211	3/ Longitudinal	2,0,0

Students shall be exposed to the basic principles of structures and building structural systems.

Historical perspective – structural principles – Morphological representation of structures – structure and architecture – structure and form.

Title	***Code***	***Semester/duration***	***credits***
History and Theory of Architecture III	ARH 211	3/ Longitudinal	2,0,0

Students shall continue with contextual architecture for Islamic civilization, art and architecture: Islamic architecture – Origins and beginnings – Regional developments – Historical evolutions – Islamic art and decoration.

Title	***Code***	***Semester/duration***	***credits***
Environmental Studies I	ARE 211	3/ Longitudinal	2,0,3

The environment as a container of buildings but also contained in building and the interaction of man-environment.

Building physics – basic principles of heat, light, sound – climate and environmental descriptions.

Title	***Code***	***Semester/duration***	***credits***
Building Function I	ARF 211	3/ Longitudinal	2,0,0

The building as an activity system, introducing indoor and outdoor activity typologies and descriptions. Educational buildings: siting, location, configuration, functional analysis and aesthetics applying the elements of form and space.

Title	*Code*	*Semester/duration*	*credits*
Computer Studies III	ARC 211	3/ Longitudinal	1,0,3

Further development and application of software in architectural design utilizing more visualization techniques and effects with a variety of relevant software's

Title	*Code*	*Semester/duration*	*credits*
Design studio IV	ARS 221	4/ Longitudinal	4,8,0

Students shall proceed to higher level in design and creativity. Deeper studies of design of form and function and presentation techniques in computer and modelling.

Design of educational building – Functions and requirements- examples – analysis of space and relationships – Form – modelling – presentation.

Title	*Code*	*Semester/duration*	*credits*
Construction Technology II	ART 221	4/ Longitudinal	2,2,0

Further development in construction technology utilizing different materials and techniques for various typologies of building components.

Masonry Construction: Foundations, walls, roofs – Openings in brick and stone – Bick bonding – Floor construction: concrete, tiles, other.

Title	*Code*	*Semester/duration*	*credits*
Structure II	ARR 221	4/ Longitudinal	2,0,0

Structural knowledge is further developed as an architectural creation of form for various components.

Concepts of structural behavior: graphic approach – Representation in physical models of systems and forces.

Title	*Code*	*Semester/duration*	*credits*
History and Theory of Architecture IV	ARH 221	4/ Longitudinal	2,0,0

Students are exposed to the advent and roots of the modern movements in architecture design and art. Visual and contextual characteristics and philosophies.

Modern architecture – postmodern architecture – pioneers of modern architecture.

Title	*Code*	*Semester/duration*	*credits*
Environmental Studies II	ARE 221	4/ Longitudinal	2,0,3

Man-environment relation is further elaborated and more comprehensively analyzed for the built environment.

Thermal behavior of buildings: environmental and climatic context – Mitigation and enhancement, through design, materials and construction – ventilation.

Title	*Code*	*Semester/duration*	*credits*
Building Function II	ARF 221	4/ Longitudinal	2,0,0

Residential systems are presented in this module to familiarize students and gain knowledge on housing policies, neighborhood plans, residential designs, low cost, low and medium density, residential designs, social and environmental aspects.

Title	*Code*	*Semester/duration*	*credits*

Computer Studies IV	ARC 221	4/ Longitudinal	1,0,3

Students shall proceed to more in-depth application of design software in detailed visualization, presentations, and set-ups.

Title	***Code***	***Semester/duration***	***credits***
Design studio V	ARS 311	5/ Longitudinal	4,12,0

The studies program in this semester V shall tackle a residential project at the neighborhood level taking into consideration overall planning and design architectural typologies.

Title	***Code***	***Semester/duration***	***credits***
Construction Technology III	ART 311	5/ Longitudinal	2,2,0

This is a further developed construction module whereby students shall learn about the characteristic technical issues of multi-story building, building cores, skin, floors and internal partitioning systems.

Multi story construction – external walling – partitions – staircases – Railing and metal screens – shading device systems – Insulation of heat and water.

Title	***Code***	***Semester/duration***	***credits***
Structure III	ARR 311	5/ Longitudinal	2,1,0

In this module III in structures the students are introduced to structure as a form generator and the intimate relations and design opportunities between structure and architectural form are elaborated.

Principles of frame structures – Principles of roofing systems – Large space roofing systems – contemporary structure and architectural form.

Title	***Code***	***Semester/duration***	***credits***
History and Theory of Architecture V	ARH 311	5/ Longitudinal	2,0,0

Students are introduced to the philosophical and creative origins and impacts of contemporary architectural design. Leading architects and architectural works are addressed and analyzed.

Contemporary architecture, developments, critique – structuralism – de constructivism – Digital architecture – contemporary art and architecture – parametricism.

Title	***Code***	***Semester/duration***	***credits***
Building Services I	ARB 311	5/ Longitudinal	2,0,0

This module introduces the role of building services in the efficiency and quality of an architectural design. Basic principles and their design allowance in the building architecture are addressed.

Water supply and disposal: networks, storage, disposal.

Title	***Code***	***Semester/duration***	***credits***
Building Function III	ARF 311	5/ Longitudinal	2,0,0

The special needs and characteristics of transportation buildings are introduced.

Design of transportation buildings: Brief – Functions and circulation analysis – spatial analysis – configuration options and examples – Form – modelling – presentation.

Title	*Code*	*Semester/duration*	*credits*
Design studio VI	ARS 321	6/ Longitudinal	6,12,0

Design studio VI shall address transportation buildings. Terminal, rail station, airport, bus terminals components shall be analyzed for location, access, movement and circulation typologies and functional efficiency and architectural impression.

Title	*Code*	*Semester/duration*	*credits*
Construction Technology IV	ART 321	6/ Longitudinal	2,2,0

A relatively in-depth technical approach for how the building parts come together in different typologies and the methods for achieving that.

Construction practice: material preparation – layout and fixing – placement and handling for different components of building – construction equipment and machining.

Title	*Code*	*Semester/duration*	*credits*
Building services II	ARB 321	6/ Longitudinal	2,2,0

This module introduces in further depth the role of building services in the efficiency and quality of an architectural design. Basic principles and their design allowance in the building architectural are addressed.

Sewage disposal systems – disposal – treatment – Garbage disposal. And treatment. Recycling and reuse concepts and technologies.

Title	*Code*	*Semester/duration*	*credits*
Urbanism I	ARU 321	6/ Longitudinal	2,0,0

Students are introduced to settlement planning with general historical developments and contexts. Emphasis shall be on spatial aspects. Urban design shall constitute the core of the approach to this course.

Planning Theory: National, regional, urban – Urban design Theory and principles of urban design of residential areas.

Title	*Code*	*Semester/duration*	*credits*
Construction Management I	ARO 321	6/ Longitudinal	2,0,0

In this module I the basic principles of management are introduced to familiarize the students with its significance and applications. Construction management and design management are focused, as creatively productive processes.

Title	*Code*	*Semester/duration*	*credits*
Building Function IV	ARF 321	6/ Longitudinal	2,0,0

In this module the wider context of architecture is introduced: buildings with wider communal and cultural impact.

Design of recreational / cultural / buildings – Brief formation – Functional and optical analysis – landscape and built form – Modeling – presentation.

Title	*Code*	*Semester/duration*	*credits*
Structure IV	ARR 321	6/ Longitudinal	2,1,0

In structure IV advanced modern structure systems and materials are presented with emphasis on space structures, towers and the architectural expression of the structure systems. Form and structure shall be the learning theme.

Title	*Code*	*Semester/duration*	*credits*

Design studio VII	ARS 411	7/ Longitudinal	18,0,0

Studio VII represents the synthesis of previous design training and learning material. An urban design project shall represent the context of an architectural project which is then technically detailed as a buildable project.

Urban design project: Analysis and concept development. Architectural Design project: concept, preliminary and developed design – presentation.

Title	***Code***	***Semester/duration***	***credits***
Construction Technology V	ART 411	7/ Longitudinal	2,2,0

In this construction module students learn about the properties and specifications of materials and components and the basis of selection and application in project components.

Finishing, Furnishing and fitting – landscape and extend constructions.

Title	***Code***	***Semester/duration***	***credits***
Urbanism II	ARU 411	7/ Longitudinal	2,0,0

In this module of urbanism II the planning context of certain city functions is discussed. Their spatial planning is developed applying planning standards. Their urban design represents the core of this module.

Planning theory – City sectors planning: industrial, commercial centers – codes and standards.

Title	***Code***	***Semester/duration***	***credits***
Construction Management II	ARO 411	7/ Longitudinal	2,0,0

In this module of construction management II construction management and design management methods are elaborated. Specifications and bills of quantities are introduced as an essential professional knowledge.

Title	***Code***	***Semester/duration***	***credits***
Advanced computer studies	ARV 411	7/ Longitudinal	1,0,3

In this module students are introduced and trained in advanced applications and design software to produce videos, animations and study visuals. Parametric design is introduced with application and software.

Title	***Code***	***Semester/duration***	***credits***
Building Function V	ARF 411	7/ Longitudinal	2,0,0

In this module of building functions V students learn about more technically complex building types, their planning and specialized technical characteristics and provisions. Typologies include industrial and factory buildings, health buildings.

Title	***Code***	***Semester/duration***	***credits***
Building Service III	ARS 411	7/ Longitudinal	2,0,0

This module introduces the role of building services in the efficiency and quality of an architectural design. Basic principles and their design allowance in the building architecture are addressed.

Themes shall be electrical network distribution, lighting for internal and external areas. Air conditioning, cooling, ventilation is introduced with emphasis on their constructional and spatial requirements.

Title	*Code*	*Semester/duration*	*credits*
Design studio VIII	ARS 421	8/ Longitudinal	4,16,0

In this design studio a continuation in the development and finalization of production drawings is the main learning theme. Specification and quantification are included.

Technical solutions – Detailed design – Production drawings.

Title	*Code*	*Semester/duration*	*credits*
Construction Technology VI	ART 421	8/ Longitudinal	2,2,0

This construction module VI exposes the students to recent and contemporary advances in techniques and methods of production including total fabrication, CAM-CAD processes.

Contemporary technologies in construction – Factory production – Prefabrication

Title	*Code*	*Semester/duration*	*credits*
Construction Management III	ARO 421	8/ Longitudinal	2,0,0

In this module of construction management III students learn about contracts in design services and project construction including bidding and engagement procedures, FIDIC international and local versions.

Title	*Code*	*Semester/duration*	*credits*
Building Function VI	ARF 421	8/ Longitudinal	2,0,0

In this module of building functions students are introduced to methods and techniques for studying and analyzing complex building relationships centering on an urban design level and considering movement, location, way-finding, connectivity.

Title	*Code*	*Semester/duration*	*credits*
Graduation Project I	ARG 511	9/ Longitudinal	3,21,0

Students in this module prepare for their graduation project by search and study of relevant aspects which constitute the main input in their design.

Research on nature and scape of an approved architectural project – Review of similar projects – standards – Brief development – Site selection and analysis. Design strategies – preliminary concepts.

Title	*Code*	*Semester/duration*	*credits*
Research method	ARR 511	9/ Longitudinal	2,0,0

Various research methods and techniques are surveyed in an introductory format considering the main knowledge areas: science and humanities. Research in architecture is further elaborated in terms of theory, method and techniques for visual research and the use of multimedia.

Title	*Code*	*Semester/duration*	*credits*
Graduation Project II	ARG 521	10/ Longitudinal	3,21,0

In this final semester students shall produce a design project with the input of semester 9 whereby ability in generating a design efficiently reflecting functional, formal and technology qualities.

Design studies – conceptual design - preliminary design – Developed design – Technical solutions – model – Presentation.