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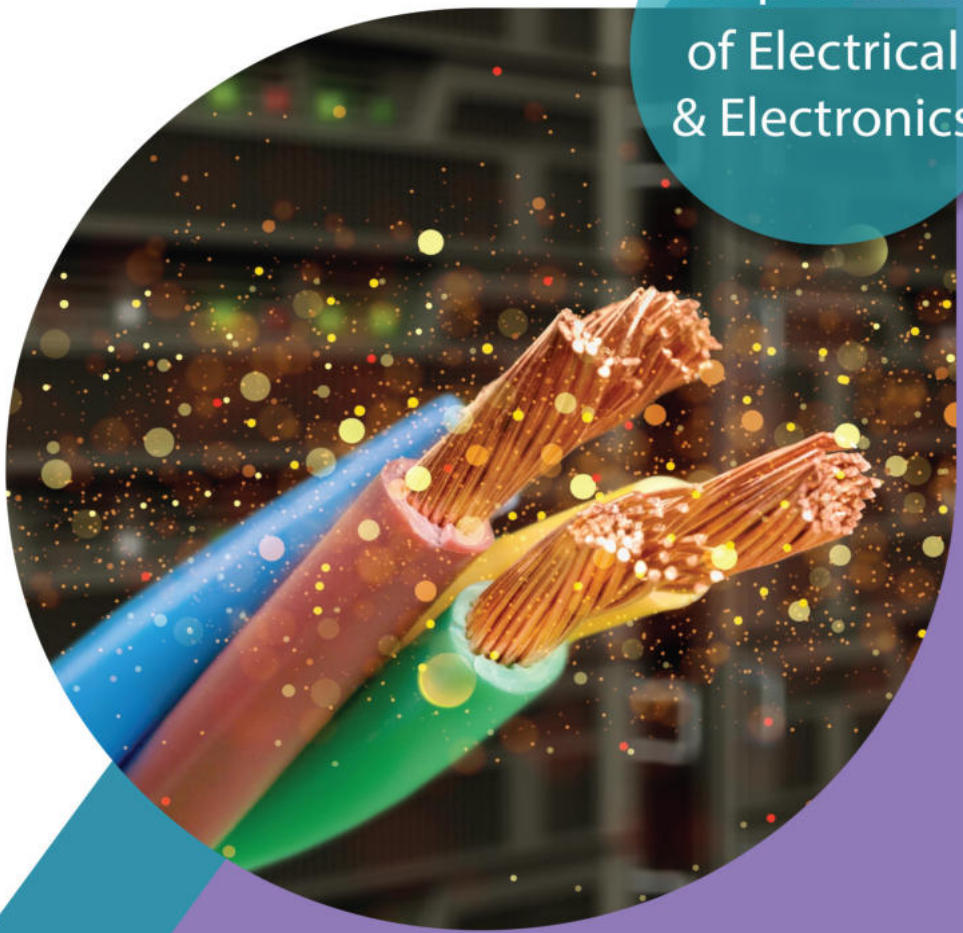
Department of Electrical & Electronics



Undergraduate & Graduate

PROSPECTUS

National University - Sudan

5TH EDITION JULY 2024 - JUNE 2028

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Welcome

Note from The President of NUSU

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01

This is the 5th Edition of the PROSPECTUS of the National University-Sudan (NUSU). In this document registered students will find information about the mission, vision and values of NUSU, and all programme details and activities. This edition includes both UNDERGRADUATE and GRADUATE course outlines. NUSU aims at high-class education in medical, technological and social sciences. This is reflected in this comprehensive outline. It describes the basis of NUSU's educational philosophies, programme objectives including the characteristics of the graduate, strategies and methods, degree structure, semester duration and credit hour load, and brief outline of content. This represent a narrow window into the complex organization of NUSU. More information on the rationale of modules, behavioural objectives, and assessment can be found in the curriculum of each Faculty. The calendars, year plans and timetables are issued for each semester with the exact dates for teaching sessions, other learning opportunities, assessment, feedback, and holidays.

NUSU is now 19 years old. It is still developing, and trying to set traditions of availing all activities in its publications, that may remain relevant for 3-4 years, before new editions are issued. The councils and committees of NUSU, while compiling this, are drawing their experience from lo-

cal and worldwide, up-to-date educational practices. Concurrently, other documents (Student Manual, Staff Handbook, Induction packages, and policies and procedures) are re-written and updated, in view of the emerging concerns about student welfare, environment, students with special needs, and virtual online educational resources.

There is a strong focus on synergy between modern education, developmental needs, and employment market requirements. This has laid down a wide area of maneuvers in the choice of specific disciplines and modules. In each discipline, a detailed career advice has been added in this edition to show students the opportunities available if they choose to be employed or opt to start their own business to employ others.

The reputability of NUSU has attracted students from about 25 countries and all continents. This representation requires quality of premises and services, as well as understanding of diversity, inclusiveness, and considerations for non-discrimination in the educational activities and campus life. International students and the Sudanese students whose families are living outside Sudan, receive special induction, supervision, and directives by the Deanship of Student Affairs, and regular courses shown in this prospectus as Sudanese Studies.

It is my pleasure to invite all qualified students to join NUSU's exciting new and innovative educational programmes. Students, parents, and sponsors are welcome to visit the campus. They will receive guidance from the HELP DESK at the Main Gate. They will be escorted to buildings and connected with the leadership of the university or faculties. Our primary target is to create guest satisfaction. Your comments and feedback are important for us to continue improvement to meet our goals.

Last, but not least, we would like to invite our higher education colleagues, inside and outside the Sudan, to read this publication. Our special request: please have a critical look at this and show us our faults. You may suggest means of correcting them, and tell others about the positive and bright spots of this attempt. Your advice will be highly appreciated.

Prof. Qurashi M. Ali PhD, MD, FRCPE
President, National University, Sudan

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ACKNOWLEGEMENTS

02

Worldwide, the overall innovations and their modifications stem from the efforts of Professor Bashir Hamad. Every page of our documents could not be finalized, or brought to fruition, without his fatherly approval and comments or traces of his educational spirit. His direct and indirect contributions to the curriculum of this University and continuous encouragement are gratefully acknowledged, particularly those related to educational strategies, instruction, and evaluation. The following have reviewed and reorganized the final versions of this prospectus: Prof. A/Rahman Eltom MD,PhD, Prof. A Rahman Biri MD FRCP, Prof. Elthami Abdul Mageed PhD, (medicine), Hassan M. Ali PhD, Dr. Ahmed Abusham PhD and Dr. Salah Ibrahim PhD, and Dr. Fatma Mukhtar MSc. (pharmacy), Dr. Kamal Khalil MD.Dr. Elfatih A Mageed MD (physiotherapy), Dr. M. A. Siddiq PhD. Prof. Awad Haj Ali PhD. (computer and health informatics program), Prof. Ibrahim Ghandor and Dr. Abdalla Darous, Dr. Enas Badawi PhD, Dr. Arif Affan (dentistry), Prof. Sayda H. Elsafi MD, PhD and Dr. Nihal Mirza MD, Dr. M. Sirelkhatim, Dr. M. Abdelgadir, Dr. Maha Magoub (medical laboratory sciences), Dr.Abdel Moneim Saeed PhD, Dr. M. A. Elsheikh PhD Dr. Elsir Ali Saeed PhD, Dr. M. Elfadil PhD, Prof.Maha Esmeal (imaging technology), Prof. Awatif Ahmed PhD, and Ms. Fatma Bhruddin MSc, Dr. Sumia Ibrahim PhD (nursing and midwifery), Prof. Salih Faghiri PhD, Prof. Omer Elmagli PhD, and Prof. Hassan Kamal PhD, Dr. M. A. Osman, Dr. Mutaz Suliman, Dr. A Azim Almahal PhD, and Prof. A Gadir M. Ahmed PhD (management sciences). The contributions of Dr. Nadir Hasanain {Engineering) , Prof. A Latif Elboni and Dr. Ibrahim Mirghani (International Relations) are outstanding.The list, of those who, knowingly or unknowingly, contributed curricular details or ideas registered in Editor's memory or documents, is exhaustive. Our thanks are to the following professors: A/Hameed Lutfi, M.Y. Sukkar, Elbagir Ali El Faki, Amir El Mubarak, Omar Abdul Aziz, Othman Taha, Othman Khalafalla, Ali Habbour, Omar A. Mirghani, Awadelseed Mustafa, Mubarak Majzoub, M. Awadalla Salih, Hafiz El Shazali, Jaafar M. Malik, Othman Hamour, Ali Karar, A/Alla A/Wahid, El Tayeb Abdul Rahman, Eisa Othman El Amin, Mamoun Homeida, Hassan M. Ahmed, Ali Abdul Rahman Barri, Ibrahim M. A/Rahim, Ahmed A. Muhammadani, Mukhtar El-Khatim, A/Rahman A/Hafeez, Sayed M. Ahmed, Awad A/Rahman El-Awad, M. Elamin El-Sharif, Kamal Zaki, A/Rahman El-Tom, Ghazi Salahuddin, Bakri Osman Saeed, Mohyddin Majzoub, Jamal Suleiman, Abbas ElKarib, ElGamri ElRadi, Salah M. Omer, Majid Mustafa, Muzamil Hassan A/Qadir, M. A/Rahim A/AAl, Khalid Musa, Bakri Musa Abdul Karim, Tahir Othman Ali, Omar Siddiq, Fathel Rahman Ahmed Ali, A.Moneim Sahal, Omar Habbal, Mickell Seefldt, Ara Tekian, Margaret Uguroglu, Saleh A. Al Damegh, Zeinel Ab-

deen Karar, A/Rahman Eltom, Ahmed Fahal, Kamal Qurashi, Ammar Khamis, Elamin I. Eneima, Elsheikh A Elobeid, Sara M. Husein, Abubakr Suliman, Elfatih A/Majeed, Mabyua Mustafa, Mustafa Idris, Amin O Sidahmed, Ammar Eltahir, Mr. Suleiman M. Dafa'Alla, Salah Faraj, and many more, we will add them as soon as we are reminded. There is no intention of omission of any effort or opinion.

Most of the "Dentistry Curriculum" has been adapted, with permission, from experts all over the world, mainly deans and heads of departments in the Sudanese dental colleges, and institution in dental sciences. The outstanding effort of professors Ibrahim Ghandour, Yahya Eltayeb, Ibrahim Elkamil, Osman Elgindi, Ahmed Suliman, Abbas Ghariballa, Nadia A. Yahia, Elnur Ibrahim and the improvements made by Enas Badawi, Eman Khair, and Suha A/Gadir is gratefully acknowledged.

The Engineering curriculum has been designed by committees headed by Dr. Nadir Hasanain as dean and head of civil department, and valuable contributions by Prof. Seifeldin Sadig. The International Relations and diplomatic studies curriculum has been written first by Dr. Ibrahim Mirghani and has been edited and adapted to the national requirements by Prof. A Latif Albouni and Bakri A/Karim.

The whole idea could not have seen the light without the encouragement of the Investors' Corporation and Board of Trustees of the National University, who spend days every week responding to routine and emerging issues of financing. On their behalf, I would like to thank the genius and friendly contribution of Mr. Zahir Twahry for his artistic preparation of the 3rd and 4th editions and other NUSU publications. The final editing of most of the undergraduate manuscripts has been skillfully and patiently carried out by Prof. A Rahman Osman Beeri Former Secretary of Academic Affairs. The graduate prospectus has been compiled by Prof. M. M. A. Abulnur, Dean of Graduate Studies and Scientific Research, and Dr. M. Abd Al Kader and Dr. Hatem Al Rufaai.

WHAT IS THE NATIONAL UNIVERSITY?

03

1. MISSION, VISION AND VALUES

The **VISION** of the National University is to be a world-class leading provider of private higher education in the Sudan, in the aspects of elegance of environment and structures, excellence of curricula and learning strategies, quality of management systems, commitment of investors and employees to customer satisfaction (students, relatives, and regulators), distinguished graduates in academic achievements, general ethical standards, and concern with professionalism and original research production.

The **MISSION** is to: (1) constantly strive to provide efficient and best-in-class professionals, in their specialties, (2) meet and exceed our customer needs and expectations, and (3) stay ahead of the competition by creating safe and rewarding workplace facilities and innovating new quality output, services, and relationships in transparent, honest, and fair business.

The **VALUES** are : (1) obligations to treat the public and one another with personal and professional integrity, consideration, and mutual respect, (2) commitment to honesty, truthfulness, respect for human dignity, and professional ethical behaviour, (3) fair treatment of all citizens and employees, with no discrimination on the basis of morphology or ideology (4) promotion of democratic values, hard work, perseverance, commitment to success, accepting responsibility and accountability for one's conduct and obligations, and (5) creating and maintaining a respected reputation and positive image in the community as a trusted partner through excellent care of the individual and family, and responsibility towards the community and environmental problems and concerns.

2. DOCUMENTS

The legal documents of the University include: (1) the University Charter, (2) Academic Regulations (3) Rules of Activity and Conduct (4) Study Fees' Regulations, (5) Employment Regulations, (6) National Employment Penalty Regulations, (7) Contracts and Salary Scale, (8) Job Descriptions, (9) Staff Handbook, (10) Students' Manual, (11) Quality Manual, (12) Teaching, Learning and Assessment Policy, (13) Prospectus and Curricula, (14) Organizational Chart, (15) Committee Structure, (16) Logbooks of students' skills and activities, (17) Year Plans, (18) Academic Calendars, (19) Programme Evaluation Forms, (20) Portfolio of Architectural and Structural Designs of Buildings, (21) External Examiners' Appointment, Reporting and Response documents and (22) numerous policies and procedures in areas of quality, safety, and non-discrimination.

3. BOARD OF TRUSTEES

The Board of Trustees (BOT) is formed according to the Charter to include the investors, the academicians, the representative of the Ministry of Higher Education, and public figures of interest in education or eminent individuals involved in social accountability issues of universities. The current BOT is chaired by Dr. Taha Eltayeb A. Elimam, and includes in its membership: Prof. Qurashi M. Ali, Dr. Amin O. Sidahmed, Dr. M. Sirelkatim Ali, Prof. A-Rahman Osman Beeri, Prof. Osama A-rahman Elamin, Eng. M. Awadelkarim Elgasim, Dr. Saad Subahi, Dr. Elhadi Bakheet, Eng. Yousif A. Yousif, Prof. A-Moneim Algousi, Dr. Ismail Qurashi, Prof. Hassan M. Ali, Deans of faculties, and representatives appointed by the Ministry of Higher Education and approved by the President of the Sudan.

4. RIGHTS

4.1 GENDER RIGHTS

Throughout this manual (and the webpage) every effort has been made to use he/she, his/her, him/her. It may not be possible to assure that this fair use has been consistent. Any such unintended mistake should be taken to mean both sexes. Females have been addressed in situations of special concerns, in gender-specific issues, mainly out of respect for their specialized roles.

4.2 EXCLUSION OF LIABILITY AND DISCLAIMER

Throughout this manual (and the webpage) every effort has been made to ensure that expert, accurate, and up-to-date guidance has been included. The administrative and academic authority continuously updates the NUSU data and academic regulations to satisfy the emerging needs, more quickly than publications would reflect. Approved changes are shown at the official noticeboards of the University. Accordingly, neither the Ministry of Higher Education, nor the NUSU administration, shall be liable to any person or entity with respect to any loss or damage caused or alleged to be caused by the information contained or omitted from this manual (or the webpage).

4.3 COPYRIGHTS

a. The curriculum timetable and course details resemble many of those (or may contain parts) in other colleges in which the "President of NUSU" has been the main or essential member in the bodies responsible for curriculum design and evaluation. In many institutions he has been one of the driving forces for innovation. These institutions include: University of Gezira (Sudan), Sultan Qaboos University (Oman), Omdurman Islamic University, Alzaeim Al-Azhari University, University of Medical Science and Technology, African International University, National Ribat University, Al-Razi University (Sudan), and Al Qassim University (Saudi Arabia). Major innovations have been added to improve on the experience of the above institutions. This manual (and the webpage), in addition to comprehensive compilations in each program document (to be given to each student) is an entity of its own. Therefore, the total set of details, which is not available in any other institution so far, may not be

copied or published without written permission from the National University- Sudan.

b. The teaching material available in the webpage, and other published material in the University notes, is original and should not be reproduced for commercial use, in any form without written permission of the National University- Sudan. Non-profitable teaching purposes are allowed. Our teachers and colleagues, who are mentioned in the "Acknowledgements", are free to use this material because it is all from them, we could not single out what is ours from theirs.

5. ENTRANCE REQUIREMENTS

A. Applications must be through the Ministry of Higher Education (Sudan) Admission Directorate, based on passing a fresh Sudan (or equivalent) School Certificate or equivalent qualification (please see relevant booklets provided at that office). Older 5-10 years' School Certificates may be considered, if vacancies are there, and details are approved by the Admission Office. The newly introduced online application dismiss disqualified applicants automatically.

B. Direct applications are welcome, but will be entered online by the University to the Admission Directorate for approval.

C. International applications will be processed similarly, but candidates are advised to follow the application procedure in the webpage, and wait for a response, before arriving in the Sudan. The NUSU Administration takes 5 working days (after receipt of application) to finalize acceptance. Electronic communication is preferred. For security reasons. A student who is granted acceptance by the NUSU will NOT be allowed by the Ministry of Internal Affairs to transfer to any other university after arrival, except after studying and passing, at least, one academic year..

D. Mature students qualified with a previous health science professional degree may be considered. In this case early application is recommended (6 months before national intake in September every year), because of the time it may take for the approval of the School Certificate by Ministries of General Education and Higher Education, Sudan.

E. Final decision on acceptance depends on the results of an interview to confirm if the student has the aptitude to join a specialty, and is free from physical and psychological inabilities that are not compatible with the responsibilities of a specific or hardship profession. But individuals with special needs are welcome and will find NUSU a conducive environment of values against discrimination.

F. Transfer NUSU from other universities may be considered for enrollment in Semesters 2, 3, 4 or 5 only, based on the approval of the General Directorate of Admission in the Ministry of Higher Education.

6. STAFF AND RECRUITMENT

Academic and administrative staff interested in joining the National University-Sudan, may show their intention by filling the e-recruitment form included in the webpage. A response will be sent

by e-mail within 48 hours, and further instructions will follow. Appointment of academic staff is based on academic excellence in the areas of research and teaching. Academic applicants with no research records or grants will not be considered for full-time positions in this university. Full- and part-time staff list may be looked up in Academic Staff section of the webpage.

Applicants interested in joining other private educational institutions in the Sudan can reach them through our web-page. The employment conditions and salary scale are not (currently) available in this manual or website.

7. LOCATION AND MAPS

A. The Country: The best advantage of this National University is that it is located in Sudan, an Afro-Arab country with rich human and natural life resources. The inhabitants are either Arabs or Africans.. The Sudan educational institutions are known, worldwide, for their academic excellence, ethical heritage and professional teaching perfection. A Sudanese national, wherever he/she may be is unique in considerateness, courtesy, and hospitality. In almost 80% of the country, it is the safest in the world. A single lady can jog in Khartoum, or any other city, in the middle of the night unbothered. Sudanese abide voluntarily by strong moral codes and respect for females as foreigners. The media-nourished concepts of North-South or West-East conflicts have largely exaggerated the reality. The color of people has no significance in this country, maybe the only country in the world where color has never and can never be a real cause of conflict. Media are prototyping other countries' dilemmas on a local setup that has got some developmental problems. It is interesting that the Arabs in this country are mainly non-white, and the non-Arabs are not necessarily black, contrary to what the media have publicized. The luckiest person in the world, any moment, is the one who has been received by a Sudanese host.

Prot Sudan

Khartoum

B. The City: The capital is Khartoum, a city made up of three cities striding the White Nile, Blue Nile as they join to form the River Nile. This has given it unique panoramic landscapes and scenery. There are about 4-6 million inhabitants, mostly in traditional houses, known for their spacious yards. Khartoum city is the official capital crowded with governmental offices, ministries, embassies and international organizations. There are some affluent districts where the price of a house may be as expensive as in New York or Tokyo, and other areas of modest housing. Therefore students have a wide range of choice. Transportation used to be a problem, now it is quite easy, but still, students are advised to find accommodation as near as possible to the University premises.

C. Premises and Environment : (See map). The National University permanent building is located in the Eastern part of Khartoum called Al Raqi District, near the Khartoum-Medani Highway, in an affluent newly established residential area. This region has an interlacing and frequent network of transport, yet the wide roads give no impression of crowdedness, or noise pollution. This accessibility is an invaluable asset for an educational institution. The University block, a purpose-built structure, assumes a masterpiece of architectural innovation (see pictures). The National University is open to students and staff for 18 hours on weekdays and 6 hours on weekends. The library, self-directed learning facilities are available for registered students and staff. Limited access to research laboratories is allowed for certain students who are involved in staff's research projects. Certain sport facilities (Basket- ball and volleyball) are within the premises. In-door recreational facilities are available in the Cafeteria. The source of pride for the University is the design of its beautiful, environmentally friendly, and durable facilities that support its mission. Students and employees are expected to respect and work towards achieving that. Directives from them to their visitors are very important to maintain and improve the level of standards of perfection we intend to reach. There are few similar, or near, buildings of excellence of space and quality, so far, in higher education institutions in the Sudan.

   A 10-floor teaching hospital building stands next to the main University block and accommodates over 300 beds with full tertiary care facilities. A 5-floor building accommodate the Faculty of Engineering. NUSU owns a 35000 M2 area in Albagair Suburban Area, in which a new campus is being built. It includes a rural hospital.

8. PROGRAMME FEES

A list of tuition fees is published by the MHESR every year. Private institutions keep updating such list, but a student accepted in one particular academic year will NOT be charged with the fees published for fresh students. Fees cover teaching and administrative activities of the University including laboratories and in-campus training. Accommodation and food subsidies are NOT included. Transportation to and from the University or off-campus training sites is NOT included, but the University tries to provide that for selected activities. Additional fees are variable for compensations of absence or failure. Students pay for all courses Training outside the campus and examinations [substitute or supplementary], scheduled in the Summer or Holidays, based on the credit hour load of the courses. Fees for such compensations are usually not published in Academic Calendar, but requested by students or their sponsors.

Background

The Faculty of Engineering & Architecture at the National University – Sudan (NUSU–FOEA) aspires to be a leading center of excellence in engineering education, architectural innovation, and applied research both nationally and internationally. It is committed to producing highly competent, ethical, and forward-thinking engineers and architects through rigorous, interdisciplinary training aligned with global standards.

The faculty emphasises design thinking, technological integration, and sustainable development, preparing graduates to address complex challenges in infrastructure, energy, urban planning, and digital systems. Through a curriculum that blends theory with hands-on experience, students are equipped to contribute meaningfully to industry, academia, and society.

NUSU–FOEA fosters a culture of innovation, collaboration, and lifelong learning, encouraging students to engage in real-world projects, industry partnerships, and community development initiatives. The faculty upholds core values such as integrity, excellence, and respect for diversity, and strives to maintain a reputable role in advancing engineering and architectural solutions for a more resilient and equitable future.

Our Vision

The (NUSU–FOEA) aspires to become a premier center of excellence in engineering and architectural education, research, and societal impact, both nationally and internationally. Its goal is to deliver innovative, interdisciplinary training that aligns with global standards and empowers students to become creative, ethical, and solution-oriented professionals.

The faculty is committed to advancing technological innovation, sustainable design, and infrastructure development through evidence-based teaching, applied research, and strong industry engagement. It fosters critical thinking, lifelong learning, and collaborative problem-solving across engineering and architectural disciplines.

By cultivating partnerships with academic institutions, industry leaders, and communities,

NUSU–FOEA aims to contribute meaningfully to national development, environmental resilience, and the global engineering landscape. Upholding values of integrity, excellence, and inclusivity, the faculty strives to shape a generation of professionals capable of designing a smarter, more equitable future.

Our Mission

The NUSU-FOEA is committed to fostering academic excellence, advancing technological innovation, and promoting sustainable development within a dynamic, student-centered learning environment. The Faculty aims to cultivate competent, ethical, and visionary engineers and architects who are dedicated to lifelong learning, creative problem-solving, and socially responsible practice.

Graduates are envisioned as innovative thinkers equipped to address complex engineering and design challenges across diverse contexts, local, regional, and global. Through rigorous education, hands-on experience, and interdisciplinary collaboration, students develop the skills to lead transformative projects in infrastructure, energy, urban planning, and architectural design.

In partnership with industry, government, and communities, the Faculty strives to make meaningful contributions to national development, environmental resilience, and the advancement of engineering and architectural standards in Sudan and beyond.

Our Values

The NUSU-FOEA core values include:

- Commitment to community-centered innovation: We strive to address societal challenges through engineering and architectural solutions that are ethical, sustainable, and responsive to local needs.
- Integrity, honesty, and respect: All actions within the Faculty are guided by truthfulness, transparency, and respect for human dignity, fostering trust and professionalism in every endeavour.
- Equity and inclusivity: We ensure fair treatment for all students, staff, and stakeholders, regardless of ethnicity, appearance, religion, or ideology, creating a welcoming and diverse academic environment.
- Dedication to excellence and accountability: We promote hard work, perseverance, and a culture of responsibility, encouraging students and faculty to pursue excellence while being accountable for their conduct and contributions.
- Collaborative spirit and global outlook: We value teamwork, interdisciplinary collaboration, and international engagement, preparing graduates to thrive in a globally connected engineering and architectural landscape.

- Environmental stewardship and sustainability: We uphold principles of ecological responsibility, integrating sustainable practices into design, construction, and technological innovation.
- Positive institutional image and public trust: We aim to maintain a reputable presence in the community by delivering high-quality education, impactful research, and ethical professional services.

Our Objectives:

- To graduate professionals holding degrees in engineering and architecture who demonstrate technical excellence, ethical integrity, and a strong commitment to sustainable development and community engagement.
- To uphold and promote the values and cultural heritage of Sudan, integrating national identity and ethical principles into the educational philosophy and professional practice of all graduates.
- To enhance engineering and architectural research by leveraging the university's laboratories, digital infrastructure, and interdisciplinary collaboration to address pressing technological and environmental challenges.
- To contribute to community development by offering engineering and design services through university-led initiatives and partnerships with governmental and non-governmental organisations, thereby improving infrastructure and quality of life.
- To participate in the planning and implementation of national development projects, utilising the expertise of faculty members and consultants to support strategic goals in urban planning, energy, transportation, and environmental resilience.
- To promote continuous professional development by organising local and international workshops, seminars, and conferences aimed at advancing the skills and innovation capacity of engineers and architects.
- To ensure access to modern tools and technologies by maintaining state-of-the-art laboratories, design studios, and software resources, in collaboration with industry partners and relevant ministries.

Departments

The Faculty of Engineering & Architecture comprises three harmonised, interrelated departments that collectively form the backbone of engineering and architectural education, research, and professional practice. These departments foster a comprehensive understanding of design, technology, and infrastructure, ensuring that future engineers and architects are well-equipped with the knowledge, skills, and ethical standards essential for excellence in their

fields.

Working synergistically, these departments provide an integrated academic experience that balances theoretical foundations, practical applications, innovation, and community engagement. Their collective goal is to produce competent, creative, and socially responsible professionals ready to meet the evolving demands of engineering and architectural practice both locally and globally.

The departments are:

- Architecture Department
- Civil Engineering Department
- Electrical & Electronics Engineering Department

Department of Architecture

The Department of Architecture is dedicated to advancing design excellence through rigorous education, research, and mentorship. Its faculty of experienced architects and scholars serves as role models, emphasising the integration of creative vision with technical precision and cultural sensitivity.

Rooted in both tradition and innovation, the department fosters a deep understanding of spatial design, environmental responsibility, and urban dynamics. Students are challenged to explore architecture as a multidisciplinary practice, where aesthetics, functionality, and sustainability converge to shape the built environment.

Through studio-based learning, critical discourse, and hands-on projects, the department cultivates future architects who are not only skilled designers but also thoughtful contributors to society. Its commitment to ethical practice, contextual awareness, and lifelong learning ensures graduates are prepared to lead in both local and global architectural landscapes.

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.

Teaching Programmes:

- Core architectural concepts are imparted to students primarily during their design

studio years, where theoretical knowledge is integrated with hands-on practice.

- In the Faculty of Engineering & Architecture, the department leads the Architectural Design course series, beginning in the second year and intensifying through the fourth and fifth years. These courses cover fundamental principles of spatial organisation, form, function, and contextual design, with increasing complexity in urban, institutional, and mixed-use projects.
- The department also conducts the Sustainable Architecture and Environmental Design course, focusing on climate-responsive strategies, energy efficiency, and ecological integration. Students learn to apply passive design techniques, material selection, and environmental analysis tools to real-world challenges.
- Additionally, the department offers the Urban Planning and Theory course, which introduces students to the dynamics of city development, zoning, public space design, and socio-cultural factors influencing urban form.

Research & Innovation:

- Emphasis on applied research to enhance the quality, sustainability, and cultural relevance of the built environment. The department encourages investigations into architectural design methodologies, material technologies, and spatial performance to address real-world challenges in urban and rural contexts.
- Promotes multidisciplinary collaboration across engineering, environmental science, sociology, and digital technologies. Faculty and students engage in joint research projects that explore smart cities, heritage conservation, climate-responsive design, and community-driven planning.
- Supports design research, post-occupancy evaluations, and architectural audits to assess the impact of built spaces on human behaviour, energy consumption, and social equity. These initiatives inform policy, practice, and pedagogy, reinforcing the department's commitment to innovation and evidence-based design.

Department of Civil Engineering

- The Department of Civil Engineering is dedicated to advancing infrastructure excellence through rigorous education, applied research, and professional mentorship. Its faculty of experienced engineers and scholars serves as role models, emphasising the integration of analytical rigour with practical innovation and ethical responsibility.
- Rooted in both foundational engineering principles and emerging technologies, the department fosters a deep understanding of structural integrity, environmental stewardship, and sustainable development. Students are challenged to explore

civil engineering as a multidisciplinary field, where design, materials, and systems converge to shape resilient communities and modern infrastructure.

- Through project-based learning, fieldwork, and collaborative problem-solving, the department cultivates future civil engineers who are not only technically proficient but also socially conscious contributors to national and global development. Its commitment to safety, sustainability, and lifelong learning ensures graduates are equipped to lead in diverse sectors, including construction, transportation, water resources, and urban planning.

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.

Teaching Programmes:

- Core civil engineering principles are introduced to students through a blend of theoretical instruction and practical application, particularly during their structural and infrastructure-focused studio courses. These experiences emphasise the integration of design, analysis, and construction methodologies.
- Within the Faculty of Engineering & Architecture, the department leads the Structural Design and Analysis course series, beginning in the second year and advancing through the fourth and fifth years. These courses cover essential topics such as load-bearing systems, material behaviour, and design codes, with increasing complexity in bridges, high-rise buildings, and public infrastructure projects.
- The department also conducts the Sustainable Infrastructure and Environmental Engineering course, which emphasises eco-conscious design, resource efficiency, and resilience. Students explore water management systems, green construction practices, and environmental impact assessments, applying engineering tools to address global sustainability challenges.
- Additionally, the department offers the Transportation and Urban Infrastructure Planning course, introducing students to the planning and design of road networks, transit systems, and urban utilities. The curriculum integrates traffic flow theory, geospatial analysis, and socio-economic considerations to prepare students for holistic infrastructure development.

Research & Innovation:

Emphasis on applied research to improve infrastructure resilience, environmental sustainability, and socio-cultural integration. The department encourages investigations into structural systems, construction materials, geotechnical innovations, and transportation networks to address pressing challenges in both urban and rural development.

Promotes multidisciplinary collaboration across civil engineering, environmental science, urban planning, and data analytics. Faculty and students engage in joint research projects focused on climate-adaptive infrastructure, disaster risk reduction, heritage preservation, and inclusive urban mobility, fostering holistic solutions for evolving societal needs.

Supports performance-based design, lifecycle assessments, and post-construction evaluations to examine the long-term impact of civil infrastructure on safety, resource efficiency, and community well-being. These initiatives inform engineering standards, public policy, and educational frameworks, reinforcing the department's commitment to innovation, sustainability, and evidence-driven practice.

Department of Electrical & Electronics Engineering

The Department of Electrical & Electronics Engineering is dedicated to advancing technological innovation through rigorous education, research, and mentorship. Its faculty of accomplished engineers and scholars serve as role models, emphasising the integration of theoretical insight with practical expertise and ethical responsibility.

Rooted in both classical engineering foundations and cutting-edge advancements, the department fosters a deep understanding of electrical systems, electronic devices, and intelligent technologies. Students are challenged to explore electrical engineering as a multidisciplinary practice, where physics, computation, and design converge to power modern life.

Through lab-based learning, collaborative experimentation, and real-world applications, the department cultivates future engineers who are not only technically adept but also visionary contributors to society. Its commitment to sustainable innovation, global relevance, and lifelong learning ensures graduates are prepared to lead in diverse fields such as energy systems, embedded electronics, telecommunications, and automation.

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.

Teaching Programmes:

- Core electrical and electronics engineering concepts are imparted to students primarily through laboratory-intensive courses, where theoretical foundations are integrated with hands-on experimentation and system design.
- Within the Faculty of Engineering & Architecture, the department leads the Circuit Design and Analysis course series, beginning in the second year and intensifying through the fourth and fifth years. These courses cover fundamental principles of analogue and digital circuits, signal processing, and embedded systems, with increasing complexity in automation, instrumentation, and real-time applications.
- The department also conducts the Renewable Energy Systems and Power Electronics course, focusing on sustainable energy conversion, smart grid technologies, and efficient power management. Students learn to apply simulation tools, design photovoltaic and wind systems, and analyse energy storage solutions in response to global energy challenges.
- Additionally, the department offers the Communication Systems and Electromagnetic Theory course, which introduces students to the principles of wireless communication, antenna design, and signal transmission. The curriculum explores modulation techniques, network protocols, and the socio-technical impact of connectivity in modern society.

Research & Innovation:

- Emphasis on applied research to advance intelligent systems, energy efficiency, and digital connectivity. The department encourages investigations into circuit design, embedded technologies, and power systems to address real-world challenges in industrial automation, renewable energy, and smart infrastructure.
- Promotes multidisciplinary collaboration across engineering, computer science, environmental studies, and telecommunications. Faculty and students engage in joint research projects exploring Internet of Things (IoT), robotics, wireless networks, and energy management systems, contributing to the development of smart cities and sustainable technologies.
- Supports innovation in system modeling, hardware prototyping, and performance evaluation to assess the reliability, scalability, and environmental impact of electrical

and electronic solutions. These initiatives inform industry practices, academic curricula, and national development strategies, reinforcing the department's commitment to evidence-based engineering and technological advancement.

Administartion

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Faculty Dean

Associate Professor of Electrical & Electronics Engineering

Dr. Sawsan M. Almakawy

Deputy Dean

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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 cur-

vature, 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-MnO2 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 Mod-

el, 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 Enrgy 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 multi-storied 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, Ş and ş 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

Fundamentals of Control Theory: Open-loop vs. closed-loop control, Historical development and real-world applications. Differential Equations and Transfer Functions-Laplace transforms.

Block diagrams and signal flow graphs. State-Space Representation: State variables and state equations, Relationship between state-space and transfer functions.

Time Response of Systems: First- and second-order systems Step, impulse, and ramp responses.

Stability Analysis: Definitions of stability, Routh-Hurwitz criterion

Bode and Nyquist Plots, Frequency response characteristics, Stability criteria using Nyquist. Root Locus Analysis.

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 Con-

volution 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

Overview of Control System Applications: Mechanical, electrical, and process control examples.
Proportional, Integral, and Derivative (PID) Control: Controller tuning methods (Ziegler-Nichols).
Compensation: Lead, Lag, Lead-lag compensation.
Stability using Bode Method: Gain and phase margins, Sensitivity functions.
Advanced Design Techniques using Root Locus Higher-order systems.
Effects of added poles and zeros.
State-Feedback Control (Pole Placement), Ackermann's formula.
Observer Design, Luenberger observer, Estimation techniques.

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

Correlation between Time and Frequency Responses.
Polar Plots.
Log Magnitude versus Phase Plots.
All Pass and Minimum Phase Systems.
Nyquist Stability Criterion.
Assessment of Relative Stability.
Constant M and N Circles.
Input-output and internal stability.
Error coefficients and system type.
Introduction to nonlinear control (describing functions).
Introduction to optimal control (linear quadratic regulator).

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 cells.

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 ṢPF 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 Baseband 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 10th 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 10th 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.

National University

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National University Sudan

Undergraduate & Graduate

PROSPECTUS

National University - Sudan

5TH EDITION JULY 2024 - JUNE 2028

National University - Sudan

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