Curriculum for
Electrical Engineering
Bachelor of Engineering Program
2023

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

CURRICULUM

OF

ELECTRICAL ENGINEERING

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Pakistan Engineering Council (PEC)
&
Higher Education Commission (HEC)
Islamabad

Contents

PREFACE

The curriculum, with varying definitions, is considered as a roadmap or plan of teaching-learning process that students of an academic programme are required to undergo. It includes objectives and learning outcomes, course contents, scheme of studies, teaching approaches, and assessment methodologies. Since knowledge in all fields and sectors is expanding at a faster pace and new disciplines are also emerging; it is imperative that curricula should be dynamic having regular review and updation.

University Grants Commission (UGC) was the authorised authority to develop, review and revise curricula beyond Class-XII vides Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled “Supervision of Curricula and Textbooks and Maintenance of Standard of Education”. With the repeal of the UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v). In compliance with this provision, the HEC has been undertaking the development of curricula for new/ emerging fields and revision of curricula after regular intervals through respective National Curriculum Revision Committees (NCRCs) until 2018.

As a policy change and expanding higher education base under HEC, the curriculum review and development task has been shifted to the respective regulators and HEIs. PEC also having a mandate under its Act of Parliament and especially after attaining Washington Accord full signatory status and IPEA licensing authority, took up the challenge to review and develop the curricula for engineering programs based on the Outcome-Based Education (OBE) System. PEC has therefore constituted an Engineering Curriculum Review and Development Committee (ECRDC) comprising of eminent engineers and professionals from academia and industry to take up the task of curricula review and updation. Nevertheless, the basic templates developed by HEC NCRC have been followed as guidelines.

Under OBE based curriculum review and development framework, PEC held national and regional levels stakeholders and industrial consultation workshops by engaging HEIs, industry, technical and consulting organizations. The experts' feedback and suggestions were translated into the curriculum review process while taking into consideration the dynamics of technological advancement, industrial needs and management-cum-soft skills for engineering graduates.

This curriculum document would serve as a guideline whereas allowing HEIs to tame/ change within the framework by introducing courses in support of local/ required industrial demand as well as satisfying the revised 11 GAs (Graduate Attributes) and 13 PCs (Professional Competency) covering core and elective courses, considered as beauty of the OBE system in the international arena. At the same time, this curriculum framework would fulfill the purpose of meeting our national, social and economic needs leading towards attainment of Sustainable Development Goals (SDGs-2030).

It would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards.

While approving this curriculum in the 10^{th} meeting of ECRDC-Main, Engr. Lt. Gen (Retd.) Javed Mahmood Bukhari (Convener) appreciated and complemented the role of PEC by doing a great job in many endeavors. He lauded the PEC initiatives and accomplishments being made by the current Governing Body & Management Committee under the Leadership of Engr. Muhammad Najeeb Haroon (Chairman PEC) and Engineering Accreditation Board (EAB) under the Convener-ship of Engr. Dr. Niaz Ahmad Akhtar (Convener EAB/ Vice-Chairman Punjab) for promoting standards of engineering education as well as practice of engineering for ultimate achievement to promote rapid growth in the socio-economic field of Pakistan.

He acknowledged the contribution and tangible input rendered by members/ experts of ECRDC-Main and respective discipline-wise Committees/ Sub-Groups and the continued support of Engr. Dr. Nasir Mahmood Khan (Secretary/ Registrar- PEC) for developing these undergraduate engineering programs curricula and producing quality work output.

The Convener also expressed gratitude to PEC and HEC for collaborative efforts and synergy for uplifting the standards of education particularly in engineering field in the country. He praised the working of HEC on issuing an Undergraduate Education Policy (UEP) to be implemented from Fall-2023 for all HEIs and Councils. In this regard, he appreciated PEC EAB's working and notification of engineering education guidelines/ framework document which is developed in the light of HEC-UEP. He anticipated that these combined efforts will continue to achieve the Sustainable Development Goals (SDGs) of enhancing the quality of engineering education towards economic growth at national level.

1. Engineering Curriculum Review & Development Committee (ECRDC)

PEC in its efforts towards quality engineering education, took up the challenge of curriculum review and development for engineering programs after due consent of HEC. A high-level Engineering Curriculum Review and Development Committee (ECRDC), led by Engr. Lt. Gen (Retd.) Javed Mahmood Bukhari, Member Governing Body/ Rector, NUST was constituted (for the term 2021-2024), whereas other eminent members from industry and academia were involved in the task of curricula review and updation, besides developing curriculum for new/ emerging fields. The main responsibility of ECRDC is to oversee the entire curriculum review and development process while setting policies and guidelines for the subject ECRDCs working in their respective domains. The 9th meeting of the main ECRDC and first of this term, was held on 31st May 2022 at PEC Head Office Islamabad, wherein the Convener briefed the scope, objective and ToRs of the Committee and also endorsed the subject ECRDCs comprising of eminent engineers and professionals from academia and industry.

1.	Engr. Lt. Gen (Retd.) Javed Mahmood Bukhari Convener (ECRDC-Main)/ Member PEC Governing Body/ Rector NUST, Islamabad	Convener
2.	Engr. Prof. Dr. Altaf Mukati Vice President (Academics) SZABIST University, Karachi	Dy. Convener
3.	Engr. Prof. Dr. Bhawani Shankar Chowdhry Member, PEC Governing Body / Prof. Emeritus /Advisor MUET, Jamshoro	Member
4.	Engr. Prof. Dr. Shahid Khattak Convener, Elect Engg & Allied Disciplines	Member
5.	Engr. Prof. Dr. Ehsan Ullah Khan Kakar Convener, Civil Engg & Allied Disciplines	Member

6.	Engr. Prof. Dr. Syed Mushtaq Shah Convener, Mechanical Engg & Allied Disciplines	Member
7.	Engr. Prof. Dr. Amanat Ali Bhatti Convener, Materials, Metallurgical, Mining and Petrogas & Allied Disciplines	Member
8.	Engr. Prof. Dr. Naveed Ramzan Convener, Chemical Engg & Allied Disciplines	Member
9.	Engr. Dr. Muhammad Ashraf Convener, Agricultural Engg. & Allied Disciplines	Member
10.	Engr. Muhammad Raza Chohan Convener, Common to All (Non-Engg Component)	Member
11.	Mr. Hidayatullah Kasi HEC Representative	Member
12.	Engr. Dr. Nasir Mahmood Khan	Secretary / Registrar, PEC
13.	Engr. Niaz Ahmed Khaskheli Sr. Additional Registrar, EAD	Secretary ECRDC

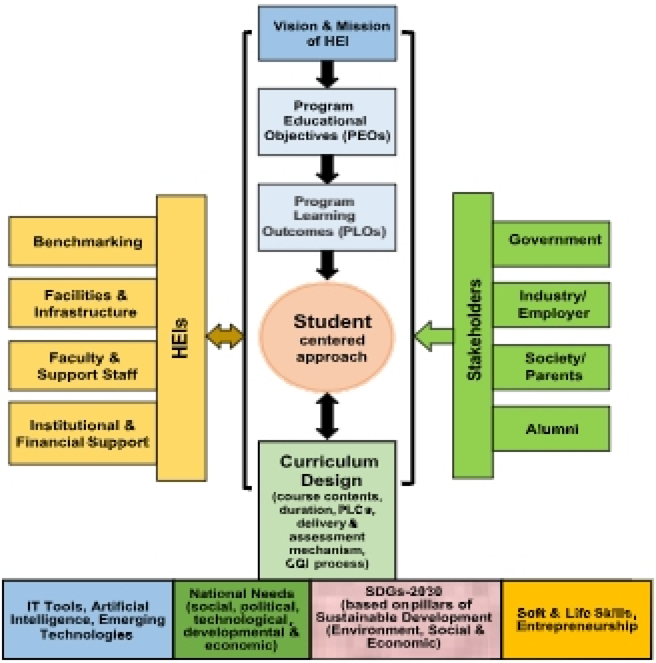
2. ECRDC Agenda

- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance & progress, and thereby submission to the relevant forum for adoption/ notification.
- Each Member of ECRDC will also work in the capacity of Convener for respective disciplines as mentioned against their names and as per their ToRs.

3. OBE-Based Curriculum Development Framework

Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student centered system that concerns what the students will know and be able to do as learning outcomes. The curriculum development under OBE is therefore an integration of graduates' attributes and stakeholders' feedback in cognizance with the institution's Vision and Mission.

Outcome Based Education (OBE) Curriculum Development Framework



4. PDCA Approach to Curriculum Design and Development

The process of curriculum design and development constitutes various interconnected elements with the objective of achieving the intended purpose of the program. The Plan-Do-Check-Act approach (PDCA) as explained below has been followed in the curriculum development and review process.

Plan. This stage begins with an analysis of the stakeholders' needs of faculty, current and past students, employers and society in general. The stakeholders' needs are translated into human resource terminology i.e. graduate competencies which in turn translated into educational taxonomy and learning outcomes. Based on the learning outcomes, the curriculum is designed backward to meet PLOs.

Do. The Do plan stage is implemented where the curriculum is delivered and learning outcomes are assessed to gauge the achievement of PLOs.

Check. This stage involves the analysis of assessment results and feedback from students and faculty. Areas for improvement are also identified during this stage.

Act. When the learning outcomes are achieved, the curriculum, learning and teaching strategies and assessment methods are standardized. Best practices are shared and improvement is made for the next cycle of PDCA.

5. ECRDC for Electrical and Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Electrical and Allied Engineering disciplines took up the task to review and update the curriculum for Electrical Engineering degree program. The subject Committee had several meetings besides multiple sessions of Sub-Groups and the concluding meeting of ECRDC Electrical & Allied Disciplines was conducted on 18-1-2024 at PEC Head Office, Islamabad. The Committee comprised of the following members:

1.	Engr. Prof. Dr. Shahid Khattak Ex-VC UET, Mardan	Convener
2.	Engr. Dr. Noor Muhammad Sheikh Professor, GCU, Lahore	Member
3.	Engr. Mian Sultan Mehmood CEO, Creative Group of Companies	Member
4.	Engr. Nasir Ayaz Khan Gurmani Chief Engineer, Strategic Planning MEPCO	Member
5.	Engr. Prof. Dr. Zubair Ahmed Sheikh President, MAJU Karachi	Member
6.	Engr. Dr. Zahid Hussain Khand Professor & Registrar, IBA Sukkur	Member
7.	Engr. Dr. Faizullah Khan Kakar Professor, BUITEMS Quetta	Member
8.	Engr. Dr. Nasir Baig Director (Satellite), Axiohesheng Islamabad	Member

9.	Engr. Muhammad Imran Khan Cheema Head Business Development IP, Descon	Member
10.	Engr. Abdul Rehman Sheikh Senior Manager, PTCL Karachi	Member
11.	Engr. Prof. Dr. Muhammad Kamran Vice Chancellor, MNS-UET, Multan	Member
12.	Engr. Dr. Noor Muhammad Khan Professor, Capital University of Science & Technology, Islamabad	Co-opted Member
13.	Engr. Dr. Syed Madad Ali Shah Professor, IBA Sukkur	Co-opted Member
14.	Engr. Dr. Hafiz Ashiq Hussain Professor, Air University, Islamabad	Co-opted Member
15.	Engr. Dr. Kamran Liaquat Bhatti Associate Professor, NFC-IET, Multan	Co-opted Member
16.	Engr. Dr. Zahir Javed Paracha Professor, PIET Multan	Co-opted Member
17.	Engr. Dr. Naeem Iqbal Professor, PIEAS Islamabad	Co-opted Member
18.	Engr. Dr. Tariq ullah Jan Associate Professor, UET Peshawar	Co-opted Member
19.	Engr. Dr. Saad A. Qazi Professor, NED-UET Karachi	Co-opted Member
20.	Engr. Dr. Gulistan Raja Professor, UET Taxila	Co-opted Member
21.	Engr. Prof. Dr. Abdul Rehman Memon Former VC MUET, Jamshoro	Co-opted Member
22.	Engr. Zafar Mahmood CEO, Inter-SES Islamabad	Co-opted Member

23.	Engr. Abdul Khalique Sheikh Director, K-Electric	Co-opted Member
24.	Engr. Dr. Muhammad Saeed FAST NUCES, Islamabad	Co-opted Member
25.	Mr. Hidayatullah Kasi Representative HEC	Co-opted Member
26.	Engr. Niaz Ahmad Sr. Additional Registrar/ HoD-EAD	Secretary ECRDC
27.	Engr. Osaf Mahmood Malik Section Head (Curriculum & Development)	Additional Registrar-EAD
28.	Engr. Syed Haider Abbas Bokhari	Assistant Registrar-EAD
29.	Mr. Muhammad Irfan	Office Superintendent-EAD

The working on curriculum development of Electrical Engineering was initiated in 2022 by the previous EAD team comprising of Engr. Dr. Ashfaq Ahmed Sheikh (Sr. Additional Registrar), Engr. Ghulam Karim (Additional Registrar) and Engr. Daniyal Hameed (Assistant Registrar). The contribution of previous as well as current EAD team was highly acknowledged and appreciated by the Convener ECRDC Electrical and Allied Engineering Disciplines.

Sub-Group Electrical Engineering (Foundation)

1.	Engr. Dr. Noor Muhammad Khan Professor, Capital University of Science & Technology Islamabad	Lead Sub-Group
2.	Engr. Dr. Gulistan Raja Professor, UET Taxila	Member
3.	Engr. Prof. Dr. Muhammad Kamran Vice Chancellor, MNS-UET, Multan	Member

Sub-Group Electrical Engineering (Breadth)

1.	Engr. Dr. Noor Muhammad Sheikh Professor, GCU, Lahore	Lead Sub-Group
2.	Engr. Prof. Dr. Zubair Ahmed Sheikh President, MAJU Karachi	Member

Sub-Group Electrical Engineering (Depth)

1.	Engr. Dr. Bhawani Shankar Chowdhry Professor Emeritus, Advisor MUET, Jamshoro	Lead Sub-Group
2.	Engr. Prof. Dr. Shahid Khattak Ex-VC UET, Mardan	Member
3.	Engr. Dr. Syed Madad Ali Shah Pro-VC & Professor, IBA Sukkur	Member
4.	Engr. Prof. Dr. Muhammad Kamran Vice Chancellor, MNS-UET, Multan	Member
5.	Engr. Prof. Dr. Zubair Ahmed Sheikh President, MAJU Karachi	Member
6.	Engr. Dr. Noor Muhammad Sheikh Professor, GCU, Lahore	Member
7.	Engr. Dr. Hafiz Ashiq Hussain Associate Professor, Air University, Islamabad	Member

Sub-Group Electrical Engineering (Power)

1.	Engr. Dr. Kamran Liaquat Bhatti Associate Professor, NFC-IET, Multan	Lead Sub-Group
2.	Engr. Dr. Zahir Javed Paracha Professor, PIET Multan	Member
3.	Engr. Prof. Dr. Muhammad Kamran Vice Chancellor, MNS-UET, Multan	Member
4.	Engr. Dr. Hafiz Ashiq Hussain Associate Professor, Air University, Islamabad	Member
5.	Engr. Mian Sultan Mehmood CEO, Creative Group of Companies	Member

Sub-Group Electrical Engineering (Electronics)

1.	Engr. Dr. Bhawani Shankar Chowdhry Professor Emeritus, Advisor MUET, Jamshoro	Lead Sub-Group
2.	Engr. Dr. Nasir Baig Director (Satellite), Axiohesheng Islamabad	Member
3.	Engr. Dr. Tariq ullah Jan Associate Professor, UET Peshawar	Member
4.	Engr. Muhammad Imran Khan Cheema Head Business Development IP, Descon	Member

Sub-Group Electrical Engineering (Telecom/ Communications)

1.	Engr. Dr. Syed Madad Ali Shah Pro-VC & Professor, IBA Sukkur	Lead Sub-Group
2.	Engr. Dr. Nasir Baig Director (Satellite), Axiohesheng Islamabad	Member

3. Engr. Dr. Faizullah Khan Kakar — Member
   Professor, BUITEMS Quetta
4. Engr. Dr. Noor Muhammad Khan — Member
   Professor, Capital University of Science & Technology Islamabad
5. Engr. Dr. Gulistan Raja — Member
   Professor, UET Taxila
6. Engr. Zafar Mahmood — Member
   CEO, Inter-SES Islamabad

Sub-Group Electrical Engineering (Control & Signal Processing)

1. Engr. Dr. Noor Muhammad Sheikh — Lead Sub-Group
   Professor, GCU, Lahore
2. Engr. Dr. Naeem Iqbal — Member
   Professor, PIEAS Islamabad
3. Engr. Dr. Tariq Ullah Jan — Member
   Associate Professor, UET Peshawar

Sub-Group Electrical Engineering (Computer, Computing & Information Security)

1. Engr. Dr. Zubair Ahmed Sheikh — Lead Sub-Group
   President, MAJU Karachi
2. Engr. Dr. Zahid Hussain Khand — Member
   Professor & Registrar, IBA Sukkur
3. Engr. Zafar Mahmood — Member
   CEO, Inter-SES Islamabad
4. Engr. Dr. Syed Madad Ali Shah — Member
   Pro-VC & Professor, IBA Sukkur
5. Engr. Prof. Dr. Muhammad Younus Javed — Member
   VC, Mirpur University of Science & Technology, Mirpur

Sub-Group Electrical Engineering (Emerging Fields)

1.	Engr. Dr. Hafiz Ashiq Hussain Associate Professor, Air University, Islamabad	Lead Sub-Group
2.	Engr. Dr. Naeem Iqbal Professor, PIEAS Islamabad	Member
3.	Engr. Dr. Tariq ullah Jan Associate Professor, UET Peshawar	Member

Sub-Group Electrical Engineering (Health Safety & Environment)

1.	Engr. Abdul Rehman Sheikh Senior Manager, PTCL Karachi	Lead Sub-Group
2.	Engr. Dr. Zubair Ahmed Sheikh President, MAJU Karachi	Member
3.	Engr. Zafar Mahmood CEO, Inter-SES Islamabad	Member

Sub-Group Electrical Engineering (Non Engineering)

1.	Engr. Dr. Faizullah Khan Kakar Professor, BUITEMS Quetta	Lead Sub-Group
2.	Engr. Dr. Nasir Baig Director (Satellite). Axiohesheng Islamabad	Member
3.	Engr. Dr. Muhammad Saeed FAST NUCES, Islamabad	Member

The ECRDC Electrical and Allied Engineering Disciplines appreciated the extra-ordinary efforts and contribution of Engr. Prof. Dr. Shahid Khattak (Convener), Engr. Prof. Dr. Noor Muhammad Khan (Co-opted Member) & Engr. Osaf Mahmood Malik (Section Head Curriculum & Development) for compilation of course contents and proofreading of this curriculum booklet.

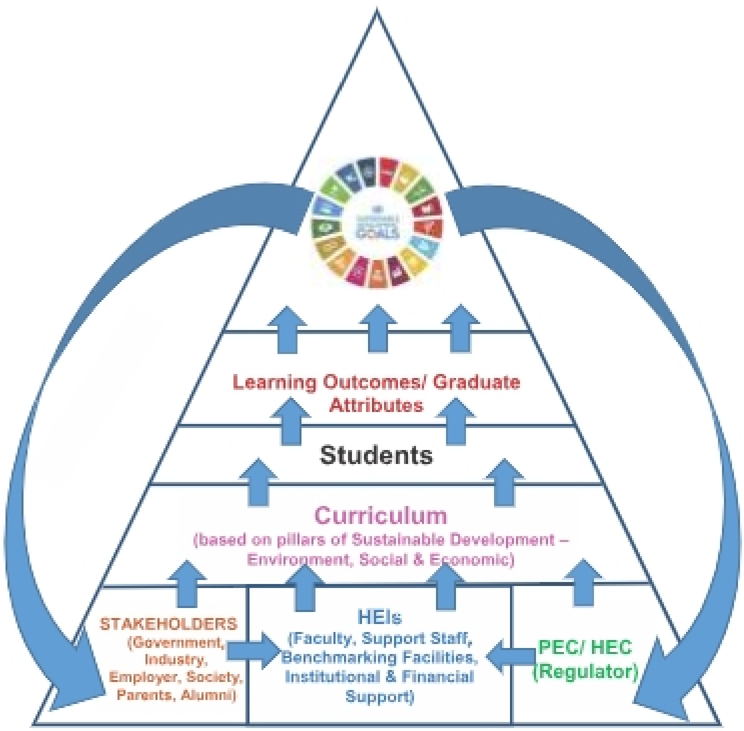
6. Agenda of ECRDC for Electrical and Allied Engineering Disciplines

- The Subject ECRDC will work under the overall directions and supervision of the main ECRDC comprising all Conveners.
- The key driving lines for the development of the engineering curriculum for each discipline will be the overall policy of Pakistan Engineering Council in conjunction with international commitments (Washington Accord, IPEA etc.) and Government policies/ HEC.
- Review of policies and stakeholders' feedback for the sector(s) relevant to the respective discipline.
- Comparative study of the curricula being offered at various engineering universities/institutions already following the OBE-based system.
- Development and finalization of complete scheme and curriculum for respective discipline including all aspects.

The Convener Engr. Prof. Dr. Shahid Khattak highlighted the important benchmarks and international best practices to be considered for the development/ revision of the curriculum while taking into account the Outcome Based Education (OBE) system. He also suggested that the Committee comprising professors and experts from academia, industry and R&D institutions have provided useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Electrical Engineering for achieving sustainable developments while addressing socio-economic issues and challenges envisaged in Goal-4 of the Sustainable Development Goals-2030.

- Goal-1: No Poverty
- Goal-2: Zero Hunger
- Goal-3: Good Health and Well-being
- Goal-4: Quality Education
- Goal-5: Gender Equality
- Goal-6: Clean Water and Sanitation
- Goal-7: Affordable and Clean Energy
- Goal-8: Decent Work and Economic Growth
- Goal-9: Industrial Innovation and Infrastructure

- Goal-10: Reduced Inequalities
- Goal-11: Sustainable Cities and Communities
- Goal-12: Responsible Consumption and Production
- Goal-13: Climate Action
- Goal-14: Life Below Water
- Goal-15: Life on Land
- Goal-16: Peace, Justice and Strong Institution
- Goal-17: Partnerships for the Goals



The curriculum therefore has been designed based on the above SDGs alongside their mapping strategy with the program mission, objectives, learning attributes and the scheme of study.

7. Attainment of Graduate Attributes and Professional Competencies

The development of an engineering professional is an ongoing process with important identified stages. The first stage is the attainment of an accredited educational qualification i.e., the graduate stage. The fundamental purpose of engineering education is to build a knowledge base and attributes to enable the graduate to continue learning and to proceed to formative development that will develop the competence required for independent practice. The second stage, following a period of formative development, is professional registration. The fundamental purpose of formative development is to build on the educational base to develop the competencies required for independent practice in which the graduate works with engineering practitioners and progresses from an assisting role to taking more responsibility as an individual and as a team member until competence can be demonstrated at this level required for registration. Once registered, the practitioner must maintain and expand competence.

The baseline for developing the curriculum of the engineering program and setting the graduate attributes are the defined set of Knowledge and Attitude Profiles approved by International Engineering Alliance (IEA) in version 4.0.

7.1 Knowledge and Attitude Profile

In order to inculcate different dimensions of thinking mathematical, computational, design and creativeness among students in Cognitive, Psychomotor and Affective domains, the curriculum is designed to cover the following 9x knowledge and attitude profiles. These profiles reflect an indicated volume of learning and the work attitude against which graduates must be able to perform.

- **WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

- **WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

- **WK3:** A systematic, theory-based formulation of engineering fundamentals required in the relevant engineering discipline.

- **WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

- **WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

- **WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

- **WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development (Represented by the 17 UN Sustainable Development Goals (UN-SDG).

- **WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

- **WK9:** Ethics, inclusive behavior and conduct; Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability, etc. with mutual understanding and respect, and of inclusive attitudes.

7.2 Graduate Attribute Profiles (GAs)/ Program Learning Outcomes (PLOs)

Graduate attributes (GAs) form a set of individually assessable outcomes that are the components indicative of the graduate's potential to acquire competence to practice at the appropriate level. The graduate attributes are exemplars of the attributes expected from a graduate of an accredited program. Graduate attributes are clear, succinct statements of the expected capability, qualified if necessary, by a range indication appropriate to the type of program. The GAs have been revised in version 4.0 of IEA with distinctive change being the merger of GA-6 Engineer and Society; and GA-7 Environment and Sustainability as the single GA of 'The Engineer and the World'. There are also minor changes in the statements of revised GAs approved as version 4.0 of IEA.

The engineering curriculum is the most important instrument for grooming the students based on 11x Graduate Attributes (GAs) encompassed under the Program Learning Outcomes (PLOs). Program outcomes are the narrower statements that describe what students are expected to know and be able to do at the time of graduation. These PLOs mainly relate to the knowledge, skills and attitudes that students acquire while progressing through the program. Specifically, it is to be demonstrated that the students have acquired the defined GAs. The program must demonstrate that by the time of graduation, the students have attained a certain set of knowledge, skills and behavioral traits, at-least to some acceptable minimum level. This minimum threshold value (i.e., KPI for PLO attainment) should not be less than 50% even to begin with; however, as the program progresses through its evolution, it is expected that this minimum threshold value would subsequently be raised to higher values through program's CQI. Specifically, it is to be demonstrated that all students of a batch to be accredited have acquired the following graduate attributes (GAs) set according to the revised framework of International Engineering Alliance (IEA) version-4.0:

- **PLO-1 Engineering Knowledge:** Apply knowledge of mathematics, natural science, engineering fundamentals and Engineering specialization to the solution of complex engineering problems (WK-1-WK-4).

- **PLO-2 Problem Analysis:** Identify, formulate, conduct research literature, and analyse complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences (WK-1-WK-4).

- **PLO-3 Design/Development of Solutions:** An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations (WK-5).

- **PLO-4 Investigation:** Conduct investigation of complex Engineering problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions (WK-8).

- **PLO-5 Tool Usage**: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex Engineering problems, with an understanding of the limitations (WK-2 and WK-6).

- **PLO-6 The Engineer and the World:** Analyze and evaluate sustainable development impacts to society, the economy, sustainability, health and safety, legal frameworks, and the environment while solving complex engineering problems (WK-1, WK-5, and WK-7).

- **PLO-7 Ethics:** Apply ethical principles and commit to professional ethics and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK-9).

- **PLO-8 Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multi-disciplinary, face-to-face, remote and distributed settings (WK-9).

- **PLO-9 Communication:** Communicate effectively and inclusively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, and make effective presentations, taking into account cultural, language, and learning differences (WK-1 and WK-9).

- **PLO-10 Project Management and Finance:** Demonstrate knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, to manage projects in multidisciplinary environments (WK-2 and WK-5).

- **PLO-11 Lifelong Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change (WK-8 and WK-9).

The graduate attributes are stated generically and are applicable to all engineering disciplines. In interpreting the statements within a disciplinary context, individual statements may be amplified and given particular emphasis but they must neither be altered in substance nor individual elements ignored. HEI is expected to prepare the PLO mapping with the whole curriculum as per their OBE design.

7.3 Professional Competence Profiles

A professionally or occupationally competent person has the attributes necessary to perform the activities within the profession or occupation to the standards expected in independent employment or practice. The professional competence profiles for each professional category record the elements of competence necessary for performance that the professional is expected to be able to demonstrate in a holistic way at the stage of attaining registration.

Professional competence can be described using a set of attributes corresponding largely to the graduate attributes, but with different emphases. For example, at the professional level, the ability to take responsibility in a real-life situation is essential. Unlike the graduate attributes, professional competence is more than a set of attributes that can be demonstrated individually. Rather, competence must be assessed holistically. Thirteen elements of professional competence as approved by the IEA for global benchmarking are mentioned as follows:

- **EC1 Comprehend and apply universal knowledge:** Comprehend and apply advanced Engineering knowledge of the widely-applied principles underpinning good practices.

- **EC2 Comprehend and apply local knowledge:** Comprehend and apply advanced Engineering knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction of practices.

- **EC3 Problem analysis:** Define, investigate and analyze complex Engineering problems using data and information technologies where applicable.

- **EC4 Design and development of solutions:** Design or develop solutions to complex Engineering problems considering a variety of perspectives and taking account of stakeholder views.

- **EC5 Evaluation:** Evaluate the outcomes and impacts of complex Engineering activities.

- **EC6 Protection of society:** Recognize the foreseeable economic, social, and environmental effects of complex Engineering activities and seek to achieve sustainable outcomes.

- **EC7 Legal, regulatory, and cultural:** Meet all legal, regulatory, and cultural requirements and protect public health and safety in the course of all Engineering activities.

- **EC8 Ethics:** Conduct Engineering activities ethically.

- **EC9 Manage engineering activities:** Manage part or all of one or more complex Engineering activities.

- **EC10 Communication and Collaboration:** Communicate and collaborate using multiple media clearly and inclusively with a broad range of stakeholders in the course of all Engineering activities.

- **EC11 Continuing Professional Development (CPD) and Lifelong learning:** Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.

- **EC12 Judgement:** Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of all complex Engineering activities.

- **EC13 Responsibility for decisions:** Be responsible for making decisions on part or all of the complex Engineering activities.

The professional competence profiles are stated generically and are applicable to all engineering disciplines. The application of a competence profile may require amplification in different regulatory, disciplinary, occupational or environmental contexts. In interpreting the statements within a particular context, individual statements may be amplified and given particular emphasis but must not be altered in substance or ignored.

8. Mapping of Bachelors of Engineering Program with UN SDGs

The Engineering Programs are vital for achieving sustainable development while addressing socio-economic issues and challenges envisaged in United Nation's Sustainable Development Goals i.e. UN SDGs (Figure 1) as under;

Figure 1: United Nation's Sustainable Development Goals (UN SDGs)

9. Concept Note on the Incorporation of UN SDGs in Curriculum

The United Nations' Sustainable Development Goals (SDGs) provide a global framework for addressing pressing societal and environmental challenges. In the context of engineering education and curriculum, integrating sustainable solutions is essential to contribute towards achieving these SDGs. This note explores how complex engineering problem (CEP) solving and complex engineering activities (CEAs) can align with specific SDGs and emphasizes the role of engineering in promoting sustainable development.

The CEP solving and CEAs play a pivotal role in developing innovative solutions that address societal challenges, fostering sustainable development. Thus, the analysis of a complex engineering problem needs to include consideration for sustainable development in the light of UN SDGs. Prospective sustainable solution resulting from a CEP-solving activity or CEA can be related to specific SDG(s).

It is pertinent to mention that it is not mandatory for an HEI to map all 17 SDGs with its engineering program. Only those SDGs may be mapped which are covered in CEP-solving activities, CEAs, semester projects, open-ended labs, capstone projects or co- and extra-curricular activities with holistic consideration for sustainable development.

The documentation or any deliverable of the activity will stand as evidence of the addressal of the respective SDG. For example, embedding renewable energy concepts, such as solar and wind power, into class/ lab CEPs/ CEAs and final-year/ capstone projects can align them with the targets set for SDG-7. Similarly, focusing on cutting-edge technologies like the Internet of Things (IoT) and smart grids in class/ lab projects and final-year projects can work for SDG-9. By addressing CEPs/ CEAs aligned with specific SDGs, engineers can contribute significantly to global efforts to build a more sustainable and equitable world.

The effectiveness of the incorporation of SDG targets in class/ lab projects or CEPs/ CEAs can be further enhanced by encouraging the students to:

- Include Life Cycle Assessment (LCA) methodologies in class/ lab projects or CEPs/ CEAs to evaluate the environmental impact of products and systems.
- Collaborate with the students of other disciplines to address interconnected challenges.
- Emphasize the use of sustainable materials and manufacturing processes in the design and production of components.
- Assess the social implications of their projects, considering factors like community well-being, accessibility, and inclusivity.

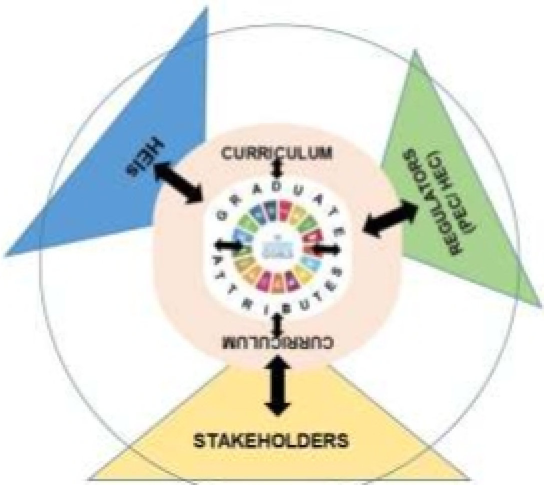


Figure : Consideration of UN SDGs in curriculum design

10. Correlation Matrix PLOs-ECs-WKs-SDGs

A correlation matrix has been established to link Program Learning Outcomes (PLOs) with the corresponding engineering competencies, knowledge and attitude profiles, as well as the targeted UN Sustainable Development Goals (SDGs) by 2030. This mapping has been developed in accordance with the revised definitions of Graduate Attributes and Professional Competences (GAPCs) approved in version 4.0 of the International Engineering Alliance (IEA).

PLOs	ECs **	WKs	SDGs (Proposed)
PLO-1 **Engineering Knowledge:** Breadth, depth and type of knowledge, both theoretical and practical	**EC-1** **Comprehend and apply universal knowledge** **& EC-2** **Comprehend and apply local knowledge**	(WK-1, WK-2, WK-3 & WK-4) **WK-1** **Natural sciences** and awareness of relevant **social sciences** **WK-2** **Mathematics & computing** **WK-3** **Engineering fundamentals** **WK-4** **Engineering specialist knowledge**	SDG-9
PLO-2 **Problem Analysis**: Complexity of analysis	**EC-3** **Problem analysis**	(WK-1, WK-2, WK-3 &WK-4) **WK-1** **Natural sciences** and awareness of relevant **social sciences** **WK-2** **Mathematics & computing** **WK-3** **Engineering fundamentals** **WK-4** **Engineering specialist knowledge**	Selected SDGs from SDG - 1 to 17 (relevance as per curriculum)
PLO-3 **Design/Development of Solutions:** Breadth and uniqueness of engineering problems i.e., the extent to which problems are original and to which solutions have not previously been identified or codified	**EC-4** **Design and development of solutions**	**WK-5** **Engineeringdesign and operations**	SDG-1, 2, 3, 6, 10, 11, 12, 13, 14 (relevance as per curriculum)

PLO-4 **Investigation:** Breadth and depth of investigation and experimentation	**EC-5** **Evaluation**	**WK-8** **Research literature**	SDG-9
PLO-5 **Tool Usage:** Level of understanding of the appropriatenessof technologies andtools	**EC-3** **Problem analysis** **& EC-5** **Evaluation**	(WK-2 & WK-6) **WK-2** **Mathematics & computing** **& WK-6** **Engineering practice**	SDG-9
PLO-6 **The Engineer and the World:** Level ofknowledge and responsibility for sustainable development	**EC-6** **Protection of society** **& EC-7** **Legal, regulatory, and cultural**	(WK-1, WK-5 & WK-7) **WK1** **Natural sciences** and awareness of relevant **social sciences** **WK-5** **Engineeringdesign and operations** **& WK7** **Engineering in Society**	Selected SDGs from SDG - 1 to 17 (relevance as per curriculum)
PLO-7 **Ethics:** Understanding andlevel of practice	**EC-8** **Ethics:** No differentiation in this characteristic	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-8 **Individual and Collaborative Team work:** Role inand diversity of team	**EC-10** **Communication and Collaboration**	**WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16
PLO-9 **Communication:** Level of communication according to type of activities performed	**EC-10** **Communication and Collaboration**	(WK-1 & WK-9) **WK-1** **Natural sciences and awareness of relevant social sciences** **& WK-9** **Ethics, inclusive behavior and conduct**	SDG- 5, 10, 16

PLO-10 **Project Management and Finance:** Level of management required for differing types of activity	**EC-9** **Manage engineering activities**	(WK-2 & WK-5) **WK-2** **Mathematics & computing** **& WK-5** **Engineering** **design and operations**	SDG-9
PLO-11 **Lifelong Learning:** Duration and manner	**EC-11** **Continuing Professional Development (CPD) and lifelong learning** **EC-12** **Judgement** **EC-13** **Responsibility for decisions**	**WK-8** **Research literature**	SDG-9, 13

** ECs are expected to be demonstrated by graduates during their practical experiences, which have been mapped with PLOs to reflect integration in the designed curriculum.

The relationship matrix has been generically designed as a guiding framework for HEIs and is applicable to all engineering disciplines. When interpreting the matrix within a specific context, revisions or amplifications may be incorporated to highlight particular emphasis or compliance with rationalized program requirements.

11. Program Salient Features

The undergraduate engineering program has been based on the following salient features:

- **Duration:** 4 years
- **Number of Semesters:** 8
- **Total Number of Credit Hours:** 130 - 136
  - General Education for Engineering Discipline: Minimum 38 Credit Hours
  - Engineering Domain (including computer courses, foundation, breadth, depth/major courses): Minimum 72 Credit Hours
  - FYDP/ Capstone Project: 06 Credit Hours
  - Multidisciplinary Engineering/Specialty Courses: Minimum 06 Credit Hours
  - HEIs have the flexibility of 8-14 Credit Hours to add courses either in Engineering, Non-Engineering or both Domains to fulfill the program objectives in line with the overall Vision/ Mission of the Institute concerned.
- **Number of Weeks per Semester:** 15 - 18
- **Number of Credit Hours per Semester:** 15 - 18

The proposed framework presented here and the consequent Electrical Engineering curriculum in the subsequent sections may be regarded as a guiding principles. Higher Education Institutes (HEIs) possess the flexibility to modify courses within Engineering, Non-Engineering, or both domains. This adaptability is intended to meet the program objectives while staying consistent with the overall Vision/ Mission of the respective Institute. However, it is crucial to note that certain general education courses, including their titles and credit hours, are mandated by the HEC and must not be altered.

The curriculum matrix covering the defined knowledge and attitude profiles should therefore be composed of general education/ non-engineering domain (humanities, math, management and natural sciences), and engineering domain with Electrical Engineering, foundation, breadth, depth and multidisciplinary courses (including safety) so that different streams could be encouraged within each discipline, enabling students to undertake a range of Complex Problem Solving and Complex Engineering Activities. The students may select electives from any of the streams with guidelines from their respective advisors. The knowledge areas of Non-Engineering and Engineering domains have been broadly mapped with 11x PLOs and 9x WKs using the guiding framework of IEA version 4.0 in the following table:

Knowledge Profile (WK-1 to WK-9)	**Knowledge Area**	**Sub-Area**	**Courses**	**Credit Hours**
General Education/ Non-Engineering Domain				
WK-1/ WK-2	**Natural Sciences**	Math	As per program requirements	12-15
		Physics	***Applied Physics	3-9
		Chemistry	***Applied Chemistry	
		Natural Science/ Math Elective	*** Math Elective	
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	**Functional English	3
			** Expository Writing	3
		Culture	** Islamic Studies or Ethics	2
			**Ideology & constitution of Pakistan	2
			*Arts & Humanities Elective (Languages or study of religion)	2
		Social Science	***Social Science Elective	2
			** Civics and Community Engagement	2
	Management Sciences	Professional Practice	***Project Management	2
			**Entrepreneurship	2
	Computer Sciences	Basic Computing	**Applications of ICT	3

Engineering Domain				
Knowledge Profile (WK-1 to WK-9)	**Knowledge Area**	**Sub-Area**	**Courses**	**Credit Hours**
WK-2/ WK-4/ WK-5/	Advanced Computer and Information Sciences	ICT/AI/ Data Science/ Cyber Security		6-9
WK-2/ WK-3	Foundation Engg Courses		Specific to Program Objectives and outcome	22-24
WK-1/ WK-2/ WK-4	Core Breadth of Engg Disciplines		Specific to Program Objectives and outcome	22-24
WK-5/ WK-6	Core Depth of Engg Disciplines		Specific to Program Objectives and outcome	22-24
				Min 72
WK-1/ WK-2/ WK-3/ WK-4/ WK-7/ WK-9	Multi disciplinary Engg Courses		Specific to Program Objectives and outcome	6
			Occupational Health and Safety (Mandatory 01 credit hours)	
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-9	Final Year Design Project (FYDP)/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6
WK-6/ WK-7/ WK-9	Industrial Training	Internship (06-08 Weeks)		Mandatory & Qualifying

WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem-Based Learning (PBL)	
	(Flexible Engineering/ Non-Engineering) Courses may be adjusted as per the requirements	8-14
	Total (Credit Hours)	**130-136**

Note: * University may offer any course within the specific broader subject domain/ cluster to meet the given credits.

** HEC designed model courses may be used by the university.

*** PEC ECRDC designed courses.

- **Industrial Training:** Internship of at least 6 - 8 weeks is a mandatory part of degree requirements to be carried out during 3rd to 4th year of program; must be supervised, monitored, evaluated, and reflected in the transcripts under a prescribed mechanism and with defined and mapped rubrics with program outcomes. The assessment phase should focus about;

  - Selection of internship in line with elective subjects/ specific streams
  - Qualifying weightage: 70%
    - At least 75% attendance is mandatory 10%
    - Assessment report from the employer 50%
    - Evaluation at relevant HEIs/ Deptt – presentation 40%

- **Final Year Design Project (FYDP)/ Capstone**: FYDP aims to challenge innovative, creative, technical, management and presentation skills of a graduate to bring together the learning over the degree program.
- A final year design project (FYDP) is the confluence of an engineering program. Undertaking a final year design project is a compulsory requirement. It should mainly comprise literature search, individual analysis, modeling and simulation, AI (Artificial Intelligence) and computational data analytics, design of infrastructure, software, firmware and Algorithm Engineering / Informatics related to the program to demonstrate a functional concept including rapid prototyping, where applicable.
- The FYDP shall include complex engineering problems and design systems, components or processes integrating core areas and meeting specific needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- A project of this nature should invariably lead to an integration of the knowledge and practical skills as mandated in the program outcomes. In this context, projects of multidisciplinary nature should be encouraged.
- The FYDP should span over two consecutive semesters, i.e. semester 7 & 8, totaling 6-credit hours and should be fully supervised, assessed and reflected in the transcripts under a prescribed mechanism to prepare for joining the industry after graduation.
- **Faculty:** The faculty must be trained for the Outcome-Based Education (OBE) system. Their familiarity with the program objectives and outcomes, understanding of the Outcome-Based Assessment (OBA) cycle, enthusiasm for developing an effective program, and the ability to become an active player towards its overall implementation are the key factors for ensuring

the attainment of program objectives. The faculty is expected to have the ability to ensure proper implementation of the program, and develop processes for evaluation, assessment and CQI. A formal training program to groom the faculty should be instituted so that they become effective instructors in applying pedagogical skills in all aspects of Teaching, Learning and Assessment covering all domains of Knowledge, Skills and Attitude.

- **Personal Grooming:** Personal Grooming of young faculty members and students is very important in order to develop and support their professional skills. Therefore, it is required that HEIs should conduct/arrange sessions or counseling hours on a regular basis to provide guidance for personal grooming as it is important for positive self-image and increasing the confidence level of the individuals. It would help in enhancing students' self- esteem and would go a long way in developing an attractive personality by adopting habits like personal hygiene, clothing, appearance, interaction and expressive skills, etc. The students should be motivated and equipped to be entrepreneurs in their relevant field.

- **Presentation and Communication Skills:** Special focus should be given to inculcate communication and presentation skills amongst the graduates through individual and group presentations, technical writing and discussions, throughout the program as a regular feature.

This Curriculum has been designed to guide and facilitate the universities and departments to formulate their own programs according to the industrial needs, emerging trends and recent developments in the field of Electrical Engineering. The HEIs have the flexibility to incorporate changes in the proposed curriculum within given range of credit hours for engineering and non-engineering domain.

12. Framework for Bachelor of Electrical Engineering (General) Curriculum

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Subject Area	Name of Course	Th	Lab	Cr Hrs	Total Courses	Total Credits
General Education Domain/ Non-Engineering Domain								
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	Functional English**	3	0	3	2	6
			Expository Writing**	3	0	3		
		Culture	Ideology and Constitution of Pakistan**	2	0	2	3	6
			Islamic Studies/ Ethics**	2	0	2		
			Arts & Humanities Elective*	2	0	2		
		Social Sciences	Civics & Community Engagements**	2	0	2	2	4
			Social Science Elective***	2	0	2		
	Management Sciences	Professional Practice	Project	2	0	2	2	4
			Entrepreneurship**	2	0	2		
	Computer Sciences	Basic Computing	Applications of ICT**	2	1	3	1	3
WK-2/ WK-1	**Natural Sciences**	Mathematics	Calculus & Analytical Geometry	3	0	3	4	12
			Complex Variables & Transforms	3	0	3		
			Linear Algebra	3	0	3		
			Differential Equations	3	0	3		
		Natural Sciences	Applied Physics**	2	1	3	2	6
			Maths / Natural Science Elective	3	0	3		
General Education Domain/ Non-Engineering Domain							**16**	**41**

Note: * University may offer any course within the specific broader subject domain/ cluster to meet the given credits.

** HEC designed model courses may be used by the university.

*** PEC ECRDC designed courses.

Engineering Domain								
Knowledge Profile (WK-1 to WK-9)	**Knowledge Area**	**Subject Area**	**Name of Course**	**Th**	**Lab**	**Cr. Hrs**	**Total Course**	**Total Credits**
WK-2 WK-4 WK-5	**Advanced Computer and Information Sciences**	ICT/AI/ Data Science/Cyber Security	Computer Programming	3	1	4	2	8
			Data Structures and Algorithms	3	1	4		
WK-2 WK-3	**Engineering Foundation**		Electrical Workshop Practice	0	1	1	9	28
			Linear Circuit Analysis	3	1	4		
			Electrical Network Analysis	3	1	4		
			Digital Logic Design	3	1	4		
			Electromagnetic Field Theory	3	0	3		
			Electronic Devices and Circuits	3	1	4		
			Engineering Drawing	0	1	1		
			Signals and Systems	3	1	4		
			Probability Methods in Engineering	3	0	3		
WK-1 WK-2 WK-4	**Major Based Core Courses (Breadth and Depth)**		Communication Systems	3	1	4	10	38
			Electrical Machines	3	1	4		
			Linear Control Systems	3	1	4		
			Electronic Circuit Design	3	1	4		
			Power Electronics	3	1	4		
			Microprocessors and Interfacing	3	1	4		
			Digital Signal Processing	3	1	4		
			Computer Communication Networks	3	0	3		
			Power Distribution and Utilization	3	1	4		
			Power System Analysis	3	0	3		
WK-1/ WK-2/ WK-3/ WK-4	**Multi-Disciplinary Engineering Courses**		MDEE	3	0	3	2	4
			Occupational Health and Safety	1	0	1		
WK-6 WK-8 WK-7	**Final Year Design Project (FYDP)**		FYDP (Part – I)	0	2	2		6
			FYDP (Part – II)	0	4	4		

WK-6/ WK-7	**Industrial Training**	6-8 weeks industrial training mandatory (Non-Credit)					**Mandatory & Qualifying**	
WK-6/ WK-7	**Community Service**	30 hours Community service (Non-Credit)						
Total (Engineering Domain)							**84**	
WK-1 To WK-9	**Flexible Engg/ Non-Engg Courses*** **		Flexible Elective-I****	3	0/1	3/4	3	9/11
			Flexible Elective-II****	3	0/1	3/4		
			Flexible Elective-III****	3	0	3		
Total (Credit Hours)							**134-136**	

Note: Quran Translation (QT) Credits will be allowed as over and above 136 Cr. Hrs.

* Depth Elective Course I and II.

** Elective subjects may be offered from the pool of subjects given below.

*** Multi-Disciplinary Engineering Electives may be offered from the pool of subjects given below.

**** Flexible Engg/ Non-Engg elective is any subject of interest from the Engg/ Non-Engg domain for which the pre-requisite requirements are satisfied.

13. Scheme of Studies for Bachelor of Electrical Engineering (General) Curriculum

1st Year				
First Semester				
S. No.	Course Title	(Credit Hours) Theory	Lab	Total Cr. Hrs.
1	Functional English	3	0	3
2	Calculus and Analytical Geometry	3	0	3
3	Linear Circuit Analysis	3	1	4
4	Applications of ICT	2	1	3
5	Engineering drawing	0	1	1
6	Applied Physics	2	1	3
	Total	**13**	**4**	**17**
Second Semester				
S. No.	Course Title	(Credit Hours) Theory	Lab	Total Cr. Hrs.
1	Differential Equations	3	0	3
2	Maths/Natural Science Elective	3	0	3
3	Electrical Workshop Practice	0	1	1
4	Ideology and Constitution of Pakistan	2	0	2
5	Computer Programming	3	1	4
6	Electronic Devices and Circuits	3	1	4
	Total	**14**	**3**	**17**

2nd Year				
Third Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Complex Variables and Transforms	3	0	3
2	Arts and Humanities Elective	2	0	2
3	Digital Logic Design	3	1	4
4	Data Structures and Algorithms	3	1	4
5	Electrical Network Analysis	3	1	4
6	Occupational Health and Safety	1	0	1
	Total	**15**	**3**	**18**

Fourth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Social Sciences Elective	2	0	2
2	Linear Algebra	3	0	3
3	Islamic Studies/Ethics	2	0	2
4	Probability methods in Engineering	3	0	3
5	Signals and Systems	3	1	4
6	Electromagnetic Field Theory	3	0	3
	Total	**16**	**1**	**17**

3rd Year				
Fifth Semester				
S. No.	Course Title	(Credit Hours)		Total Cr. Hrs.
		Theory	Lab	
1	Electrical Machines	3	1	4
2	Microprocessors and Interfacing	3	1	4
3	Communications Systems	3	1	4
5	Civic and Community Engagement	2	0	2
5	MDEE ******	3	0	3
	Total	**14**	**3**	**17**

Sixth Semester				
S. No.	Course Title	(Credit Hours)		Total Cr. Hrs.
		Theory	Lab	
1	Expository Writing	3	0	3
2	Linear Control Systems	3	1	4
3	Power Distribution & Utilization	3	1	4
4	Electronic Circuit Design	3	1	4
5	Project Management	2	0	2
	Total	**14**	**3**	**17**

Final Year				
Seventh Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Digital Signal Processing	3	1	4
2	Power Electronics	3	1	4
3	Flexible Engg/Non Engg-I	3	0/1	3/4
4	Power System Analysis	3	0	3
5	Final Year Project-I	0	2	2
	Total	**14**	**4/5**	**16/17**

Eighth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Entrepreneurship	2	0	2
2	Flexible Engg/ Non Engg-II	3	0/1	3/4
3	Flexible Engg/ Non Engg-III	3	0	3
4	Computer Communication Networks	3	0	3
5	Final Year Project-II	0	4	4
	Total	**11**	**4/5**	**15/16**

Note: The outlined scheme of studies is provided solely for guidance, and its application in Higher Education Institutions (HEIs) may vary, as long as the underlying framework is adhered to.

14. Framework for Bachelor of Electrical Engineering (Specialization) Curriculum

Knowledge Profile (WK-1 to WK-9)	Knowledge Area	Subject Area	Name of Course	Th	Lab	Cr Hrs	Total Courses	Total Credits
General Education Domain/ Non-Engineering Domain								
WK-1/ WK-5/ WK-7/ WK-9	**Humanities**	English	Functional English**	3	0	3	2	6
			Expository Writing**	3	0	3		
		Culture	Ideology and Constitution of Pakistan**	2	0	2	3	6
			Islamic Studies/ Ethics**	2	0	2		
			Arts & Humanities Elective*	2	0	2		
		Social Sciences	Civics & Community Engagements**	2	0	2	2	4
			Social Science Elective***	2	0	2		
	Management Sciences	Professional Practice	Project	2	0	2	2	4
			Entrepreneurship**	2	0	2		
	Computer Sciences	Basic Computing	Applications of ICT**	2	1	3	1	3
WK-2/ WK-1	**Natural Sciences**	Mathematics	Calculus & Analytical Geometry	3	0	3	4	12
			Complex Variables & Transforms	3	0	3		
			Linear Algebra	3	0	3		
			Differential Equations	3	0	3		
		Natural Sciences	Applied Physics**	2	1	3	2	6
			Maths / Natural Science Elective	3	0	3		
General Education Domain/ Non-Engineering Domain							**16**	**41**

Note: * University may offer any course within the specific broader subject domain/ cluster to meet the given credits.

** HEC designed model courses may be used by the university.

*** PEC ECRDC designed courses.

Engineering Domain								
Knowledge Profile (WK-1 to WK-9)	**Knowledge Area**	**Subject Area**	**Name of Course**	**Th**	**Lab**	**Cr. Hrs**	**Total Course**	**Total Credits**
WK-2/ WK-4/ WK-5/ WK-6	**Advanced Computer and Information Sciences**	ICT/AI/ Data Science/ Cyber Security	Computer Programming	3	1	4	2	8
			Data Structures and Algorithms	3	1	4		
WK-2/ WK-3	**Engineering Foundation**		Electrical Workshop Practice	0	1	1	9	28
			Linear Circuit Analysis	3	1	4		
			Electrical Network Analysis	3	1	4		
			Digital Logic Design	3	1	4		
			Electromagnetic Field Theory	3	0	3		
			Electronic Devices and Circuits	3	1	4		
			Engineering Drawing	0	1	1		
			Signals and Systems	3	1	4		
			Probability Methods in Engineering	3	0	3		
WK-2/ WK-4/	**Major Based Core (Breadth)**		Communication Systems	3	1	4	5	20
			Microprocessors and Interfacing	3	1	4		
			Electrical Machines	3	1	4		
			Linear Control Systems	3	1	4		
			Power Distribution and Utilization	3	1	4		
WK-5/ WK-6	**Major Based Core (Depth)***		Depth Elective (Core)-I*	3	0/1	3/4	5	15/18
			Depth Elective (Core)II*	3	0/1	3/4		
			Depth Elective-III**	3	0/1	3/4		
			Depth Elective-IV**	3	0	3		
			Depth Elective-V**	3	0	3		

WK-3/ WK-4/ WK-2/ WK-1	**Multi-Disciplinary Engineering Electives****		MDEE***	3	0	3	2	4
			Occupational Health and Safety	1	0	1		
WK-6/ WK-8/ WK-7	**Final Year Design Project (FYDP)**		FYDP (Part-I)	0	2	2	2	6
			FYDP (Part-II)	0	4	4		
WK-6/ WK-7/ WK-9	**Industrial Training**	6-8 weeks industrial training mandatory (Non-Credit)					**Mandatory & Qualifying**	
	Community Service	Community service (Non-Credit)						
Total (Engineering Domain)							**25**	**81-84**
WK-1 To WK-9	**Flexible Engg/ Non-Engg Courses*****	Flexible Elective-I****		3	0/1	3/4	3	9 11
		Flexible Elective-II****		3	0/1	3/4		
		Flexible Elective-III****		3	0	3		
							3	9 11
Total (Credit Hours)							**131-136**	

Note: Quran Translation (QT) Credits will be allowed as over and above 136 Cr. Hrs.

* Depth Elective Course I and II.

** Elective subjects may be offered from the pool of subjects given below.

*** Multi-Disciplinary Engineering Electives may be offered from the pool of subjects given below.

**** Flexible Engg/ Non-Engg elective is any subject of interest from the Engg/ Non-Engg domain for which the pre-requisite requirements are satisfied.

15. Scheme of Studies for Bachelor of Electrical Engineering (Specialization) Curriculum

1st Year				
First Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Functional English	3	0	3
2	Calculus and Analytical Geometry	3	0	3
3	Linear Circuit Analysis	3	1	4
4	Applications of ICT	2	1	3
5	Engineering drawing	0	1	1
6	Applied Physics	2	1	3
	Total	13	4	17
Second Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Differential Equations	3	0	3
2	Natural Science Elective ***	3	0	3
3	Electrical Workshop Practice	0	1	1
4	Ideology and Constitution of Pakistan	2	0	2
5	Computer Programming	3	1	4
6	Electronic Devices and Circuits	3	1	4
	Total	14	3	17

2nd Year				
Third Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Complex Variables and Transforms	3	0	3
2	Arts and Humanities Elective *	2	0	2
3	Digital Logic Design	3	1	4
4	Data Structures and Algorithm	3	1	4
5	Electrical Network Analysis	3	1	4
6	Occupational Health and Safety	1	0	1
	Total	**15**	**3**	**18**
Fourth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Social Sciences Elective **	2	0	2
2	Linear Algebra	3	0	3
3	Islamic Studies/Ethics	2	0	2
4	Probability and Statistics for Engineers	3	0	3
5	Signals and Systems	3	1	4
6	Electromagnetic Field Theory	3	0	3
	Total	**16**	**1**	**17**

3rd Year				
Fifth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Electrical Machines	3	1	4
2	Microprocessors and Interfacing	3	1	4
3	Communications Systems	3	1	4
4	Civics and Community Engagement	2	0	2
5	MDEE ******	3	0	3
	Total	**14**	**3**	**17**
Sixth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Expository Writing	3	0	3
2	Linear Control Systems	3	1	4
3	Power Distribution & Utilization	3	1	4
4	Depth Elective (Core) - I ****	3	0 1	3/4
5	Project Management	2	0	2
	Total	**14**	**2/3**	**16/17**

Final Year				
Seventh Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Depth Elective (Core) -II ****	3	0/1	3 4
2	Depth Elective - III *****	3	0/1	3/ 4
3	Flexible Engg/ Non-Engg Elective - I	3	0/1	3/ 4
4	Depth Elective - IV *****	3	0	3
5	Final Year Project-I	0	2	2
	Total	**12**	**2/5**	**14/17**

Eighth Semester				
S. No.	**Course Title**	**(Credit Hours)**		**Total Cr. Hrs.**
		Theory	**Lab**	
1	Entrepreneurship	2	0	2
2	Depth Elective-V *****	3	0	3
3	Flexible Engg/ Non-Engg Elective -II	3	0/1	3
4	Flexible Engg/ Non-Engg Elective -III	3	0	3
5	Final Year Project-II	0	4	4
	Total	**11**	**4/5**	**15/16**

Note: The outlined scheme of studies is provided solely for guidance, and its application in Higher Education Institutions (HEIs) may vary, as long as the underlying framework is adhered to.

*** List of Arts and Humanities Electives (2+0)**
• Communication and Presentation Skills • Beginners Spanish • Elementary Arabic • Elementary French • Elementary Chinese • History • Philosophy • Professional Ethics • Any other Relevant Course / Language decided by the HEI as per requirement.
****List of Social Science Electives (2+0)**
• Sociology for Engineers • Sociology • Social phycology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming • Any other relevant course decided by the HEI as per requirement.
*****Proposed Electives for Natural Science (3+0)**
• Multivariable Calculus • Discrete Mathematics • Numerical Analysis • Applied Chemistry • Biology or any related course appropriate for the program. • Any other relevant course decided by the HEI as per requirement.

Major Based Core (MBC) Depth Electives (Proposed)

****Power Stream Depth Core I & II	****Telecom/ Communications Stream Depth Core I & II
• Power Generation (Depth Core-I) • Power System Analysis (Depth Core-II)	• Electronic Circuit Design (Depth Core-I) • Computer Communication Networks (Depth Core-II)
*****Proposed Electives for Power Stream	*****Proposed Electives for Telecom/ Communications Stream
• Electrical Power Transmission • Power System Protection • Power System Operation & Control • Electrical Machine Design & Maintenance • High Voltage Engineering • Renewable Energy Systems • FACTS and HVDC Transmission • Smart Grid • Power Electronics • Artificial Intelligence • Instrumentation and Measurement • Any other relevant course decided by the HEI as per requirement.	• Digital Communications • Wireless and Mobile Communications • Satellite Communications • Navigation Systems • Next Generation Networks • Internet of Things (IoT) • Wireless Network System • Telecommunications Standards & Regulations • Network Management • Telecommunications Traffic Engineering • Optical Communications • Microwave & Radar systems • Transmission & Switching System • Antenna & Wave Propagation • Any other relevant course decided by the HEI as per requirement.

****Electronics Stream Depth Core I & II	****Computer Systems Stream Depth Core I & II
• Electronic Circuit Design (Depth Core-I) • Power Electronics (Depth Core-II)	• Computer Communication Networks (Depth Core-I) • Operating Systems (Depth Core-II)
*****Proposed Electives for Electronics Stream	*****Proposed Electives for Computer Systems Stream
• Analogue Integrated Electronics • FPGA Based Digital Design • VLSI Design • Optoelectronic • Digital Control • Biomedical Instrumentation • Digital Signal Processing • RF and Microwave Engineering • Nanotechnology • Micro Electromechanical Systems (MEMS) • Industrial Electronics • Application Specific Integrated circuits (ASIC) Design • Embedded Systems • Internet of Things (IoT) • Artificial Intelligence • Any other relevant course decided by the HEI as per requirement.	• Data Base Systems • Digital Image Processing • Data Communication • Computer Graphics • Computer Vision • Image and Video Coding • Network Protocols and Standards • Network Security • Network and System Programming • Computer Organization • Computer Architecture • Digital Systems Design • Robotics • Unmanned Aerial Vehicles (UAVs) • Cloud Computing • Cyber Security Systems • Geo-informatics • Digital Signal Processing • Digital Control • Internet of Things (IoT) • Embedded Systems • Artificial Intelligence • Any other relevant course decided by the HEI as per requirement.

****Electric Vehicles Stream Depth Core I & II
• Automotive Engineering (Depth Core-I) • EV Charging Devices and Technologies (Depth Core-II)
*****Proposed Electives for Electric Vehicles Stream
• Sensors and Actuators • EV Batteries and Ancillaries • EV Software • EV Control Systems • EV Integration with Power Grid • Autonomous Vehicles • EV Circuits and Electronics • EV Body and Chassis Design • Vehicular Networking • EV Dynamics • Any other relevant course decided by the HEI as per requirement.

******Proposed Electives for Multi-Disciplinary Domain (MDEE)
• Applied Mechanics • Fluid Mechanics • Thermodynamics • Surveying & Levelling • Bio-Mechanics • Environmental Engineering • Software Engineering • Optimization Techniques • Any other relevant course decided by the HEI as per requirement.

16. Program Specific Laboratories

The following labs specific to electrical engineering discipline be ensured to cover relevant knowledge domains but not limited to;

- Electrical Engineering Workshop
- Computer Lab
- Linear Circuit Analysis Lab
- Electrical Network Analysis Lab
- Digital Logic Design Lab
- Electronic Devices and Circuits Lab
- Engineering Drawing Lab
- Signals and System Lab
- Communication Systems Lab
- Microprocessors and Interfacing Lab
- Electrical Machines Lab
- Linear Control Systems Lab
- Power Distribution and Utilization Lab
- Electronic Circuit Design lab
- Power Electronics Lab
- Artificial Intelligence Lab
- Automotive Engineering Lab (required only if EV specialization is offered)

- ***"Labs/ Practical: The course practical/ labs should be defined and synchronized with the course outline (Theory part)."***

- ***"All safety protocols, manuals and log books etc. should be maintained and complied by each lab."***

17. Courses Details and Teaching-Assessment Approaches

In the following sections, Course Outlines and teaching-assessment approaches are given for guidance based on a typical semester system. The instructors may adopt or adapt accordingly defining CLOs, course delivery plan, innovative teaching approaches and assessment techniques.

Suggested Teaching & Assessment Methods include Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Project/Field Visits Group discussion, Community Service, Report Writing Social Impact Review and Social Audit of Engg Project.

Further, assessment may be carried out through Mid Term, Report writing/ Presentation, Assignments, Term Project, Quizzes and Final Term Exam etc.

17.1 Non-Engineering Domain

FUNCTIONAL ENGLISH

UGE Policy V1.1: General Education Course

Credits: 03
Pre-Requisite: Nil

DESCRIPTION
This course is designed to equip students with essential language skills for effective communication in diverse real-world scenarios. It focuses on developing proficiency in English language usage: word choices, grammar and sentence structure. In addition, the course will enable students to grasp nuanced messages and tailor their communication effectively through application of comprehension and analytical skills in listening and reading. Moreover, the course encompasses a range of practical communication aspects including professional writing, public speaking, and everyday conversation, ensuring that students are equipped for both academic and professional spheres. An integral part of the course is fostering a deeper understanding of the impact of language on diverse audiences. Students will learn to communicate inclusively and display a strong commitment to cultural awareness in their language use. Additionally, the course will enable them to navigate the globalized world with ease and efficacy, making a positive impact in their functional interactions.

COURSE LEARNING OUTCOMES

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

1. Apply enhanced English communication skills through effective use of word choices, grammar and sentence structure.
2. Comprehend a variety of literary / non-literary written and spoken texts in English.
3. Effectively express information, ideas and opinions in written and spoken English.
4. Recognize inter-cultural variations in the use of English language and to effectively adapt their communication style and content based on diverse cultural and social contexts.

COURSE OUTLINE

1. **Foundations of Functional English:**
    - Vocabulary building (contextual usage, synonyms, antonyms and idiomatic expressions)
    - Communicative grammar (subject-verb-agreement, verb tenses, fragments, run-ons, modifiers, articles, word classes, etc.)

- Word formation (affixation, compounding, clipping, back formation, etc.)
- Sentence structure (simple, compound, complex and compound-complex)
- Sound production and pronunciation.

2. **Comprehension and Analysis:**
   - Understanding purpose, audience and context.
   - Contextual interpretation (tones, biases, stereotypes, assumptions, inferences, etc.).
   - Reading strategies (skimming, scanning, SQ4R, critical reading, etc.).
   - Active listening (overcoming listening barriers, focused listening, etc.).
3. **Effective Communication:**
   - Principles of communication (clarity, coherence, conciseness, courteousness, correctness, etc.).
   - Structuring documents (introduction, body, conclusion and formatting).
   - Inclusivity in communication (gender-neutral language, stereotypes, cross-cultural communication, etc.).
   - Public speaking (overcoming stage fright, voice modulation and body language).
   - Presentation skills (organization content, visual aids and engaging the audience).
   - Informal communication (small talk, networking and conversational skills).
   - Professional writing (business e-mails, memos, reports, formal letters, etc.).

PRACTICAL REQUIREMENT

As part of the overall learning requirements, students will also be exposed to relevant simulations, role-plays and real-life scenarios and will be required to apply skills acquired throughout the course in the form of a final project.

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "Understanding and Using English Grammar" by Betty Schrampfer Azar.
2. "English Grammar in Use" by Raymond Murphy.
3. "The Blue Book of Grammar and Punctuation" by Jane Straus.
4. "English for Specific Purposes: A Learning-Centered Approach" by Tom Hutchinson and Alan Waters.
5. "Cambridge English for Job-hunting" by Colm Downes.
6. "Practical English Usage" by Michael Swan.

7. "Reading Literature and Writing Argument" by Missy James and Alan P. Merickel.
8. "Improving Reading: Strategies, Resources, and Common Core Connections" by Jerry Johns and Susan Lenski.
9. "Comprehension: A Paradigm for Cognition" by Walter Kintsch.
10. "Communication Skills for Business Professionals" by J.P Verma and Meenakshi Raman.

EXPOSITORY WRITING

UGE Policy V1.1: General Education Course

Credits: 03
Pre-Requisite: Functional English

DESCRIPTION

Expository Writing is a sequential undergraduate course aimed at refining writing skills in various contexts. Building upon the foundation of the pre-requisite course, Functional English, this course will enhance students' abilities of producing clear, concise and coherent written texts in English. The course will also enable students to dissect intricate ideas, to amalgamate information and to express their views and opinions through well-organized essays. The students will further be able to refine their analytical skills to substantiate their viewpoints using credible sources while adhering to established ethical writing norms. Additionally, the course will highlight the significance of critical thinking enabling students to produce original and engaging written texts.

COURSE LEARNING OUTCOMES

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

1. Understand the essentials of the writing process integrating pre-writing, drafting, editing and proof reading to produce well-structured essays.
2. Demonstrate mastery of diverse expository types to address different purposes and audiences.
3. Uphold ethical practices to maintain originality in expository writing.

COURSE OUTLINE

1. **Introduction to Expository Writing:**
    - Understanding expository writing (definition, types, purpose and applications)
    - Characteristics of effective expository writing (clarity, coherence and organization)
    - Introduction to paragraph writing
2. **The Writing Process:**
    - Pre-writing techniques (brainstorming, free-writing, mind-mapping, listing, questioning and outlining etc.)
    - Drafting (three stage process of drafting techniques)
    - Revising and editing (ensuring correct grammar, clarity, coherence, conciseness etc.)
    - Proof reading (fine-tuning of the draft)

- Peer review and feedback (providing and receiving critique)

3. **Essay Organization and Structure:**
   - Introduction and hook (engaging readers and introducing the topic)
   - Thesis statement (crafting a clear and focused central idea)
   - Body Paragraphs (topic sentences, supporting evidence and transitional devices)
   - Conclusion (types of concluding paragraphs and leaving an impact)
   - Ensuring cohesion and coherence (creating seamless connections between paragraphs)
4. **Different Types of Expository Writing:**
   - Description
   - Illustration
   - Classification
   - Cause and effect (exploring causal relationships and outcomes)
   - Process analysis (explaining step-by-step procedures)
   - Comparative analysis (analyzing similarities and differences)
5. **Writing for Specific Purposes and Audiences:**
   - Different types of purposes (to inform, to analyze, to persuade, to entertain etc.)
   - Writing for academic audiences (formality, objectivity, and academic conventions)
   - Writing for public audiences (engaging, informative and persuasive language)
   - Different tones and styles for specific purposes and audiences
6. **Ethical Considerations:**
   - Ensuring original writing (finding credible sources, evaluating information etc.)
   - Proper citation and referencing (APA, MLA, or other citation styles)
   - Integrating quotes and evidences (quoting, paraphrasing, and summarizing)
   - Avoiding plagiarism (ethical considerations and best practices)

PRACTICAL APPLICATIONS AND CAPSTONE PROJECT

As part of the overall learning requirements, students will be required to build a writing portfolio having a variety of expository texts and present the same at the end of the course showcasing proficiency in expository writing.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The St. Martin's Guide to Writing" by Rise B. Axelrod and Charles R. Cooper.

2. "They Say / I Say: The Moves That Matter in Academic Writing" by Gerald Graff and Cathy Birkenstein.
3. "Writing Analytically" by David Rosenwasser and Jill Stephen.
4. "Style: Lessons in Clarity and Grace" by Joseph M. Williams and Joseph Bizup.
5. "The Elements of Style" by William Strunk Jr. and E.B. White.
6. "Good Reasons with Contemporary Arguments" by Lester Faigley and Jack Selzer.
7. "Writing to Learn: How to Write - and Think - Clearly About Any Subject at All" by William Zinsser.
8. "The Norton Field Guide to Writing" by Richard Bullock, Maureen Daly Goggin, and Francine Weinberg.
9. "The Art of Styling Sentences" by Ann Longknife and K.D. Sullivan.
10. "Writing Today" by Richard Johnson-Sheehan and Charles Paine

ISLAMIC STUDIES

UGE Policy V1.1: General Education Course

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with a comprehensive overview of the fundamental aspects of Islam, its beliefs, practices, history and influence on society. It will further familiarize students with a solid foundation in understanding the religion of Islam from an academic and cultural perspective. Through this course, students will have an enhanced understanding of Islam's multifaceted dimensions which will enable them to navigate complex discussions about Islam's historical and contemporary role, fostering empathy, respect, and informed dialogue.

COURSE LEARNING OUTCOMES

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

1. Demonstrate enhanced knowledge of Islamic foundational beliefs, practices, historical development, spiritual values and ethical principles.
2. Describe basic sources of Islamic law and their application in daily life.
3. Identify and discuss contemporary issues within the Muslim world including social challenges, gender roles and interfaith interactions.

COURSE OUTLINE

1. **Introduction to Islam:**
   - Definition of Islam and its core beliefs.
   - The Holy Quran (introduction, revelation and compilation).
   - Hadith and Sunnah (compilation, classification, and significance).
   - Key theological concepts and themes (Tawhid, Prophethood, Akhirah etc.).
2. **Sirah of the Holy Prophet (Peace Be Upon Him) as Uswa-i-Hasana:**
   - Life and legacy of the Holy Prophet PBUH
   - Diverse roles of the Holy Prophet PBUH (as an individual, educator, peace maker, leader etc.)
3. **Islamic History and Civilization:**
   - World before Islam.
   - The Rashidun Caliphate and expansion of Islamic rule.
   - Muslims contributions to philosophy, science, medicine, mathematics, and culture.

4. **Islamic Jurisprudence (Fiqh):**
    - Fundamental sources of Islamic jurisprudence.
    - Pillars of Islam and their significance.
    - Major schools of Islamic jurisprudence.
    - Significance and principles of Ijtihad.
5. **Family and Society in Islam:**
    - Status and rights of women in Islamic teachings.
    - Marriage, family, and gender roles in Muslim society.
    - Family structure and values in Muslim society.
6. **Islam in the Modern World:**
    - Relevance of Islam in the modern world (globalization, challenges and prospects).
    - Islamophobia, interfaith dialogue, and multiculturalism
    - Islamic responses to social, ethical, and technological changes
7. **Introduction to Islamic Trade and Finance:**
    - Islamic Financing Structures
    - The Stability of Islamic Financial System
    - Financial Engineering
    - Regulation of Islamic Financial Institutions

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. "The Five Pillars of Islam: A Journey Through the Divine Acts of Worship" by Muhammad Mustafa Al-Azami.
2. "The Five Pillars of Islam: A Framework for Islamic Values and Character Building" by Musharraf Hussain.
3. "Towards Understanding Islam" by Abul A' la Mawdudi.
4. "Islami Nazria e Hayat" by Khurshid Ahmad.
5. "An Introduction to Islamic Theology" by John Renard.
6. "Islamic Civilization Foundations Belief & Principles" by Abul A' la Mawdudi.
7. "Women and Social Justice: An Islamic Paradigm" by Dr. Anis Ahmad.
8. "Islam: Its Meaning and Message" by Khurshid Ahmad.

Note: This course is compulsory for Muslim and optional for non-Muslim undergraduate students. Non-Muslim students can opt for nay course of at least the same or more credits in subjects such as religious studies, ethics, theology, comparative religion, Christian ethics, etc.

IDEOLOGY AND CONSTITUTION OF PAKISTAN

UGE Policy V1.1: General Education Course

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with a fundamental exploration of the ideology and the constitution of Pakistan. The course focuses on the underlying principles, beliefs, and aspirations that have been instrumental in shaping the creation and development of Pakistan as a sovereign state. Moreover, the course will enable students to understand the core provisions of the Constitution of the Islamic Republic of Pakistan concerning the fundamental rights and responsibilities of Pakistani citizens to enable them function in a socially responsible manner.

COURSE LEARNING OUTCOMES

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

1. Demonstrate enhanced knowledge of the basis of the ideology of Pakistan with special reference to the contributions of the founding fathers of Pakistan.
2. Demonstrate fundamental knowledge about the Constitution of Pakistan 1973 and its evolution with special reference to state structure.
3. Explain about the guiding principles on rights and responsibilities of Pakistani citizens as enshrined in the Constitution of Pakistan 1973.

COURSE OUTLINE

1. **Introduction to the Ideology of Pakistan:**
   - Definition and significance of ideology.
   - Historical context of the creation of Pakistan (with emphasis on socio-political, religious, and cultural dynamics of British India between 1857 till 1947).
   - Contributions of founding fathers of Pakistan in the freedom movement including but not limited to Allama Muhammad Iqbal, Muhammad Ali Jinnah., etc.
   - Contributions of women and students in the freedom movement for separate homeland for Muslims of British India.
2. **Two-Nation Theory:**
   - Evolution of the Two-Nation Theory (Urdu-Hindi controversy, Partition of Bengal, Simla Deputation 1906, Allama Iqbal's Presidential Address 1930, Congress Ministries 1937, Lahore Resolution 1940).
   - Role of communalism and religious differences.

3. **Introduction to the Constitution of Pakistan:**
   - Definition and importance of a constitution.
   - Ideological factors that shaped the Constitution(s) of Pakistan (Objectives Resolution 1949).
   - Overview of constitutional developments in Pakistan.
4. **Constitution and State Structure:**
   - Structure of Government (executive, legislature, and judiciary).
   - Distribution of powers between federal and provincial governments.
   - 18th Amendment and its impact on federalism.
5. **Fundamental Rights, Principles of Policy and Responsibilities:**
   - Overview of fundamental rights guaranteed to citizens by the Constitution of Pakistan 1973 (Articles 8-28).
   - Overview of Principles of Policy (Articles 29-40).
   - Responsibilities of the Pakistani citizens (Article 5).
6. **Constitutional Amendments:**
   - Procedures for amending the Constitution.
   - Notable constitutional amendments and their implications.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "The Idea of Pakistan" by Stephen P. Cohen.
2. "Ideology of Pakistan" by Javed Iqbal.
3. "The Struggle for Pakistan" by I.H. Qureshi.
4. "Pakistan the Formative Phase" by Khalid Bin Sayeed.
5. "Pakistan: Political Roots and Development" by Safdar Mahmood.
6. "Ideology of Pakistan" by Sharif-ul-Mujahid.
7. "The Struggle for Pakistan: A Muslim Homeland and Global Politics" by Ayesha Jalal.
8. "Jinnah, Pakistan and Islamic Identity: The Search for Saladin" by Akbar S. Ahmed.
9. "The Making of Pakistan: A Study in Nationalism" by K.K. Aziz.
10. "Pakistan: A New History" by Ian Talbot.
11. "Pakistan in the Twentieth Century: A Political History" by Lawrence Ziring.
12. "The Constitution of Pakistan 1973". Original.
13. "Constitutional and Political Development of Pakistan" by Hamid Khan.
14. "The Parliament of Pakistan" by Mahboob Hussain.
15. "Constitutional Development in Pakistan " by G.W. Choudhury.
16. "Constitution-Making in Pakistan: The Dynamics of Political Order" by G.W. Choudhury.

* List of Arts and Humanities Electives (2+0)
• Communication and Presentation Skills • Beginners Spanish • Elementary Arabic • Elementary French • Elementary Chinese • History • Philosophy • Professional Ethics

COMMUNICATION AND PRESENTATION SKILLS

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Write clearly, concisely, and grammatically correctly in various forms, avoiding errors.
2. Read critically to understand information better and improve vocabulary.
3. Deliver engaging presentations with effective communication and visuals.
4. Adapt communication style to audience and context, demonstrating active listening.

COURSE OUTLINE

Writing Skills

- Vocabulary Building
- Writing Skills: Essays and Letters
- Common Writing Errors
- Purposeful Writing

Reading Skills

- Skimming and Scanning
- Critical Reading
- Reading for Understanding
- Techniques and strategies to develop sound vocabulary.

Listening Skills

- Introduction to Communication Process
- Seven Cs of Communication
- Types of Listening
- Listening for Comprehension

Speaking Skills

- Verbal and Non-Verbal Communication
- Basics of Presentation Skills
- Presentation Strategies and public speaking skills.
- Use of Audio-Visual Aids
- Basics of Group Communication
- Listening Skills
- Communicate effectively in job interviews.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Project / Field Visits, Group discussion, Community Service, Report Writing, Social Impact Review and Social Audit of Engineering Project

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Anchor in English-II (Lessons 1-5), A SPELT Publication
2. Christopher Fry, "Summary Writing (Book-I)", Oxford University Press
3. College Essays by John Langlan
4. Barron's TOFFL iBT Edition
5. Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna
6. Writing for Computer science by Justin Zobel Research Methodologies – A step by step guide for beginners, Ranjit Kumar.

BEGINNERS SPANISH

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Greet and introduce yourself and others in basic Spanish, stating your profession, nationality, activities, and family members.
2. Comprehend the Spanish alphabet, numbers, telling the time, days of the week, months, and weather descriptions.
3. Describe people, places, your likes and dislikes, using basic vocabulary and simple sentence structures.
4. Communicate in basic Spanish for everyday situations like eating out, shopping, daily activities, and work, in both formal and informal settings.

COURSE OUTLINE

- Greeting and introducing yourself and others: profession, nationality, activities and family
- the alphabet numbers, telling the time, days of the week, the months, the weather
- describing people and places, likes and dislikes
- Spanish in context: eating out, shopping, daily activities, work formal and informal situations
- describing past events
- expressing opinions.
- Grammatical structures: pronunciation, present tense: regular, irregular and reflexive verbs, personal pronouns, definite and indefinite articles, adjectives and nouns: gender and number, asking a question, demonstrative adjectives and pronoun, prepositions of place, verbs, adverbs of frequency, introduction to the past tense (pretérito indefinido).

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio./video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Ele Actual A1 by Virgilio Boribio, Publisher: Editorial SM; ISBN: 978-84-675-4741-

ELEMENTARY ARABIC

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. **Greet** and introduce yourself and others in basic Arabic, utilizing both formal and informal forms of address.
2. **Formulate** basic questions in Arabic using proper structure to inquire about everyday topics.
3. **Describe** yourself and others using relevant vocabulary and adhering to singular and plural noun/adjective formation and gender agreements.
4. **Construct** grammatically correct sentences in the present tense, incorporating conjugated verbs, definite and indefinite articles, and possessive adjectives.

COURSE OUTLINE

Vocabulary

- Greetings and introductions
- Formal and informal address
- Question formation for asking basic questions
- Speaking about yourself and others
- Arabic numbers
- Everyday life vocabulary

Grammar

- Conjugating verbs in the present tense
- Formation of singular and plural nouns and adjectives
- Feminine and Masculine Forms
- Definite and indefinite articles
- Possessive adjectives (feminine and masculine)
- Adjectives and adjective agreements
- Sentence structure

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review.

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Al-Kitaab fii TaCallum al-Arabyya: A Textbook for Beginning Arabic (Part 1), 3rd Edition, Brustad, Al-Batal, AlTonsi, Georgetown University Press, 2011. ISBN: 978-1-58901-736-8

ELEMENTARY FRENCH

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. **Engage** in basic social interactions using greetings, numbers, and calendar expressions.
2. **Express** likes and dislikes on various topics, including weekend and school activities.
3. **Describe** aspects of your family, home, shopping experiences, and food preferences through basic vocabulary.
4. **Formulate** grammatically correct sentences in the present tense using regular and irregular verbs, subject pronouns, possessive adjectives, and the verbs "aller" and "venir" to express the future and immediate past.

COURSE OUTLINE

- Social greetings, Number, Calendar and time, expressing likes and dislikes, Talking about weekend and school activities, Family and the home, Shopping, Food
- Grammatical structures:
  - Subject pronouns and the verb être
  - Present tense regular –er verbs
  - Agreement and placement of adjectives
  - The verb aller and its use in expressing the future
  - The verb venir and the immediate past
  - Possessive adjectives
  - Present tense irregular verbs
  - Interrogative pronouns qui and que
  - Partitive article

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Débuts. Siskin, Williams-Gascon, Field. McGraw-Hill

ELEMENTARY CHINESE

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. **Utilize** Hanyu Pinyin to accurately sound and read Chinese characters, mastering standard pronunciation.
2. **Recognize** and write approximately 260 basic Chinese characters, applying them in simple communication.
3. **Construct** grammatically correct sentences by understanding fundamental word order and the usage of particles in Chinese.
4. **Formulate** different types of questions to effectively seek information in daily situations.

COURSE OUTLINE

- Use Hànyǔ Pīnyīn to speak and read with standard Chinese pronunciation.
- Read and write about 260 Chinese characters.
- Understand the basic word order of Chinese sentences and the use of particles.
- Use different types of questions.
- Identify people and things
- Use time expressions and numbers.
- Use adjectives to describe people and things.
- Express possession and existence
- Express wishes, obligations, capabilities, possibilities and permissions.
- State likes and dislikes.
- Explain where something is located.
- Describe how an action is performed.

SUGGESTED TEACHING METHODS

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Group discussion, Community Service, Report Writing, Social Impact Review

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Kung Fu (I): An Elementary Chinese Text. By John C. Jamieson and Lin Tao. Hong Kong:Chinese University Press, 2002

HISTORY

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Define the concept of history, distinguishing its key characteristics and recognizing its evolving nature.
2. Describe the intricate relationship between memory, historical records, and the construction of history, critically examining their interconnected roles.
3. Evaluate the nature of historical inquiry, including its methods, limitations, and potential biases.
4. Explain the epistemological nature of history, including its methods of knowledge production and the challenges it faces.
5. Identify and categorize different forms of historical narratives based on their focus, methodology, and purpose.

COURSE OUTLINE

- What is History?
- Memory, Record and History
- Nature of History:
- Utility, Benefits & importance of History:
- Epistemological nature of History:
- Forms and Classification of History

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Burke, Varieties of Cultural History, Cornell University Press, 1977
2. Carlo, Ginzburg. Clues. Myths, and the Historical Method, John Hopkins: University Press, 1992
3. Carr, E. H., What is History? Harmondsworth: Penguin, 1961
4. Cohn, Bernard. An Anthropologist among Historians and Other Essay, Oxford University Press, 1988
5. Collingwood, R. G. The Idea of History. Oxford: Oxford University Press, 1978.
6. Daniels, Studying History: How and Why, New Jersey, 1981.

7. Gertrude Himmalfarb. The New History and the Old, Cambridge: Harvard University Press, 1987
8. Govranski. History Meaning and Methods, USA, 1969
9. Hegel. Elements of the Philosophy of Right. Cambridge University Press, 1991

PHILOSOPHY

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Examine the fundamental nature of philosophy, exploring its scope, purpose, and relevance to the engineering discipline.

2. Apply principles of arguments and logic in the context of philosophical analysis, developing the ability to construct and evaluate logical reasoning.

3. Examine different perspectives on knowledge within epistemology, relating these perspectives to engineering practices and the development of technological solutions.

4. Analyze the concept of induction, exploring its role in reasoning and its applications in the engineering field.

5. Compare and contrast the philosophical perspectives of rationalism and empiricism, considering their implications for the understanding of engineering phenomena.

COURSE OUTLINE

- Introduction: The Nature of Philosophy
- Arguments and Logic in Philosophy
- Epistemology – Skepticism and Certainty
- Epistemology: The Scope and Limits of Knowledge
- Epistemology: Knowledge
- Induction
- Rationalism and Empiricism
- Philosophy and Meaning

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Hales, S. D. (2021). This is philosophy: An introduction. John Wiley & Sons.

2. Hospers, J. (2013). An introduction to philosophical analysis. Routledge.
3. Hurley, P. J. (2014). A concise introduction to logic. Cengage Learning.
4. Rachels, J., & Rachels, S. (1986). The elements of moral philosophy (p. 9). Philadelphia: Temple University Press.
5. Solomon, R. C., & Higgins, K. M. (2013). The big questions: A short introduction to philosophy. Cengage Learning.
6. Stewart, D. (2010). Fundamentals of Philosophy. 6th. Boston: Pearson

PROFESSIONAL ETHICS

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Define key terms: profession, ethics, and their relation to law/morality.
2. Analyze ethical frameworks and their application in engineering. Identify desirable personality traits for ethical behaviour.
3. Explain ethical livelihood in engineering, including halal earning.
4. Describe professional ethics in engineering societies and codes of conduct.
5. Apply critical thinking and problem-solving in ethical situations.

COURSE OUTLINE

- Profession; What is a Profession? and Professional Ethics.
- Ethics; What is Ethics?, Why study Ethics?, Professional Ethics, Difference between Laws, morals, and Ethics: Character Ethics, Personality Ethics, Value &Virtue Ethics, and Characteristics of Code of Ethics
- Personality Traits, Desirable Personality Traits and Undesirable Personality Traits, Trust and Honesty, Sincerity, Truthfulness, Politeness, Respect & Etiquettes,
- Human values, values, morals and ethics, Moral Code of Islam, Struggle for Rizq e Halaal. To identify and adopt the legitimate, lawful and ethical sources of earning / livelihood.
- Moral development, moral dilemma, dealing with moral dilemma, moral autonomy, Fulfilment of Promise, Pride and Arrogance, Malpractice, Engineer's moral rights, right of professional conscience, professional rights and Ethical theories, intellectual property rights, patents, design, trademark etc.
- Professional ethics, role of professional bodies, Engineering code of ethics, Engineering ethics, training in preventive ethics, questionable engineering practices, Micro and Macro ethics, examples of moral problems in engineering. Time management, Cooperation
- Inter-Personal Relations (Employer-Employee relationship), employee rights, professionalism and loyalty, right to protest, obligation of confidentiality, effect of change of job on confidentiality, conflict of interest. Grievances, Welfare, health & safety of personnel, whistleblowing

and its features, types, procedures to be followed and conditions to be satisfied before whistle blowing

- Problem-Solving, Decision-Making, Engineers responsibilities towards society welfare, environment degradation, bio-centric ethics, Ecocentric ethics, Human centered environmental ethics, Global examples of catastrophic engineering incidents. Safety, responsibilities and rights; safety and risks, responsible engineering, cost of unsafe designed product, Moral thinking, tests in moral problems solving, problem solving in engineering ethics, case studies.

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. Engineering Ethics: Concepts and Cases by Charles E. Harris Jr, 2018, 6th Ed., Cengage Learning, ISBN:978-1337554503
2. Ethics in Engineering by Mike Martin, 2022, 5th Ed., McGraw Hill, ISBN: 9781260721744
3. Attributes of Muslim Professionals in the Light of Quran & Sunnah by Akram Muhammad Zeki, 2021, Ilum Press, ISBN: 9789674911201

CIVICS AND COMMUNITY ENGAGEMENT

UGE Policy V1.1: General Education Course

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with fundamental knowledge about civics, citizenship, and community engagement. In this course, the students will learn about the essentials of civil society, government, civic responsibilities, inclusivity, and effective ways to participate in shaping the society which will help them apply theoretical knowledge to the real-world situations to make a positive impact on their communities.

COURSE LEARNING OUTCOMES

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

1. Demonstrate fundamental understanding of civics, government, citizenship and civil society.
2. Understand the concept of community and recognize the significance of community engagement for individuals and groups.
3. Recognize the importance of diversity and inclusivity for societal harmony and peaceful co-existence.

COURSE OUTLINE

1. **Introduction to Civics and Citizenship**
   - Definition of civics, citizenship, and civic engagement
   - Historical evolution of civic participation
   - Types of citizenship: active, participatory, digital etc.
   - The relationships between democracy and citizenship
2. **Civics and Citizenship**
   - Concepts of civics, citizenship, and civic engagement.
   - Foundations of modern society and citizenship.
   - Types of citizenship: active, participatory, digital, etc.
3. **State, Government and Civil Society**
   - Structure and functions of government in Pakistan.
   - The relationship between democracy and civil society.
   - Right to vote and importance of political participation and representation.
4. **Rights and Responsibilities**
   - Overview of fundamental rights and liberties of citizens under Constitution of Pakistan 1973.

- Civic responsibilities and duties.
- Ethical considerations in civic engagement (accountability, non-violence, peaceful dialogue, civility, etc.)

5. Community Engagement

- Concept, nature and characteristics of community.
- Community development and social cohesion.
- Approaches to effective community engagement.
- Case studies of successful community driven initiatives.

6. Advocacy and Activism

- Public discourse and public opinion.
- Role of advocacy in addressing social issues.
- Social action movements.

7. Digital Citizenship and Technology

- The use of digital platforms for civic engagement.
- Cyber ethics and responsible use of social media.
- Digital divides and disparities (access, usage, socioeconomic, geographic, etc.) and their impacts on citizenship.

8. Diversity, Inclusion and Social Justice:

- Understanding diversity in society (ethnic, cultural, economic, political etc.).
- Youth, women and minorities' engagement in social development.
- Addressing social inequalities and injustices in Pakistan.
- Promoting inclusive citizenship and equal rights for societal harmony and peaceful co-existence.

SUGGESTED PRACTICAL ACTIVITIES (OPTIONAL)

As part of the overall learning requirements, the course may have one or a combination of the following practical activities:

1. **Community Storytelling:** Students can collect and share stories from community members. This could be done through oral histories, interviews, or multimedia presentations that capture the lived experiences and perspectives of diverse individuals.
2. **Community Event Planning:** Students can organize a community event or workshop that addresses a specific issue or fosters community interaction. This could be a health fair, environmental cleanup, cultural festival, or educational workshop.
3. **Service-Learning:** Students can collaborate with a local nonprofit organization or community group. They can actively contribute by volunteering their time and skills to address a particular community need, such as tutoring, mentoring, or supporting vulnerable populations.
4. **Cultural Exchange Activities:** Students can organize a cultural exchange event that celebrates the diversity within the community. This

could include food tastings, performances, and presentations that promote cross-cultural understanding.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Civics Today: Citizenship, Economics, & You" by McGraw-Hill Education.
2. "Citizenship in Diverse Societies" by Will Kymlicka and Wayne Norman.
3. "Engaging Youth in Civic Life" by James Youniss and Peter Levine.
4. "Digital Citizenship in Action: Empowering Students to Engage in Online Communities" by Kristen Mattson.
5. "Globalization and Citizenship: In the Pursuit of a Cosmopolitan Education" by Graham Pike and David Selby.
6. "Community Engagement: Principles, Strategies, and Practices" by Becky J. Feldpausch and Susan M. Omilian.
7. "Creating Social Change: A Blueprint for a Better World" by Matthew Clarke and Marie-Monique Steckel

List of Social Science Electives (2+0)
• Sociology for Engineers • Sociology • Social phycology • Critical Thinking • Human Resource Management • Organizational Behavior • Engineering Law • Engineering Economics • Applied Psychology • Engineering Management • Financial Management • Marketing Management • Leadership and Personal Grooming • Any other relevant course decided by the HEI as per requirement.

SOCIOLOGY FOR ENGINEERS

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

This course is meant to provide engineering students, with an opportunity to view the discipline of sociology from the engineering perspective and will highlight its application to engineering profession. This will also enable the engineers to fit their technical ideas into a socially acceptable product /project in a more successful manner.

COURSE LEARNING OUTCOMES

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

1. Introduce to the methods and philosophy of the social science to help their understanding of the socio-cultural dimension of human existence as a fundamental reality in engineering projects etc.
2. To provide opportunity for students to begin the process of considering social problems/ issues while designing engineering products.
3. To allow engineers to play a pro-active role in critical discussions of social issues specifically.
4. To demonstrate comprehension of roles and functions of various social institutions, state organizations, Professional bodies and relationships for analyzing their social impact Assessment.

COURSE CONTENT

- **Fundamental Concepts and Importance of Sociology for Engineers**
  What is sociology? Nature, Scope, and Importance of Sociology, Sociological Perspectives and Theories, Social Interactions, Social Groups/ Social Institutions & heir interface with Engineering Project/services, Sociology & Impact of Technology & Engineering Products/Projects on Society.
- **Cultural Impacts of Engineering Projects on Society**
  Definition of Culture, Types of Culture & Elements of Culture, Culture & Power, Authority, Dominance Socialization and Personality, Role of Engineering Projects on Culture, social norms and values of Society, Cultural Infusion of Engineers in Society.
- **Theoretical Perspective of Sociology: Diffusion and Innovation; Adoption and Adaptation; Social development; Community Development**
  Community Development & Social consequences of Industrialization, Development Processes of Societal Development, Cooperation and Conflict in Community Development in Engineering Context.

- **Understanding of Societal & Ethical Norms and Values for Engineers**
  Engineering Ethics, Engineering product/services for Less privileged, Role of Engg & Technology in addressing Social inequality, Core Social Values/Norms affecting Engg Performance
- **Organizational Social Responsibility (OSR) of Engineers**
  - Extent to which development intends to sensitize societal and under privileged needs
  - Gender inclusiveness and balance
  - Special and Disadvantaged Community of the Area o Planning for community inclusiveness
  - Societal Obligation of Engineers
- **Engineers, Society and Sustainability**
  Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions.
- **Industrial & Organizational Psychology**
  Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes, Language and Communication, Motivations and Emotions, Impact of Technology on human feelings and level of Sensitivity
- **Climate Change and Ecological Friendliness from Engineering Perspective**
  Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental impact on Population & General Masses, Technological Intervention, Ecosystem and Physical Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc).
- **Social Approaches and Methodologies for Development Administration & Stakeholders Analysis:**
  All Phases of the Project (pre, post and execution) Structured, Focused Group, Stakeholder Consultative Dialogues etc. Dynamics of Social Change, Sociology of Change and Industrial Development, Social Change due to Technology Driven Economic Growth.
- **Case Studies of Different Development Projects in Social Context**
- **SIA (Social Impact Assessment):**
  Base line and need-assessment, evaluation and impact assessment surveys of the development projects. Role of Engg & Technology for Creating Social Cohesiveness & Societal Integration. Technology Based change in Collective Behavior, Social Audit of Engineering Projects.

- **Engineering Intervention for Social Stratification**
  Factors of Social Stratification, Engineering Interventions for addressing Social Stratification, Social Mobilization through Technological Innovation.

SUGGESTED TEACHING METHODS:

Lectures (audio/video aids), Written Assignments/ Quizzes, ,Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Project/Field Visits, Group discussion, Community Service, Report Writing, Social Impact Review and Social Audit of Engg Project

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Vol. 03; Special Issue. March, 2018.
2. Nichols,S.P.andWeldon,W.F.2017. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
3. Aslaksen,E.W.2016. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales,Vol.148.Nos.455-456. Gumbooya Pty Lte, Allambie Heights, Australia.
4. Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers
5. Jamison,A.,Christensen,S.H.,andLars,B.2011.A Hybrid Imagination: Science and Technology in cultural perspective
6. Vermaas,P.,Kroes,P.,Poet,l.,andHoukes,W.2011.APhilosophyofTechnolog y:FromTechnical Artefacts to Socio technical systems.
7. Mitcham,C.,andMunoz,D.2010.HumanitarianEngineering.MorganandClay poolPublishers. Riley,D.2008.Engineering and Social Justice. Morgan and Claypool Publishers.
8. Bugliarello,G.1991.TheSocial Functions of Engineering: A Current Assessment, A Chapter in“ Engineering as A Social Enterprise. Sociology

SOCIOLOGY

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

1. To introduce the necessary subject knowledge and understanding required for the successful study of Sociology and related Social Science disciplines at undergraduate.
2. To develop skills of application, analysis and evaluation in the context of the study of Social Science.
3. To develop a knowledge and understanding of sociology both at a global and national level.
4. To introduce the planning and organization skills necessary to develop as independent, autonomous learners.
5. To develop the confidence and competence of the students as learners and to assist them in taking some responsibility for their own learning through directed study and reading.

COURSE CONTENT

- Introduction: Sociological Perspective,
- The Development of Sociology,
- The Role of Values in Sociology, Prejudice In Early Sociology,
- Theoretical Perspective in Sociology. Culture: Components of Symbolic Culture, Subcultures and Counter Cultures, Cultural Universals, Animals and Culture,
- Technology and Global Village, Sociology and New Technology.
- Socialization: Social Development of Self, Mind, and Emotions,
- Socialization into Gender Social Structure and Interaction,
- Social Institutions. Research in Sociology: Research Model, Research Methods. Experiments, Ethics,
- Bureaucracy and Formal Organizations, Rationalization of Society, Formal Organizations and Bureaucracy,
- Voluntary Associations Social Classes, Economy, Politics, Power and Authority, Family, Medicine, Health and Illness, Population and Urbanization, Social Movements
- Social Psychology with special reference to attitudes, attributions and behavior, Emotions, Cognition and Thinking, Reasoning, Problem-Solving and Creativity, Personality, Intelligence, and Abnormal Behavior, etc.

- Introduction to the Field of Organizational Behaviour
- Conflict and Negotiation in the Workplace
- Leadership in Organizational Settings and Organizational Culture
- Ethics: In General an introduction and the development of ethical theory.
- Ethics in Islam, a comprehensive view with different ethics approaches and Ethics Theories
- Research Methods for Society and Sociology

SUGGESTED TEACHING METHODS:

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Henslin, Sociology: A Down-to-Earth Approach, latest edition.
2. D. Kendall, Sociology in our Times. Wadsworth Pub Co, latest edition.

SOCIAL PSYCHOLOGY

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

To impart knowledge of social psychology of attraction; attitudes and prejudice; altruism and aggression; personal and social identities; conformity; group influence and their applications in the real world

COURSE CONTENT

- Principles of sociology and psychology with emphasis on the individual and his/her reciprocal interaction with groups,
- basic psychological factors, attribution and perception of others, attitudes and attitudinal change, social attitudes, altruism, helping others, aggression, hurting others, prejudice, disliking others, discrimination and stereotypes,
- language and communication, society and cultures, culture and personality, small groups and their relation to the individual, leadership and group dynamics. Attraction, attitudes and prejudice; altruism and aggression; personal and social identities, conformity, group influence, moral and ethical issues, harassment,
- corruption and its control, thinking processes and decision making.

SUGGESTED TEACHING METHODS:

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Edward Alsworth Ross, “Social Psychology”, Macmillan, latest edition.
2. Emory Stephen Bogardus, “Essentials of Social Psychology”, Univ. of Southern, California Press, latest edition.
3. Hewstone, M., & Stroebe, W. (Eds.), “Introduction to Social Psychology”, 3rd ed., Oxford: Blackwell Publishers, latest edition.
4. Lesko, W.A. “Readings in social psychology General, classic, and contemporary selections, latest edition,

CRITICAL THINKING

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

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

1. Define critical thinking and identify its benefits in the workplace.
2. List the characteristics of a critical thinker and distinguish them from other types of thinking.
3. Explain the importance of asking questions, actively listening, and challenging assumptions.
4. Describe common creative thinking techniques like brainstorming, mind mapping, and De Bono's thinking hats. List and explain root cause analysis techniques like the 5 Whys and Ishikawa Diagram.
5. Describe strategies for effectively presenting recommendations to decision-makers and stakeholders.

COURSE CONTENT/COURSE OUTLINE

Course Overview

- Introduction
- Introduction to Critical Thinking
- Benefits of critical thinking in the workplace
- Critical thinking as a management skill
- What are the characteristics of a critical thinker?
- Other Types of Thinking
- 5 Different thinking styles
- Module Reflection
- A Critical Thinker's Mindset
- Can you develop a critical thinker's mindset?
- The Critical Thinking Process
- Step 1 - Identifying the problem
- Step 2 - Gather and evaluate your information
- Step 3 - Generate alternative solutions
- Step 4 - Select and implement a solution
- Step 5 - Evaluate your solution

- Developing Critical Thinking Skills
- Asking questions
- Active listening
- Challenging assumptions
- Creative Thinking Techniques
- Brainstorming
- Imagining the opposite
- Mind mapping
- De Bono's thinking hats
- Root Cause Analysis Techniques
- Identifying the cause of a problem
- Ishikawa Diagram (Fishbone Diagram)
- 5 Whys technique
- SWOT analysis
- Using Your REACH Profile to Support Critical Thinking
- Adapting your profile
- Presenting Your Recommendations
- Seeking approval from decision makers and Stakeholders

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Critical Thinking for Students Roy van den Brink-Budgen (4th Edition)
2. Thinking, Fast and Slow Daniel Kahneman (2011)

HUMAN RESOURCE MANAGEMENT

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

At the conclusion of the course, the students will be able to:

1. Understand key challenges and trends in Human Resource Management (HRM). Compare and contrast global and local HRM practices.
2. Explain basic principles of HRM from Islamic and indigenous perspectives.
3. Apply job analysis techniques, including HR planning, job description, and specification.
4. Differentiate between compensation and benefit packages and their management.
5. Explain staffing strategies, covering recruitment techniques, sources, and selection tests.

COURSE CONTENT/COURSE OUTLINE

- Emerging Human resource management challenges.
- Trends in HRM
- Global vs local HRM practices
- HRM from Islamic and indigenous perspective
- Basic Islamic philosophy of managing human resource
- Conducting Job analysis.
- HR Planning
- Job Description
- Job Specification
- Staffing
- Recruiting and selecting employees
- Recruitment techniques
- Sources of recruitment
- Selection tests and Interviewing techniques
- Employee development
- Performance appraisals
- Performance management
- Training and development
- Training the employees
- Types of training

- Technique of training
- Project Description and discussion
- Compensations
- Managing compensation
- Types of compensation
- Rewarding performance
- Pay for Performance
- Designing and administering benefits
- Types of benefits
- Employee relations

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. By Luis R. Gomez Mejia, David B. Balkin, Robert L. Cardy Managing Human Resources. (Fourth ed.)

ORGANIZATIONAL BEHAVIOUR

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

At the conclusion of the course, the students will be able to:

1. Explain the role of individual characteristics, abilities, and learning in organizational behavior.
2. Understand organizational behavior principles from Islamic and indigenous perspectives. Analyze human psychology through the lens of Quran and Sunnah.
3. Identify and classify different attitudes and behaviors in the workplace.
4. Recognize the importance of perception and its role in individual decision-making.
5. Apply motivation concepts, both content and process theories, and use them to design effective reward systems.

COURSE CONTENT/COURSE OUTLINE

- Foundations of Individual Behaviour:
- Biographical Characteristics, Ability, Learning
- Organizational behaviour from Islamic and indigenous perspective
- Understanding human psychology through the lenses of Quran and Sunnah
- Attitudes and Job Satisfaction
- Types of attitudes
- Types of behaviours
- Perception and Individual Decision Making
- Why perception is important
- Types of decision making
- Biases and errors in decision making
- Motivation concept
- Content theories of Motivational
- Process theories of motivation
- Motivation: from concept to application
- Applying motivation concepts for designing reward system

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Robbins, P. S., & Judge, T. A. (2009). Organizational Behaviour. 13th ed.

ENGINEERING LAW

Credits: 02
Pre-Requisite: Nil

COURSE LEARNING OUTCOMES

At the conclusion of the course, the students will be able to:

1. Define key terms: legal studies, law, sources of law.
2. Comprehend the fundamental principles of contract law as they relate to engineers.
3. Recognize the duty of care for engineers and grasp the concept of negligence in engineering. Gain insight into aspects of employment law relevant to engineers.
4. Understand intellectual property concepts, including designs, patents, copyright, and their application in engineering.
5. Learn how to enforce rights to intellectual property in the context of engineering.

COURSE CONTENT/COURSE OUTLINE

- Introduction to legal studies,
- Concepts and sources of law,
- Basic principles of the law contract as it relates to engineers,
- The duty of care for engineers and the concept of negligence,
- Aspects of employment law;
- Intellectual property,
- Designs, patents,
- Copyright in engineering,
- Enforcing rights to intellectual property.

ASSESSMENT

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. R E laidlaw, C R Young, A R Dick, Engineering Law, University Press, 1958.
2. C F Allen, Business law for engineers, University of Michigan library, 1919.

ENGINEERING ECONOMICS

Credit Hours: 02
Pre-Requisites: Nil

DESCRIPTION

This course explores the critical intersection of engineering and economics, emphasizing the pivotal role engineers play in business and strategic decision-making for large-scale projects. Participants delve into fundamental economic principles and learn to navigate complex economic landscapes inherent in engineering endeavors.

COURSE LEARNING OUTCOMES

Upon completion, participants gain expertise in making strategic economic decisions, evaluating project cash flows, and navigating economic uncertainties in engineering projects. The course equips individuals to analyze costs, assess financial viability, and contribute effectively to engineering economic decision-making processes.

COURSE OUTLINE

Engineering Economics

- Role of engineers in business
- Economic decisions v/s design decisions
- Large scale engineering projects and types of strategic economic decisions
- Fundamental principles of engineering economics

Interest Rate and Economic Equivalence

- Interest: The Cost of Money
- Economic Equivalence
- Development of Formulas for Equivalence Calculation
- Unconventional Equivalence Calculations

Understanding Money and Its Management

- Nominal and Effective Interest Rates
- Equivalence Calculations with Effective Interest Rates and with Continuous Payments
- Changing Interest Rates
- Debt Management
- Investing in Financial Assets

Present-Worth Analysis

1. Project Cash Flows

- Initial Project Screening Methods: payback Screening and Discounted Cash Flow Analysis
- Variations of Present-Worth Analysis
- Comparing Mutually Exclusive Alternatives

Annual Equivalent-Worth Analysis

- Annual Equivalent-
  Worth Criterion
- Capital Costs versus Operating Costs
- Applying Annual-Worth Analysis
- Life-Cycle Cost Analysis
- Design Economics

Rate-of-Return Analysis

- Rate of Return and Methods of Finding It
- Internal Rate-of-Return Criterion
- Mutually Exclusive Alternatives

Cost Concepts Relevant to Decision Making

- General Cost Terms; Classifying Costs for Financial Statements
- Cost Classifications for Predicting Cost Behavior
- Future Costs for Business Decisions
- Estimating Profit from Production

Depreciation and Corporate Taxes

- Asset Depreciation: Economic versus Accounting
- Book and Tax Depreciation Methods (MACRS)
- Depletion
- Income Tax Rate to be used in Economic Analysis
- The Need for cash Flow in Engineering Economic Analysis

Developing Project Cash Flows

- Cost-Benefit Estimation for Engineering Projects
- Developing Cash Flow Statements

Project Risk and Uncertainty

- Origins of Project Risk
- Methods of Describing Project Risk: Sensitivity, Break-Even and Scenario Analysis

Special Topics in Engineering Economics

- Replacement Decisions
- Capital Budgeting Decisions
- Economic Analysis in the Service Sector

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Contemporary Engineering Economics by Chan S. Park, latest edition, Pearson ISBN: 9780134105598
2. Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, latest edition, Oxford University Press, ISBN: 978-0199339273
3. Engineering Economy by Leland T. Blank and Anthony Tarquin.

APPLIED PSYCHOLOGY

Credit Hours: 2+1 = 3
Pre-Requisites: Nil

COURSE OUTLINE
Understanding Psychology • Psychology: Scientific perspective • Historical perspective • Schools of psychology • Methods of psychology • Ethical issues • Fields of psychology and their application **Biological Basis of Behavior** • Neuron and its function • Central nervous system • Peripheral nervous system • Endocrine system **Sensation and Perception** • Senses: Vision, audition, smell, taste and kinesthetic • Introduction to perception • Gestalt principles • Binocular and monocular cues • Illusions and extra sensory perception **Learning** • Definition of learning • Types of learning: Classical and operant conditioning • Punishment and its effects • Latent and observational learning **Memory** • Definition and types of memory • Processes and techniques of improving memory • Forgetting: Nature and causes **Cognition and Language** • Concept of cognition • Problem solving • Judgment and decision making • Language development • Language and cognition

- Language and culture

Intelligence and Creativity

- Concept of intelligence
- Theories of intelligence
- Assessment of intelligence
- Mental retardation
- Concept of creativity and its stages

Motivation and Emotion

- Introduction to motivation
- Factors affecting motivation
- Introduction to emotions
- Types of emotions
- Physiology and emotion
- Theories of emotion

Personality

- Defining personality
- Theories of personality
- Personality assessment

Social Thinking and Social Influence

- Social facilitation
- Attribution theory
- Crowd behavior
- Conformity, Obedience
- Helping behavior

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Atkinson R. C., & Smith, E. E. (2000).Introduction to psychology (13th ed.). NY: Harcourt
2. Brace College Publishers.
3. Coon, D., &Mutterer, J. (2008).Introduction to psychology: Gateways to mind and behavior

4. (12th ed.). USA: Wadsworth Cengage Learning.
5. Fernald, L. D., & Fernald, P.S (2005).Introduction to psychology. USA; WMC Brown Publishers

ENGINEERING MANAGEMENT

Credit Hours: 02
Pre-Requisites: Nil

DESCRIPTION

This course delves into the multifaceted aspects of technology commercialization, offering a comprehensive exploration of industrial networks, product and process development, and the critical skills required for successful business ventures. Participants will gain practical knowledge and experience in navigating the journey from concept to market, with a focus on problem-solving, teamwork, and outreach activities.

COURSE LEARNING OUTCOMES

Upon completion, participants will possess the skills and knowledge necessary for successfully commercializing new technological inventions. They will be adept at navigating the various stages, from proof of concept to market distribution, and equipped to develop robust business plans aligned with market demands and technological advancements.

COURSE OUTLINE

- Industrial networks
- Fundamentals of Product and Process development
- Business Community and New Generations of Managers
- Practical Skills Knowledge and Experience in Commercialization of New Technological Inventions
- Use of Multidisciplinary Science Based Knowledge,
- Problem Solving, Teamwork and Outreach Activity,
- Major steps in proof of concept to intellectual property protection,
- Prototype development
- Fabrication and assembly routes
- Materials procurement,
- Identification and creation of new markets
- Development of business plan
- Appropriate technology and marketing
- Distribution and financing
- Routes and strategies for specific technology under development.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

RECOMMENDED TEXT AND REFERENCE BOOKS

1. R. A. Bulgelman, Strategic Management of Technology and innovation, latest Edition McGraw Hill.

FINANCIAL MANAGEMENT

Credit Hours: 02
Pre-Requisites: Nil

COURSE OUTLINE

Risk and return (Required rate)

- Risk and Return Fundamentals: Definition, and Meanings; Basic Model; Risk Preference, Risk Preferences Behaviors; Risk of a Single Asset: (1) Risk Assessment including Scenario Analysis and Probability Distribution and (2) Risk Measurement including Standard Deviation and Coefficient of Variation; Risk of a Portfolio: Portfolio Return and Standard Deviation, Correlation, Diversification; The Capital Asset Pricing Model (CAPM): (1) Types of risk and (2) The CAPM Model covering Beta Coefficient, The Equation, The Graph, The security Market Line (SML) and Shifts in the security Market Line

Short-term Financing Decisions (Current Assets and Current Liabilities)

- Current Asset Investment Policies
- Working Capital Management
- Working Capital Terminologies: Gross VS Net; Trade-off between Profitability and Risk

Cash Operating / Conversion Cycle

- Calculating Cash Conversion Cycle; Funding Requirement of the Cash Conversion Cycle; Cash Management Alternative Strategies; Cash Budget

Management of Marketable Securities

- Inventory Management
- Inventory Levels and Costs; Common Techniques for managing Inventory

Receivables Management

- Credit Selection and Standards; Credit Terms and Policy; Credit Monitoring

Management of Receipts and Disbursements

- Float; Speeding-up Receipts and Slowing-down Payments; Cash Concentration; Zero-balance Accounts

Generic Current Assets' Management

- Financing Current Assets; Alternative Current Asset Financing Policies; Advantages and disadvantages of Short Term Financing

Management of Current Liabilities

- Sources of Short Term Financing; Spontaneous Liabilities; Accounts Payable Management; Accruals; Unsecured Sources of Short Term Financing; Bank Loans; Commercial Papers; Secured Sources of Short Term Financing; Accounts Receivables as Collaterals; Inventory as Collateral

Leverage and Capital Structure

- Leverage; Meanings and Use of Leverage; Breakeven Analysis; Operating Leverage; Financing Leverage; Capital Structure; Types/Dimensions of Capital; External Assessment of Capital Structure; Theory of Capital Structure; Target/Optimal Capital Structure, and its Determination; EBIT – EPS Approaches to Capital Structure; Variations in Capital Structures; Comparing Alternative Capital Structures; Capital Structure and Risk; Value Estimation; Maximizing Value VS Maximizing EPS

Payout Policy

- Mechanics of Payout Policy; Factors affecting Dividend Policy; Classification of Dividend Policies (General and w.r.t. Pakistan)

Long-term Debt Management

- Long-term Debt Considerations; Corporate Bonds; Preferred Stock; Leases; Mergers of Definition of Mergers; Convertible Securities; Options of Major Types of Options

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Brigham F Eugene, Houston F Joel (Latest edition), Fundamentals of Financial Management, South Western Publishers, Ohio
2. Lawrence J. Gitman, Latest Edition, 'Principles of Managerial Finance'
3. Horne Van, Jr. Wackowicz (Latest Edition), Fundamentals of Financial Management,
4. Apprentice Hall International Inc, New Jersey

MARKETING MANAGEMENT

Credit Hours: 02
Pre-Requisites: Nil

COURSE OUTLINE

- Defining Marketing For The 21st Century. Importance and scope of Marketing.
- Discussion on Course Outline:
- Some fundamental Marketing Concepts, How Marketing Management changed. How does the Marketing affect customer Value? Discussion on Project Outline
- Identifying Market Segments and Targets. Different levels of market segmentation & requirements of effective segmentation? How companies divide a market into segments?
- Creating and delivering Customer Value, satisfaction and loyalty. What is the lifetime value of customers and how can marketers maximize it? How can companies cultivate strong customer relationship? How can companies both attract and retain customers?
- Analyzing Consumer Markets & Globalization How do consumer characteristics influence buying behavior & major psychological processes influence consumer Reponses to the marketing program?
- Crafting the Brand Positioning How can a firm choose and communicate an effective positioning in the market & how brands are differentiated.
- Creating Brand Equity Neuro Marketing How brands create brand Equity
- Setting Product Strategy Product characteristics & classification How companies differentiate products?
- How should a company set prices initially for products or services? When should company initiate a price change? How should a company respond to a competitor's price change?
- Designing and Managing Value Networks and Channels. The students need to recognize the importance of designing marketing channel system
- Managing Retailing, Wholesaling Why companies choose different marketing channels and how these marketing channels perform?
- Designing & Managing Integrated Marketing Communications Role of Marketing Communication. What are the guidelines for effective marketing communication mix?
- Managing Mass Communications: What steps are required in developing an advertising program? How should sales promotion decisions be made?

What are the guidelines for effective brand-building events and experiences?

- Sales Promotions, Events Public Relations. Service Marketing------Presentation

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Marketing Management 16th Edition (A South Asian Perspective) by Philip Kotler & Kevin Lane Keller.
2. Basic Marketing (1st Edition) by Salman Zaheer
3. Blue Ocean Strategy by Renée Mauborgne and W. Chan Kim

LEADERSHIP AND PERSONAL GROOMING

Credit Hours: 02
Pre-Requisites: Nil

COURSE OUTLINE

Fundamentals of Leadership and Servant Leadership

- What is leadership; Leadership Traits; Servant Leadership

Foundations of Community Development

- The frame work for community and economic development; Seven theories for seven community developers; Bases of community development; Process of community development; Challenges of the process

Social Capital, Community Building and Community Development Practice

- Social capital; Community social capacity and how does it influence development • Intentional action to increase social capacity; Factors that influence the success of community-building efforts; Principles and process of practicing community development; How does community development practice relate to economic development? Professional standards of ethical practices in community development

Community development assessment,

- Community Asset mapping and surveys, Assessing local economy.
- Community Mapping; Surveys Forms; The importance of asset mapping.

Building Powerful Community Organizations

- Bringing a group together; Scanning the functions of Community Organizations present in the market; The idea generation; Developing Vision, Mission and Goals; Structuring the Organization; Defining SOPs

Marketing your Organization

- Marketing a Community Organization; Effective role and guidelines for conducting meetings

Mobilizing Resources: Raising Money

- Community development finance; Finding sources of money; Securing grants for community development projects; Preparing grant proposals

Measuring Progress

- Community development indicators, Best practices & Benchmarking

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. The heart of leadership: A leader people want to follow by Mark Miller, Berret-Kohler Publisher 2013.
2. Leadership and Art of Struggle by Steven Snyder & B. Geage Berret Kohler Publisher 2013.
3. Strategic Leadership: How to think and plan by John Adair, Kogan Page Ltd 2010

ENTREPRENEURSHIP

UGE Policy V1.1: General Education Course

Credits: 02
Pre-Requisites: Nil

DESCRIPTION

This course is designed to promote entrepreneurial spirit and outlook among students, encouraging them to think critically, identify opportunities, and transform their ideas into successful ventures. It aims at imparting them with the requisite knowledge; skills and abilities, enabling them to seize the identified opportunities for initiating ventures and successfully navigating the challenges that come with starting business and managing it. The course covers topics relevant to entrepreneurship including setting up and initiation of business (including requirements for registration and incorporation with regulators such as SECP and others), market research, opportunity identification, business planning, financial literacy for managing finances and securing funding, marketing and sales, team building and innovation. Overall, the course is geared towards personal growth and professional development for pursing innovative ideas, availing opportunities and initiating start-ups.

COURSE LEARNING OUTCOMES

By the end of this course, students shall have:

1. Knowledge of fundamental entrepreneurial concepts, skills and process;
2. Understanding on different personal, social and financial aspects associated with entrepreneurial activities;
3. Basic understanding of regulatory requirements to set up an enterprise in Pakistan, with special emphasis on export;
4. Ability to apply knowledge, skills and abilities acquired in the course to develop a feasible business plan for implementation.

COURSE OUTLINE

1. **Introduction to Entrepreneurship:**
   - Definition and concept of entrepreneurship;
   - Why to become an entrepreneur?
   - Entrepreneurial process;
   - Role of entrepreneurship in economic development.
2. **Entrepreneurial Skills:**
   - Characteristics and qualities of successful entrepreneurs (including stories of successes and failures);

- Areas of essential entrepreneurial skills and ability areas such as creative and critical thinking, innovation and risk taking.

3. **Opportunity Recognition and Idea Generation:**
   - Opportunity identification, evaluation and exploitation;
   - Idea generation techniques for entrepreneurial ventures.
4. **Marketing and Sales:**
   - Target market identification and segmentation;
   - Four P's of Marketing;
   - Developing a marketing strategy;
   - Branding.
5. **Financial Literacy:**
   - Basic concepts of income, savings and investments;
   - Basic concepts of assets, liabilities and equity;
   - Basic concepts of revenue and expenses;
   - Overview of cash-flows;
   - Overview of banking products including Islamic modes of financing;
   - Sources of funding for startups (angel financing, debt financing, equity financing etc.)
6. **Team Building for Startups:**
   - Characteristics and features of effective teams;
   - Team building and effective leadership for startups
7. **Regulatory Requirements to Establish Enterprises in Pakistan:**
   - Types of enterprises (e.g., sole proprietorship; partnership; private limited companies etc.);
   - Intellectual property rights and protection;
   - Regulatory requirements to register an enterprise in Pakistan, with special emphasis on export firms;
   - Taxation and financial reporting obligation.

PRACTICAL REQUIREMENTS

As part of the overall learning requirements, students shall be tasked with presenting a comprehensive business plan at the end of the course for a hypothetical or real business idea. This practical exercise will allow them to apply the knowledge, skills and abilities acquired in the course to develop a feasible business plan and where possible explore the possibility of implementing the plan with support and assistance from established business-persons and entrepreneurs.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Entrepreneurship: Successfully Launching New Ventures" by Bruce R. Barringer and R. Duane Ireland.
2. "Entrepreneurship: Theory, Process, and Practice" by Donald F. Kuratko.

3. "New Venture Creation: Entrepreneurship for the 21st Century" by Jeffry A. Timmons, Stephen Spinelli Jr., and Rob Adams.
4. "Entrepreneurship: A Real-World Approach" by Rhonda Abrams.
5. "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses" by Eric Ries.
6. "Effectual Entrepreneurship" by Stuart Read, Saras Sarasvathy, Nick Dew, Robert Wiltbank, and Anne-Valérie Ohlsson.

PROJECT MANAGEMENT

Credits: 02
Pre-Requisite: Nil

DESCRIPTION

The primary objective of this course is to get the fair understanding of core issues pertaining to Engineering Project Management. This course is aimed at providing both basic and some advanced exposure to emerging trends in the field of Project Management, so as to enable the engineering professionals of tomorrow to successfully complete sophisticated projects within the constraints of capital, time, and other resources with due regards to stakeholders set of expectations. Engineering students will learn key Project Management skills and strategies and will be able to face emerging challenges.

COURSE LEARNING OUTCOMES

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

1. To develop competencies in project costing, budgeting, and financial appraisal;
2. To gain exposure to project Planning Control and Management, using standard tools and schedule variance analysis;
3. To appreciate the elements of risk and quality in hi-tech projects;
4. To learn Project Management by "practice", through the medium of "End of Semester Group Project"
5. To appreciate and understand the use of computers in Project Management, especially a tool like MS Project & Primavera etc.

COURSE OUTLINE

- **Project Management Concepts**

  History of Project Management, Introduction to Project Management, Project, Program & Portfolio Management, Project characteristics, Objectives& Requirements, Project Phases/Stages, Project Life Cycle, Project Environment, Project Scope & Project Charter, Project Manager, Project Stakeholder Analysis
- **Project Proposal Development**
  Project Proposal, Characteristics of good proposal, Types of Proposals, Request for Proposal, Request for Quotation etc). Proposal Templates etc
- **Project Feasibility**
  Brief review of various aspects of Project Feasibility like Technical, Social, Managerial, Economic, Financial & Marketing, Administrative etc.
- **Project Selection Criteria (Economic Analysis of Engineering Projects)**
  Using Break Even Analysis, Cost Benefit Ratio, Internal Rate of Return, Net Present Value etc.

- **Project Contract & Procurement Management**
  Engineering contracts, Type of contracts, understanding of procurement Process & Cycle, PPRA Rules
- **Project Planning and Scheduling**
  Project Planning (Resource & HR Planning), Work Breakdown Structure, Project Network & Scheduling, Manning Schedule and Activity Charts, Critical Path Method (CPM)/Project Evaluation & Review Techniques
- **Project Costing & Estimation**
  Cost Estimation in Projects, Cost components in projects and methods for cost estimation in projects, Cost Control in Projects, Estimation of Outstanding Work, Earned Value Management, Schedule & cost variance analysis
- **Project HRM & Communication Management**
  Effective organization and communication for Successful Projects, Project Organizational Structures (Project matrix and project based organizations), Project HR Plan preparation, HR Need Assessment and HR Matrix, Building and Managing effective project team, Selection & control mechanism of HRM in Projects, Effective Communication Plan.
- **Project Risk Management**
  Definitions Project Risk, Project Risk Management Tools, Types of Project Risk, Project Risk Assessment, Risk Identification and Mitigation, Monitoring & Controlling Risk, Generic Risk Management Strategies & Technique.
- **Computer Application in Project Management**
  Basic/Elementary Introduction and hands on basic exposure of use of MS Project & Primavera P6 Software in Project Management
- **Project Quality Management**
  Defining Quality, Quality Assurance, Quality Management, 7 Quality Improvement Tools as applied to Project Management, Project Quality Management Plan, Quality Management Processes and Strategies
- **Project Closure & Termination**
  Project Evaluation, defining project success, Project Completion Criteria, Project Audit, Project Termination &When to close a project, the termination process, Project Close Up & lesson learnt, & Project Archive

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids),Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Project/Field Visits Group discussion, Community Service, Report Writing Social Impact Review and Social Audit of Engg Project

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

SUGGESTED INSTRUCTIONAL/READING MATERIALS

1. Project Management: A system Approach to Planning, Scheduling and Controlling 11th Edition, Harold Kerzner
2. Bennett, F. Lawrence. 1996. The management of engineering. New York: Wiley
3. Cleland, David. Field guide to project management. New York: Wiley.
4. Eisner, H. Essentials of project management and systems engineering management. New York: Wiley
5. Frame, J. D. Managing projects in organizations. San Francisco: Jossey-Bass
6. Goldratt, Eliyahu. Critical chain. North River Press
7. Haynes, M.E. Project management: From idea to implementation. Los Altos, CA: Crisp Publications.
8. Lewis, James, Project planning, scheduling & control. New York: McGraw-Hill
9. Lewis, James, P. 1998. Mastering project management. New York: McGraw-Hill
10. Lientz, Bennet & Rea, Kathryn. 1995. Project management for the 21st century. San Diego: Academic Press.
11. Miller, Roger & Lessard, Donald. 2000. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
12. Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall
13. Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. 1994. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall
14. Project Management by Adrienne Watt
15. J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. 2019. (Reference).

APPLICATIONS OF ICT
UGE Policy V1.1: General Education Course

Credits: 2+1=3
Pre-Requisite: Nil

DESCRIPTION

This course is designed to provide students with an exploration of the practical applications of Information and Communication Technologies (ICT) and software tools in various domains. Students will gain hands-on experience with a range of software applications, learning how to leverage ICT to solve daily life problems, enhance productivity and innovate in different fields. Through individual and interactive exercises and discussions, students will develop proficiency in utilizing software for communication, creativity, and more.

COURSE LEARNING OUTCOMES

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

1. Explain the fundamental concepts, components, and scope of Information and Communication Technologies (ICT).
2. Identify uses of various ICT platforms and tools for different purposes.
3. Apply ICT platforms and tools for different purposes to address basic needs in different domains of daily, academic, and professional life.
4. Understand the ethical and legal considerations in use of ICT platforms and tools.

COURSE OUTLINE

1. **Introduction to Information and Communication Technologies:**
    - Components of Information and Communication Technologies (basics of hardware, software, ICT platforms, networks, local and cloud data storage etc.).
    - Scope of Information and Communication Technologies (use of ICT in education, business, governance, healthcare, digital media and entertainment, etc.).
    - Emerging technologies and future trends.
2. **Basic ICT Productivity Tools:**
    - Effective use of popular search engines (e.g., Google, Bing, etc.) to explore World Wide Web.
    - Formal communication tools and etiquettes (Gmail, Microsoft Outlook, etc.).
    - Microsoft Office Suites (Word, Excel, PowerPoint).
    - Google Workspace (Google Docs, Sheets, Slides).

- Dropbox (Cloud storage and file sharing), Google Drive (Cloud storage with Google Docs integration) and Microsoft OneDrive (Cloud storage with Microsoft Office integration).
- Evernote (Note-taking and organization applications) and OneNote (Microsoft's digital notebook for capturing and organizing ideas).
- Video conferencing (Google Meet, Microsoft Teams, Zoom, etc.).
- Social media applications (LinkedIn, Facebook, Instagram, etc.).

3. **ICT in Education:**
   - Working with learning management systems (Moodle, Canvas, Google Classrooms, etc.).
   - Sources of online education courses (Coursera, edX, Udemy, Khan Academy, etc.).
   - Interactive multimedia and virtual classrooms.
4. **ICT in Health and Well-being:**
   - Health and fitness tracking devices and applications (Google Fit, Samsung Health, Apple Health, Xiaomi Mi Band, Runkeeper, etc.).
   - Telemedicine and online health consultations (OLADOC, Sehat Kahani, Marham, etc.).
5. **ICT in Personal Finance and Shopping:**
   - Online banking and financial management tools (JazzCash, Easypaisa, Zong PayMax, 1LINK and MNET, Keenu Wallet, etc.).
   - E-commerce platforms (Daraz.pk, Telemart, Shophive, etc.)
6. **Digital Citizenship and Online Etiquette:**
   - Digital identity and online reputation.
   - Netiquette and respectful online communication.
   - Cyberbullying and online harassment.
7. **Ethical Considerations in Use of ICT Platforms and Tools:**
   - Intellectual property and copyright issues.
   - Ensuring originality in content creation by avoiding plagiarism and unauthorized use of information sources.
   - Content accuracy and integrity (ensuring that the content shared through ICT platforms is free from misinformation, fake news, and manipulation).

PRACTICAL REQUIREMENTS

As part of overall learning requirements, the course will include:

1. Guided tutorials and exercises to ensure that students are proficient in commonly used software applications such as word processing software (e.g., Microsoft Word), presentation software (e.g., Microsoft PowerPoint), spreadsheet software (e.g., Microsoft Excel) among such other tools students may be assigned practical tasks that require them to

create documents, presentations and spreadsheets etc.

2. Assigning of tasks that involve creating, managing, and organizing files and folders on both local and cloud storage systems.. students will practice file naming conventions, creating directories, and using cloud storage solutions (e.g., Google Drive, OneDrive).
3. The use of online learning management systems (LMS) where students can access course materials, submit assignments, participate in discussion forums, and take quizzes or tests. This will provide students with the practical experience with online platforms commonly used in education and the workplace.

SUGGESTED INSTRUCTIONAL/ READING MATERIALS

1. "Discovering Computers" by Vernmaat, Shaffer, and Freund.
2. "GO! With Microsoft Office" Series by Gaskin, Vargas, and McLellan.
3. "Exploring Microsoft Office" Series by Grauer and Poatsy
4. "Computing Essentials" by Morley and Parker
5. "Technology in Action" by Evans, Martin and Poatsy

CALCULUS AND ANALYTICAL GEOMETRY

Credit Hours: 03
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

1. To develop a clear understanding of fundamental concepts of single variable calculus
2. To apply concepts of differentiation and integration to solve complex engineering problems

COURSE OUTLINE

1. **Analytical Geometry:**
   - Review of vectors, scalars and vector products.
   - Three dimensional coordinate system and equation of straight line and plane
2. **Functions Limit and Continuity**
   - Review of functions and graphs,
   - Limits & Continuity,
   - Techniques of Finding Limits,
   - Discontinuity,
   - Limits of Sine and Cosine and Exponential Functions
3. **Differentiation:**
   - Introduction to Derivatives
   - Examples of Derivatives
   - Derivative as Rate of Change
   - Derivative's Rules
   - Implicit Differentiation
   - Higher order derivative
   - Leibnitz Theorem
4. **Applications of Derivatives:**
   - Applications of Derivatives
   - Monotonic functions
   - Optimization problems
   - Relative and Absolute extrema
   - First and second derivative tests
   - Point of inflection
   - Concavity
   - Curvature
   - Indeterminate Forms and L' Hospital rule
   - Differentials

5. **Integration:**
   - Integrals and Properties of Integrals
   - Techniques of Integration
   - Integration by Parts
   - Definite Integrals
   - Integration of Trigonometric
   - Exponential and Inverse Functions
   - Integration by Partial Fractions
   - Reduction Rules
6. **Applications of Integration:**
   - Applications of Integration
   - Area under the curve
   - Area between curves
   - Solids of Revolution
   - Volume of Solids of revolution by disk
   - washer, Cylindrical shell & Cross Section Methods
   - Center of Pressure and Depth of Center of Pressure
   - Center of mass
   - Arc length
7. **Improper Integrals:**
   - Improper Integral
   - Integrals and Singularities
   - Convergence of improper integrals
8. **Infinite Sequence and Series:**
   - Sequence and Infinite Series
   - Convergence and Divergence of sequences and series
   - Positive Term Series
   - Integral Test
   - Basic Comparison Test
   - Limit Comparison Test
   - Ratio and Root tests
   - Alternating series
   - Absolute and Conditional Convergence
9. **Power and Taylor Series:**
   - Power series
   - Maclaurin and Taylor Series and its Applications

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass, Pearson, USA.
2. Swokowski, Onlinick & Pence: Calculus
3. Robert T. Smith & Roland B. Minton: Calculus
4. Calculus: Early Transcendentals by James Stewart. Brooks/Cole USA.

COMPLEX VARIABLES & TRANSFORMS

Credit Hours: 03
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. Explain the concept of complex number system, complex function, limit, continuity, differentiability and integral of complex valued functions
2. Utilize the theory of complex integration and power series (Taylor series. Laurent series) to solve problems from the area of residue calculus
3. Apply various transforms to solve complex integration.

COURSE OUTLINE

1. **Introduction:**
   - Review of complex numbers, Complex valued functions, Elementary functions (exponential and logarithmic functions, Trigonometric and hyperbolic functions and theirs inverses),
   - Limits and continuity,
   - Applications in Engineering

2. **Complex Differentiation and Integration**
   - Derivatives of complex valued functions, Differentiability,
   - Analyticity, Cauchy Riemann Equations, Harmonic Functions,
   - Complex integrals, Cauchy-Goursat Theorem, Independence of Path, Cauchy's Integral Formulas and Their Consequences, Applications
3. **Power Series:**
   - Taylor Series, Laurent Series, Singularities, Zeros and poles, Residue integration method, Residue theorem,
   - Conformal mapping
4. **Laplace Transformation:**
   - Linearity, Scaling, First shifting theorem, Heaviside's Shifting theorem,
   - Inverse Laplace transformation, Properties of inverse Laplace,
   - Convolution theorem, Applications in relevant engineering discipline
5. **Special functions and Fourier Transforms:**
   - Gamma, Beta functions, Periodic functions, Error function,

- Fourier Series, Fourier Sine and Cosine series,
- Fourier transform, Fourier cosine and sine transform, properties.
- Applications in relevant engineering discipline

6. **Z-Transformation:**
   - Z-transform, Properties of Z-transform, linearity and scaling, Standard Z-transform, Inverse Z-transform,
   - Inverse Z- transform by using residue, convolution theorem of Z-transform,
   - Formation of difference equation and its solution using Z-transform.

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Advanced Engineering Mathematics, by Erwin Kreyszing, Latest Edition
2. Complex Variables and Applications by Churchill, Latest Edition
3. R. J. Beerends, Fourier and Laplace Transform, Cambridge University Press, Latest Edition.
4. Jeffry A, Advanced Engineering Mathematics, Elsevier, Latest Edition

LINEAR ALGEBRA

Credit Hours: 02
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To comprehend basic concepts of Linear Algebra and optimization
2. To apply techniques of Linear Algebra and optimization for solution of engineering problem.

COURSE OUTLINE

1. **System of Linear Equations and Applications**
   - Overview of linear system of equations, Cases of unique solution, No solution and infinite solutions,
   - Echelon form, Gauss elimination method, Inversion of matrix in the context of solution of system of equations, LU factorization, Row space and column space
   - Relevant engineering case studies such as Network analysis, Traffic Flows, Balancing chemical reaction, Leontief Input-output model, Finding max stress in compound cylinder, Applications of linear systems in force balancing of structures, Markov process
2. **Vector Spaces and Transformations**
   - Vector Spaces: Real vector spaces, Subspaces, Basis and dimension, Rank, Nullity
   - Gram-Schmidt process for finding orthonormal basis
   - Linear Transformation, Kernel of Transformation, Range of Transformation, Matrix of Transformation,
   - Applications: Cryptography, Coding and decoding, Breaking of codes, Robotic Applications of linear transformations
3. **Eigenvalues and Eigen Vectors**
   - Eigenvalues, Eigenvectors, Similar matrices, Diagonalization,
   - Quadratic forms, Positive definite Matrices, Singular Value Decomposition, Inner product Spaces
   - Applications of linear Algebra: Constructing curves and surfaces, Computer graphics, Genetics
4. **Linear Programming**
   - Solution Introduction to linear programming, Optimization, Graphical method, Simplex method, Optimization problems in engineering and economics
   - Dual simplex methods, Duality theory, Primal and dual problems,

transportation models, north-west corner, least-cost and Vogel's approximations methods,
- Assignment model, the transshipment model and other relevant engineering case studies

5. **Application of Linear Algebra in Dynamical Systems**
   - Numerical System of linear ODEs, Eigenvalue problems, Homogeneous and nonhomogeneous system of ODE.
   - Dynamical systems, Population dynamics, Prey-Predator models, Stability analysis

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Introductory Linear Algebra: By Bernard Kolman and David R. Hill, Latest Edition.
2. Elementary Linear Algebra: By Howard Anton and Chris Rorrers, Latest Edition.

DIFFERENTIAL EQUATION

Credit Hours: 02
Pre-Requisites: Nil

COURSE LEARNING OUTCOMES

The knowledge units in this area collectively encompass the following:

1. To define basic mathematical concepts related to differential equations
2. To describe different types of analytical methods for solution of differential equations
3. To formulate different engineering problems in the form of differential equations

COURSE OUTLINE

1. **Basic Concepts and Modelling**
   - Linear Differential equations, Non-Linear, Differential equations, Solutions of differential equations, General solutions, Particular solutions, Initial and boundary value problems, Degree and order of ODEs
   - Formulation of first-order ODEs: Case studies related to finding age of fossils, Mixing problems and free fall motion, Finding temperature of a building, RL, RC circuits, Airplane take-off problem, Population dynamics and logistic equations etc.
2. **Analytical Methods of Solution for First-order ODEs**
   - Variable separable method, Reduction to variable separable form, Homogeneous equations, Differential equations reducible to homogeneous form, Solution of the related ODE models by these methods
   - Exact equations, Integrating factors, Linear equations and related examples, Bernoulli's equations, Orthogonal trajectories and solution of the related ODE models by these methods
3. **Mathematical Models Based on Second-order ODEs**
   - Formulation of a single RLC circuit, Spring mass systems, Earthquake model of a single story building
   - Bungee Jumper model, Bridge collapse problem etc.
4. **Analytical Methods of Solution for Second-order ODEs**
   - Homogeneous linear ODEs, Method of reduction order , Wronskain determinant to check independence of the solution, and related examples
   - Cauchy-Euler equations and related examples, Non-homogeneous linear ODEs, Method of undetermined coefficients
   - Method of variation of parameters and related example
   - Analytical solution of the related ODE models by these methods

5. Series Solution for Second-order ODEs
- Series solution of ODEs and convergence tests
- Series solution of Legendre equation, Frobenious method of solution for Bessel equation and related applications

6. Laplace Transform
- Laplace Transform, Derivation of Basic formulae, Inverse Laplace Transform, First shift theorem
- Laplace transform of integrals and derivative, Solution of second order ODEs by Laplace Transform, Unit step function and its Laplace transform, Second shift theorem, Convolution
- Application of Laplace transform to a system of ODEs and related applications

7. Partial Differential Equations
- Partial Differential Equations and their types, Applications of partial differential equations in Engineering
- Method of Separation of Variables Method (MSVM) and solution of wave equation by the MSVM
- Method of Separation of Variables Method (MSVM) and solution of heat equation by the MSVM

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Advanced Engineering Mathematics by Erwin Kreyzig, John Wiley & Sons Inc. Latest Edition.
2. Differential Equation with Boundary Value problems by D. G. Zill, M. R Cullen Latest Edition, Brooks/Cole Publishers.
3. A First Course on Differential Equations with Modelling Applications by D. G. Zill, Latest Edition, Brooks/Cole Publishers.
4. An Introduction to Mathematical Modelling by Bender, E.A., Latest Edition, Wiley, New York.

APPLIED PHYSICS

Credit Hours: 2+1 =3
Pre-Requisites: Nil

DESCRIPTION

An Applied Physics course covers fundamental topics such as vectors, mechanics, electrostatics, and magnetism, providing a strong foundation in classical physics. It then delves into specialized areas like semiconductor physics, exploring the behavior of materials crucial to modern electronics. Additionally, students study waves, oscillations, optics, and lasers, exploring into the principles behind light and its applications. The course may conclude with an overview of modern physics, offering insights into cutting-edge research and technologies.

COURSE OUTLINE

1. **Vectors:**
- Review of vectors, Ordinary Differentiation of Vector, Gradient of Scaler field, Divergence and Curl of Vector Field, Line and Surface Integrals with applications.

2. **Mechanics:**
- Newton Laws and their Applications(Simple Accelerometer, Banked Curve and Rotor), Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of law of Conservation of Energy, Angular Momentum, Centre of Mass of two-particles, Many-particles and Solid Object, Rotational Inertia of Solid Bodies.

3. **Electrostatics And Magnetism:**
- Electric field due to Discrete and Continuous Charge Distribution, Electrostatic Potential of discrete and Continuous charges, Applications of Gauss's Law, Lorentz Force and Hall effect, Ampere's Law, Magnetic Field due to Circular Current Loop and Solenoid, Magnetic dipole, Atomic and Nuclear Magnetism, Magnetization, Magnetic Materials.

4. **Semiconductor Physics:**
- Energy levels in a Semiconductor, Hole concept, Intrinsic and Extrinsic regions, Law of Mass Action. P-N junction, Transistors

5. **Waves And Oscillations:**
- Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation and Resonance, Types of Wave and Superposition Principle, Wave Speed on a stretched string. Wave equation, Energy & Power of a Wave.

6. **Optics And Lasers:**
- Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving

power of Optical Instruments. Principles for Laser action, Types of Laser, Applications of Laser.

7. **Modern Physics:**

- Planck's explanations of Black Body Radiation Photoelectric Effect, Compton Effect, De-Broglie Hypothesis, Electron Microscope, Atomic structure, X-rays and Moseley's Law, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating, Radiation Detection Instruments, Nuclear Reactions

COURSE OUTLINE (PRACTICALS)

Note: "Labs/ Practical: The course practical/labs should be defined and synchronized with the course outline"

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessmen t Methods

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Physics, By: Halliday, Resnick & Krane, Edition: 10th Edition.
2. University Physics, BY: Hugh D. Young and R.A. Freedman, EDITION: 12 Physics for Scientist & Engineers, BY: Serway, Jewett, (latest edition)

Proposed Electives for Natural Science (3+0)
• Multivariable Calculus • Discrete Mathematics • Numerical Analysis • Applied Chemistry • Biology or any related course appropriate for the program.

MULTIVARIABLE CALCULUS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Geometry of Space

- Analytical Space Geometry, Cylindrical and Spherical coordinates, Lines in space, Intersection of Line and a Plane

Vector-Valued Functions and Motion in Space

- Functions of several variables, their limits and continuity, Quadratic Surfaces, Parametric representation of curves, Velocity and Acceleration, Arc length, Tangent, Normal, Bi-normal, Curvature & Torsion

Partial Differentiation

- Partial derivatives, Total Differentials, Chain Rule with More Variables, Directional derivatives

Applications of Partial Derivatives

- Optimization Problems, Extrema of functions of several variables, Conditional extrema, Lagrange Multipliers and Example

Multiple Integrals

- Double Integration, Order of Integration, Double Integrals in Polar Coordinates, Applications: Mass and Average Value, Moment of Inertia, Triple Integrals, Rectangular and Cylindrical Coordinates, Applications and Examples, Triple Integrals in Spherical Coordinates

Vectors in 3 Space

- Introduction to vectors, Scalar and vector product, Volume of parallelepiped and tetrahedron, Gradient of a Scalar Field, Divergence of a Vector Field, Curl of a Vector Field

Integration in Vector Fields

- Line Integral, Integration Around Closed Curves. Work Done, Potential and Related Examples, Conservative and non-Conservative Fields, Green's Theorem, Divergence Theorem, Stoke's Theorem, Applications of Double and Triple integrals

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass. Pearson, USA.
2. George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry
3. Swokowski, Onlinick & Pence: Calculus
4. Robert T. Smith & Roland B. Minton: Calculus
5. Calculus: Early Transcendental by James Stewart, Brooks/Cole USA

DISCRETE MATHEMATICS

Credit Hours: 03
Pre-Requisites: Nil

COURSE OUTLINE

- Number Theory. Introduction to Sets. Set operations and properties. Venn diagrams.
- Sequences and Strings.
- Relations.
- Functions.
- Propositional logic. Conditional propositions and logical equivalence.
- Proofs. Rules of inference. Mathematical induction and recursion.
- Matrices.
- Revision
- Boolean Algebra
- Algorithms, integers and recursion.
- Counting Techniques
- Introducing graphs and trees.
- Algebraic structures.
- Languages and Grammars.
- Finite state machines.
- Revision

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Kenneth H.Rosen, "Discrete Mathematics and Its Applications", 7th Edition, McGraw Hill Books Co., 2012
2. Richard Johnsonbaugh, "Discrete Mathematics", 8th Edition, Pearson Education Asia, 2018.

NUMERICAL ANALYSIS

Credit Hours: 03
Pre-Requisites: Nil

COURSE OUTLINE

Error Analysis and Interpolation

- Error analysis, Types of error, Sources of error, Norms of vectors and matrices, Computer arithmetic, Condition number of a matrix, Significant digits and loss of significant digits, Floating point arithmetic, Binary and decimal representation, Single and double precision
- Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Linear least square approximation, Interpolation versus least square approximation, Relevant engineering case studies

Numerical Differentiation and Integration

- Derivation of numerical differentiation of first order and second order derivatives using two points, three points, and five points formulas along with its application in engineering, Relevant case studies
- Numerical integration: Trapezoidal rule, Simpson's rules, Composite Trapezoidal Simpson Rules and Romberg integration, Applications of numerical in engineering, Relevant case studies

Methods of solution a system of Linear Equations

- Solution of system of linear algebraic equations, Gauss elimination method
- LU factorization, Tridiagonal solver
- Applications of these methods in engineering disciplines, Relevant case studies

Iterative Methods for Linear and Nonlinear Equations

- Numerical Solution of nonlinear equations: Bisection method, Newton's method, Secant method, Convergence analysis of these methods
- Newton's method for system of nonlinear equations
- Solution of system of linear equations by Jacobi, Gauss Seidel and SOR methods, Applications of these methods in engineering disciplines, Relevant case studies.

Numerical Methods for IVPs and BVPs

- Euler's method and its variations, Taylor's higher order methods, Error analysis, Consistency, stability and convergence.
- Runge-Kutta methods of order 2, 3, and 4, Stiff ODEs, Consistency, stability and convergence

- Linear multistep methods, Numerical solution of system of ODEs
- Numerical solution of BVPs by Finite Difference Method
- Applications in engineering: Some relevant case studies

Numerical Methods for Computing Eigenvalues

- Eigenvalues and Eigenvectors of matrix: power method; Inverse power method, Shifted inverse power method; Applications of eigenvalues in engineering disciplines.

Numerical Optimization

- Unconstrained Optimization, Golden search ratio, Lagrange Multipliers, Method of steepest descent Applications of optimization in engineering disciplines

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Numerical Analysis: By Richard L. Burden, J. Douglas Faires, Latest Edition
2. Numerical methods for scientist and engineers by R.W. Hamming (Latest Edition)
3. Numerical methods for Engineers by Steven C. Chapra and R. P. Canale (Latest Edition)

APPLIED CHEMISTRY

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

- Basic of Elemental Chemistry, Electrochemistry, Conductive metals, Conductance and Resistance of various metals, Electrode Fabrication, Electrolytic Cells, Galvanic Cells, Cell potentials, Modification of Batteries, Transistors, resistors, capacitors and inductors modification, Corrosions, Surface Chemistry.
- Fabrication of computer chips, Solder: New requirements for lead-free fabrication to a leadfree solder. Liquid Cooling. Various coolants and their level of cooling
- Introduction and laws of Thermodynamics & heat transfer, Heat of Reactions, Entropy, Heat of Combustion & Formation, Endothermic and Exothermic Reactions & Factors involved, Fluid Chemistry, Fluids types and its Properties, Fluids and Electrolytes.
- Mechanics of Materials: Nature properties and Electrical composition of materials, ceramics, metals, Characterization of materials by using Spectroscopic Techniques, Tribology

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Fundamentals of Thermal Fluid Sciences" Yunus A. Cengel and Co-authors McGrawHill Education; latest edition.
2. "Essentials of Polymer Science and Engineering" Paul C Painter and Co-authors, DEStech Publications, latest edition.
3. Power Electronics Handbook, 4th Ed. by Muhammad H Rashid, Elsevier Inc. latest edition.
4. Advances in Heat Transfer, Edited by Ephraim M. Sparrow, John P. Abraham, John
5. M. Gorman, W. J. Minkowycz, Volume 51 Elsevier Ltd, latest edition

6. Handbook of Green Information and Communication Systems, Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, Elsevier Inc, latest edition
7. Interstellar Molecules, Their Laboratory and Interstellar Habitat, Editors: Yamada, Koichi M. T., Winnewisser, Gisbert (Eds.), Springer-Verlag Berlin Heidelberg, latest edition.
8. Recent Advances in Spectroscopy, Theoretical, Astrophysical and Experimental, latest edition.
9. Perspectives, Editors: Chaudhuri, R.K., Mekkaden, M.V., Raveendran, A.V., Narayanan, A.S. (Eds.), Springer-Verlag Berlin Heidelberg, latest edition.
10. Nanoscale, Authors: Oscar Alejandro Oviedo, Luis Reinaudi, Silvana Graciela
11. García, Ezequiel Pedro Marcos Leiva, Editor: Fritz Scholz, Publisher: Springer, latest edition
12. Electrical Energy Systems - Foundations, Energy Storage and Conversion, Artur Braun, Publisher: De Gruyter, latest edition“
13. An Introduction to Electrochemistry, By S. Glasstone, Publisher Maurice Press, latest edition.
14. “Advanced Heat and Mass Transfer” Amir Faghri, Yuwen Zhang, John Howell, Global Digital Press, latest edition
15. Introduction to Thermal Sciences” Frank W. Schmidt and Co-authors, Wiley; latest edition

17.2 Engineering Domain

COMPUTER PROGRAMMING

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

- Introduction to problem solving
- Brief review of Von-Neumann architecture,
- Introduction to programming,
- Role of compiler and linker, Introduction to algorithms
- Basic data types and variables
- Input/output constructs
- Arithmetic, comparison and logical operators,
- Conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements
- Lists and their memory organization, multi-dimensional lists,
- Introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, arrays, pointers/references, static and dynamic memory allocation, File I/O operations.
- Recursion and Searching Algorithms
- Sorting Algorithms
- Graphs and Graph Algorithms
- Trees and Binary Search Trees
- Exception Handling and Debugging
- Programming language: C/C++/ Java/ Python.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing.

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Starting out with Python, 4th Edition, Tony Gaddis.
2. Starting out with Programming Logic & Design, 4th Edition, Tony Gaddis,
3. The C Programming Language, 2nd Edition by Brian W. Kernighan, Dennis M. Ritchie
4. Object Oriented Programming in C++ by Robert Lafore

5. Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition by Guttag, John
6. Practice of Computing Using Python, 3rd Edition by William Punch & Richard Enbody
7. C How to Program, 7th Edition by Paul Deitel& Harvey Deitel
8. Problem Solving and Program Design in C++, 7th Edition by Jeri R. Hanly& Elliot Koffman

DATA STRUCTURES AND ALGORITHMS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Data Structures and Algorithms

- Overview of data structures and algorithms.
- Basic concepts of complexity analysis
- Notations and asymptotic analysis.

Abstract data types

- Complexity analysis
- Big Oh notation
- Stacks (linked lists and array implementations)
- Recursion and analyzing recursive algorithms.
- Divide and conquer algorithms.

Sorting algorithms

- Selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues)
- Linked list & its various types
- Sorted linked list
- Searching an unsorted array
- Binary search for sorted arrays

Hashing and indexing

- Open addressing and chaining
- Trees and tree traversals,
- Binary search trees, heaps
- M-way tress,
- Balanced trees
- Graphs
- Breadth-first and depth-first traversal
- Topological order
- Shortest path, adjacency matrix and adjacency list implementations
- Memory management and garbage collection

Dynamic Programming:

- Introduction to dynamic programming
- Memorization and tabulation techniques

- Applications of dynamic programming
- Introduction to greedy algorithms
- Greedy algorithms and optimization problems
- Applications of greedy algorithms
- Introduction to searching algorithms
- Linear search, binary search
- Time complexity analysis of searching algorithms

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

Assessment:

Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Data Structures and Algorithms in C++ by Adam Drozdek
2. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
3. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
4. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss
5. Java Software Structures: Designing and Using Data Structures by John Lewis and Joseph Chase

ELECTRICAL WORKSHOP PRACTICE

Credit Hours: 0+1=1
Pre-Requisites: Nil

COURSE OUTLINE

Workshop safety
- Demonstration of safety equipment
- Tools and safety gear in accordance with safety regulations
- Electric shock treatment.

Measurements
- Measurement of bolt using Vernier calipers, micrometer, and thread pitch gauge
- Familiarization with different bench fitting tools and equipment.

Preparation of Work Piece
- Preparation of work pieces of required dimensions and joining of metal work pieces in lap, butt and T-joints using electric arc welding

Familiarization with Lathe Machine
- Introduction to a lathe machine, its parts, accessories, and operations

Familiarization with Electric Cables and Switching Devices
- Familiarization with the types of cables and electric accessories including switches, plugs, circuit breakers, fuses etc., comprehending their symbols for electrical wiring schematics.

Wiring Circuits & Earthing Concepts
- Assembling a parallel electric wiring circuit for a hotel and its testing in accordance with wiring regulations.
- Demonstration of earthing concepts and installation of an earthing cable

Assembling and disassembling of a computer system
- Assembling and dissembling of a modern computer system along with its accessories.

Introduction to Circuit designing & PCB Printing
- Introduction to circuit designing and simulation using Proteus.
- Introduction to PCB printing (Fabrication of a PCB) and etching in PCB design.
- Demonstration and evaluation of a complete PCB design and fabrication.

Open Ended Lab or Semester Project:
Students will do a project in the last three weeks to summarize the technical knowledge and skills learnt in Electrical Workshop Practice and prepare a report

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Lab demonstration/experimentation, Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Project Report writing/ Presentation, Lab experiment evaluation, Assignments, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Umesh Rathore and Naresh Kumar Sharma, "A Textbook of Electrical Workshop Practices", S.K. Kataria & Sons, 1st Ed. 2019
2. S. K. Choudhury, "Elements of Workshop Technology", Vol. 1, Media Promoters & Publishers.
3. Chapman, "Workshop Technology", Part-I, II, III, CBS

LINEAR CIRCUIT ANALYSIS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Basic Electrical Concepts
- Charge, Current, Voltage, Power
- Voltage and Current sources

Voltage and Current Laws
- Ohm's Law
- Kirchhoff's Current Law
- Kirchhoff's Voltage Law
- Voltage Division in Series
- Current Division in Parallel
- Series and Parallel Sources

Nodal and Mesh Analysis
- Nodal Analysis and Super Node
- Mesh Analysis and Super Mesh
- Comparison between Nodal and Mesh Analysis

Circuit Analysis Techniques
- Linearity and Superposition
- Source Transformation
- Thevenin's and Norton's Theorems
- Maximum Power Transfer
- Delta-Wye Transformation

Energy Storing Elements
- The Inductor
- The Capacitor
- Physical construction and Mathematical Model

First Order Circuits (RL and RC)
- Transient Response
- Steady State Response

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Engineering Circuit Analysis by W. H. Hayt & J. E. Kemmerly 7th Edition
2. Basic Engineering Circuit Analysis by J. DAVID IRWIN
3. Electric circuit fundamentals by Franco
4. Introductory circuit analysis by Robert L. Boylestad

ELECTRICAL NETWORK ANALYSIS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Basic RL and RC Circuits

- Source-Free RL and RC circuits
- Unit Step Function
- Driven RL and RC circuits
- Natural and Forced Response

The RLC Circuit

- Source-Free Parallel Circuit
- RLC circuits with DC and AC excitation
- Overdamped Parallel Circuit
- Critical Damping
- Underdamped Parallel Circuit
- Source-Free Series Circuit
- Complete Response of RLC Circuit
- Lossless LC Circuit
- Series and Parallel resonance in AC circuits
- Q-Factor
- Analog Filters

Sinusoidal Steady-State Analysis

- Characteristics of Sinusoids
- Forced Response to Sinusoids Functions
- Phasor Diagrams and introduction to phasor representation of alternating voltage and current
- Impedance and Admittance
- Nodal and Mesh Analysis
- Superposition, Source Transformations and Thevenin's Theorem

AC Circuit Power Analysis

- Instantaneous Power
- Average Power, Apparent Power and Power Factor
- Effective Values of Current and Voltage
- Complex Power

Polyphase Circuits

- Polyphase Systems
- Single-Phase Three-Wire Systems
- Three-Phase Y-Y Connection

- The Delta Connection
- Power Measurement in Three-Phase Systems

Magnetically Coupled Circuits

- Mutual Inductance
- Linear Transformer
- Ideal Transformer

Complex Frequency and Laplace Transform

- Complex Frequency
- Two-port networks and their interconnections
- Laplace Transforms and Inverse Laplace Transforms
- Application of Laplace transform in circuit analysis

Circuit Analysis in s-Domain

- Impedance and Admittance in s-Domain
- Nodal and Mesh Analysis in s-Domain
- Transfer Functions

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Engineering Circuit Analysis by W. H. Hayt & J. E. Kemmerly
2. Introductory circuit analysis by Robert L. Boylestad
3. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition)
4. V.V. Burg, "Network Analysis", (Latest Edition)
5. J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
6. Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGrawHill, 7th Edition, 2007.

DIGITAL LOGIC DESIGN

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Binary Systems
- Introduction
- Number Systems and Conversions
- Arithmetic with number systems
- Signed and unsigned number systems and their arithmetic Binary Codes

Boolean Algebra & Logic Gates
- Boolean Postulates & Theorems
- Boolean Functions and their Complements
- Sum of Min Terms & Product of Max Terms
- Standard forms & Canonical Forms
- Digital logic gates

Combinational Logic
- Analysis and Design
- Code Converters
- Adders & its types
- Subtractors, Multiplier
- Magnitude Comparator
- Decoders and Encoders
- Multiplexers
- Combinational Logic using Verilog simulation

Sequential Circuits
- Latches (SR Latch, D Latch)
- Flip Flops (D Flip Flop, JK Flip Flop, T Flip Flop)
- Characteristic Tables, Characteristic Equations.
- Design and Analysis of Clocked Sequential Circuits (State Equations, State Tables,
- State Diagrams)
- Designing Counters

Registers & Counters
- Simple registers
- Registers with parallel Load
- Shift Registers/Serial to parallel Convertors
- Universal Shift Register
- Asynchronous and Synchronous Counters

- Ripple, Binary, BCD, & Johnson Counters
- Verilog for sequential logic

Introduction to Arithmetic Logic Units

- Simple Arithmetic Logic Units (ALU)
- Introduction to FPGA

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Stuies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Morris Mano and Charles R. Kime, “Logic and Computer Design Fundamentals”, Prentice Hall. Latest Edition
2. M. Morris Mano and Micheal D. Ciletti, “Digital Design with an introduction to the Verilog HDL”, Prentice Hall, 5th Edition.
3. Tocci and Widmer, "Digital Systems: Principles and Applications". Prentice Hall. Latest Edition

ELECTROMAGNETIC FIELD THEORY

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Review of Vectors and Coordinate Systems

- Vector algebra
- Coordinate systems and Transformations
- Vector calculus

Static Electric Field

- Coulomb's law and Electric Field
- Gauss' law and Divergence of Electric Flux Density
- Work, Potential, Potential Gradient and Energy in Electrostatic Field
- Current and Current Density, Conductor, Dielectrics, Boundary Conditions, Capacitance
- Laplace's and Poisson's Equations

Steady-State Magnetic Field

- Steady Magnetic Field
- Biot-Savart Law
- Ampere's Law
- Curl of H, Stoke's Theorem
- Magnetic Boundary Conditions
- Magnetic Material and Boundary Conditions
- Magnetic Flux Density
- Vector Magnetic Potential
- Inductance
- Magneto-static fields and materials

Time varying fields

- Faraday's Law
- Displacement Current Density
- Maxwell's Equations in Differential and Integral Form
- Retarded Potential

Reflection

- Reflection from perfect conductors
- Refection from perfect dielectrics

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. J. D. Kraus and Carver, "Electromagnetics", McGraw Hill
2. David K. Cheng, "Fundamentals of Engineering Electromagnetics", Addison Wesley.
3. William Hayt and John A. Buck, "Engineering Electromagnetics", McGrawHill, ISBN: 0073104639, Latest Edition.
4. Sadiku, Matthew N, "Elements of Electromagnetics", Oxford University Press, ISBN: 0195103688, Latest Edition.
5. J. D. Kraus, "Electromagnetics", John Wiley & Sons, Latest edition.

ELECTRONIC DEVICES AND CIRCUITS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Semiconductor Theory
- Introduction to Semiconductors.
- Intrinsic and Extrinsic Semiconductors.
- Doping and energy levels.

Diodes
- PN junction/ Biased PN junction.
- V-I Characteristics.
- Load Line and dynamic resistance.
- Diode models.
- Reverse recovery time and temperature effects.
- Diode Equivalent Circuits Transitions, Recovery, Specification, Notations
- Testing of Diode
- Zener Diode, Light Emitting Diodes

Diode Applications
- Load Line Analysis.
- Parallel and Series Configurations.
- Zener Diodes.
- Voltage-Multiplier Circuits
- Half wave and Full wave rectifiers.
- Clippers and Clampers.
- Logic gates.

Bipolar Junction Transistors
- Construction, Limits of Operation, Specification and characteristics.
- Testing, Casing and Terminal Identification of BJTs
- Amplifying action and variation in current gain.
- Common Emitter, Common Collector and Common Base Configurations.
- Power Ratings.

BJT Biasing Circuits
- Fixed Bias, Voltage Divider Bias and Emitter feedback Bias Circuits
- DC load line and operating point
- Biasing circuit design and stabilization
- Miscellaneous Configurations
- Transistor as a switch

BJT Small Signal Analysis
- AC Domain and BJT Modeling
- Common Emitter Amplifier

- Common Base Amplifier
- Common Collector Amplifier
- Amplifier Design and Loading effects
- Two Port Systems and Cascaded Systems
- Darlington and Feedback Pair
- Hybrid Equivalent Model and Hybrid π Model

Field Effect Transistors

- JFET Construction and Operation
- Transfer characteristics and parameters

FET Biasing Circuits

- Fixed Bias, Self-Bias and Voltage divider Bias
- Design of a bias circuit

FET Small Signal Analysis

- JFET/Depletion MOSFET small-signal model
- Common source, common drain and common gate amplifiers
- Loading effects and design of amplifier circuits

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Electronic Devices and Circuits by Theodore F. Bogart, Jr.
2. Electronic Devices and Circuit Theory, H. Boylestad and L. Nashelsky, ISBN-10: 0135026490
3. Electronic Devices, Thomas L. Floyd, ISBN-10: 0132359235

ENGINEERING DRAWING

Credit Hours: 0+1=1
Pre-Requisites: Nil

COURSE OUTLINE

Manual Drawing

- Introduction to Drawing Tools and Geometrical Construction
- Sheet Layout, Line Types, Sheet Planning and Dimensioning Principles
- Orthographic 1st angle of projection
- Orthographic 3rd angle of projection
- Isometric projection
- Sectional drawing and assembly drawing
- Reading and preparing electrical engineering drawings such as: Wiring Diagram, Power System Layout Diagram, PCB Drawing

Computer Aided Drawing (CAD)

- Layout, Line Types
- Practice in Lettering, Numbering and Geometrical Construction
- Engineering Curves – I (polygons, arcs, ellipses, parabola, hyperbola)
- Engineering Curves – II (involutes, cycloids, trochoids, spirals)
- Orthographic 1st angle of projection using CAD
- Orthographic 3rd angle of projection using CAD
- Design of 2-D Indoor Concealed Electrical Wiring Layout of a given Residential or Commercial Building using CAD
- Design of 2-D Outdoor Electrical Underground Wiring Layout of a given Outdoor area or housing society etc. using CAD
- Design of 2-D Outdoor Electrical Overhead Wiring Layout of a given Outdoor area or housing society etc. using CAD
- Introduction to 3D Modeling

Software

- 2D AutoCAD
- 3D AutoCAD
- Revit

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing.

Assessment:
Midterm Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

RECOMMENDED TEXT AND REFERENCE BOOKS

1. A. C. Parkinson, "First Year Engineering Drawing".
2. James D. Bethune, "Engineering Graphics with AutoCAD"
3. Shawna Lockhart, "Tutorial Guide to AutoCAD", Prentice Hall.
4. N.D. Bhatt, "Elementary Engineering Drawing

SIGNALS AND SYSTEMS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Fundamental Concepts of Signals & Systems

- Introduction
- Signals and their Classification
- Basic Continuous and Discrete Time Signals
- Sampling theorem and aliasing
- Operations on Signals
- Systems and Classification of Systems
- Interconnections of Systems

Linear Time Invariant Systems

- Response of a Continuous Time LTI System and Convolution Integral
- Properties of Continuous and Discrete Time LTI System
- Response of a Discrete Time LTI System and Convolution Sum
- Eigen function of Continuous and Discrete Time LTI System
- Correlation
- Convolution and Properties of Convolution
- Systems Described by Difference and Differential Equations

Laplace Transform and Continuous Time LTI Systems

- The Laplace Transform
- Laplace Transform of Some Common Signals
- Properties of Laplace Transform
- The Inverse Laplace Transform
- The System Function
- Unilateral Laplace Transform
- Solving Differential Equations by Using Laplace Transform

The Z-Transform and Discrete Time LTI Systems

- The z-Transform
- z-Transform of some Common Signals
- Properties of z-Transform
- The Inverse z-Transform
- The System Function of Discrete Time LTI System
- The Unilateral z-Transform
- Solving Difference Equations by Using z-Transform

Fourier analysis of Continuous Time Signals and Systems

- Fourier Series Representations of Periodic Signals

- The Fourier Transform
- Properties of Continuous time Fourier Transform
- Time and Frequency characterization of signals and systems
- The Frequency Response of Continuous Time LTI Systems
- Filtering and Bandwidth
- Modulation

Fourier analysis of Discrete Time Signals and Systems

- Discrete Fourier Series
- Discrete Time Fourier Transform (DTFT)
- Properties of Discrete Time Fourier Transform
- The Frequency Response of Discrete time LTI Systems
- Discrete Fourier Transform (DFT)
- Properties of Discrete Fourier Transform (DFT)
- Fast Fourier Transform (FFT)

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Alan V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals & Systems”, Prentice Hall Ed: Current
2. B. P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford, 2004
3. M. J. Roberts, "Fundamentals of Signals and Systems", McGraw-Hill, 2007
4. S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002
5. C. L. Phillips, J. M. Parr and E. A. Riskin, "Signals, Systems, and Transforms", 4th Edition, Prentice Hall, 2007.

PROBABILITY AND STATISTICS FOR ENGINEERS

Credit Hours: 3+0=3
Pre-Requisites: Nil

DESCRIPTION

This course provides the students with a deeper understanding about the theory of probability and the concepts of statistical data analysis. It discusses the types, collection, interpretation, and analysis of statistical data and gives an insight about its use in inferential statistics like regression, confidence ranges, and hypothesis testing. The course enables the students to learn and apply the tools for curve fitting via linear regression and correlation. The course also enables them to aptly deal with the problems of probability and random functions later in their engineering degree program.

COURSE OUTLINE

Basic Statistical Parameters and Data Representation

- Importance of statistics, population, sample, variables, and measurement
- Primary and secondary data,
- Frequency distribution, stem, and leaf display,
- Histogram, frequency polygon, cumulative frequency polygon,
- Simple & Multiple Bar diagrams

Measure of Central Tendency and Dispersion

- Measures of central tendency, AM, GM, HM
- Quantiles, Mode, Applications of averages
- Quartile and mean deviation, Variance, Standard deviation,
- Moments, Moment ratios, Skewness, Kurtosis
- Applications of Measure of dispersion in Engineering

Regression, Correlation and Curve Fitting

- Regression theory, Simple linear regression line
- Correlation, coefficient of correlation,
- Fitting of a first- and second-degree curves
- Principle of least squares.

Fundamental Concepts of Probability

- Set Operation
- Sample Space
- Events and Probabilities
- Probability Axioms
- Conditional Probability

- Independence
- Bayes' Theorem

Discrete Random Variables

- Probability Mass Function
- Bernoulli, Geometric, Binomial and Poisson Random Variable
- Variance and Standard Deviation
- Conditional Probability Mass Function

Continuous Random Variables

- CDF of Continuous Random Variables
- Probability density function
- Expected Value
- Uniform, Gaussian, Standard Normal Random Variables
- Probability Models
- Error Functions and Q-Functions
- Finding probabilities of a normally distributed random variable by using Standard Normal Curve.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Probability, Statistics and Random Processes for Electrical Engineering by Alberto Leon Garcia, 3rd Edition
2. Probability and Stochastic Processes – A friendly introduction for Electrical and Computer Engineers by Roy D. Yates & David J. Goodman, John Wiley and Sons Inc., 2005, Ed: 3rd
3. Probability, Random variables and Stochastic Processes by Papoulis and Pillai, Ed: 4th
4. Statistical Methods and Estimations by M. Anwar Solangi
5. Applied Statistics and Probability for Engineering by Douglas C. Montgomery
6. A First Course in Probability by Sheldon Ross 9th Edition, Prentice Hall

COMMUNICATION SYSTEMS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

- Model of a Communication System.
- Time domain and frequency domain description of signals and systems by using Fourier Transform.
- Transmission of signal though a linear system.
- Various modulation techniques. AM and FM.
- Concepts of Sampling and quantization. A/D conversion. PCM. and Delta Modulation
- Digital Modulation Techniques: ASK, PSK, DPSK, QAM
- Introduction to Wireless Mobile System
- Noise: Sources. Spectral Density and Probability Density.
- Performance of Analog and Digital Systems in the presence of Noise.
- Evaluation of Error Probability for different Digital Modulated Signals over Noisy Channel.
- Elements of Information Theory and coding techniques. Shannon's Theorem. Exchange of S/N and Bandwidth

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication Systems", Oxford University Press, Fourth Edition, 2010
2. John G. Proakis, Masoud Salehi, " Fundamentals of Communication Systems", Second Edition, Prentice Hall, 2013
3. John G. Proakis, Masoud Salehi, "Digital Communications", Fifth Edition, McGraw Hill, 2008

MICROPROCESSORS AND INTERFACING

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Microprocessor Systems

- Bus structure
- DMA and interrupts
- Microprocessor Architecture
- Memory and I/O ports
- Addressing modes
- Instruction set
- Microprocessor programming techniques
- Microcontrollers.
- Memory system design: CPU read/write timing, RAM and ROM

Interfacing

- Interface requirements
- Address decoding and interfacing dynamic RAM
- Serial, Parallel, Programmed and interrupt driven I/O
- Direct memory access and peripheral controllers
- Programmable peripheral interface
- Universe synchronous/asynchronous receiver/transmitter and programmable interrupt controller
- Data communication standards

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Embedded Systems: Introduction to Arm® Cortex TM -M Microcontrollers (Volume 1), by Jonathan W. Valvano, 5 th Edition, CreateSpace Independent Publishing Platform, 2012
2. Embedded Systems: Real-Time Interfacing to Arm® Cortex TM –M Microcontrollers, by Jonathan W. Valvano, 2nd Edition, Create Space Independent Publishing Platform, 2011

ELECTRICAL MACHINES

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Electrical Machinery Principles

- Introduction to magnetic field and circuits
- Faraday's and Lenz's law
- Magnetization curves
- Characteristics of hard and soft magnetic materials
- Losses.

DC generators and motors

- Parameters and Equivalent circuits of DC Machines and the relationships between speed
- Power and torque.

AC motors and generators

- Parameters and equivalent circuits of AC Machines.
- Rotating magnetic field
- The induced voltage and torque
- Phasor diagrams and the relationships between speed power, torque.

Transformers Equivalent circuit and phasor diagrams

- Equivalent circuit of practical transformers
- Approximate equivalent circuit, and equivalent circuit referred to primary and secondary sides
- Phasor diagram of ideal and practical transformer without load
- Phasor diagram of secondary side of practical transformer with unity
- Lagging and leading power factor
- Complete phasor diagram of practical transformer.

Transformer Tests

- Open circuit Test and calculations of magnetizing branch parameters
- Short circuit test and calculation of impedance
- Efficiency calculations
- Calculation of maximum efficiency
- Output for maximum efficiency

Transformer Taps and Voltage regulation

- Transformer taps
- Voltage regulation
- Reasons of voltage drop
- Voltage regulation under different load conditions
- Transformer phasor diagrams.

DC Generator

- Types of DC generators
- Equivalent circuit and characteristic equations
- Separately excited generator
- Shunt generator
- Voltage build-up phenomenon
- Series generator
- Compounded generator and its type; under compounded
- Over compounded and flat compounded generator
- Voltage control in all generators and terminal characteristics of all the generators

DC Motors

- Working principle, construction, and operation
- Important parts of DC motor
- Different types of DC motors
- Equivalent circuits and terminal equations
- Magnetic characteristics of DC machines
- Terminal characteristics of separately excited and shunt type DC motor.
- Construction and working of stepper motor
- Brushless DC motor and switched reluctance motor.

DC series motor

- Expression for torque, applications, terminal characteristics
- Six methods for speed control

Armature Reaction

- Concept of magnetic and magnetic neutral axis
- Placement of carbon brushes
- Armature reaction and its causes
- Components of armature reaction
- Effects of armature reaction
- Remedies for armature reaction
- Compensating winding, flux enhancement and brush shifting

Commutation:

- Commutation process
- Commutation time
- Ideal commutation
- Poor commutation
- Effects of poor commutation
- Practical difficulties
- Ldi/dt effect, interpoles
- Function of interpoles.

Tests and Losses:

- Different types of tests
- Losses and their formulation
- Power flow diagram of motor and generator
- Calculation of maximum efficiency
- Calculation of losses at different loads

Design of Armature Winding:

- Pole pitch, coil pitch, front pitch, commutator pitch
- Multiplex winding, slap winding, wave winding, design examples of lap winding
- Developed diagram, sequence diagram, parallel path diagram, characteristics of lap winding, derivation of induced EMF.

Introduction to AC Machines:

- Introduction to single phase, two phase and three phase systems.
- Waveforms and equations, phasor and polar representation, balanced and unbalanced poly phase systems.
- Types of AC motors: Main parts, Stator windings, concentrated winding, distributed winding, full pitched winding, fractional pitched winding, pole formation in AC machines, revolving magnetic field in three phase machines.

Introduction to AC Machines:

- Nature of magnetic field, properties of DC
- Single phase, two phase and three phase fields, phase sequence
- Reversal of magnetic field in three phase machines
- Speed of revolving magnetic field, conditions to produce RMF
- Phase splitting in single phase machines.
- Analytical proof of revolving magnetic field and basic mathematical expression for machines.

Induction motor and Hysteresis motor:

- Construction, working and principle of Induction motor
- Development of induced torque in induction motor
- Types of induction motor, squirrel cage and slip ring induction motor and their merits,
- Demerits and comparison, concept of rotor slip and its expression
- Concept of rotor frequency and its relationship with slip
- Equivalent circuit of induction motor
- Rotor circuit and slip effects
- Final equivalent circuit.
- Working and construction of hysteresis motor

Power and Torque Calculations:

- Power flow diagram of induction motor
- Calculation of different losses in an induction motor.
- Modification of equivalent circuit including Rconv
- The venin voltage and impedance calculation
- Calculation of current in rotor circuit
- Expression of induced torque
- Torque speed characteristics, variation of torque speed characteristics with rotor resistance and stator frequency.

Speed Control of Induction motor

- Pole changing method
- Line frequency method
- Voltage control method
- V/f control for controlling the speed
- Rotor resistance control method and torque speed characteristics for each method
- Load torque curves.

Tests on Induction motor

- No load test
- Blocked rotor test
- Resistance test and calculation of R1, R2, Xm, X1 and X2 using the data of tests.

Synchronous Generator

- Basic principle and working
- Different types of prime movers
- Salient pole and cylindrical rotors and their comparison
- Brushless exciters
- Pilot exciters
- Application of synchronous generators
- Synchronous speed expression
- DC excitation and use of permanent magnets.

Control of a synchronous generator

- Throttle, control of active power
- Power frequency characteristics
- Modes of operation of synchronous generator
- Working alone, working in parallel with same SG, and connected to infinite bus bar, house diagram and sharing of power
- Effect of excitation keeping throttle constant
- Effect of throttle keeping excitation constant
- Effect of throttle keeping excitation and power factor constant.

Salient pole synchronous generator

- q and d axis and reactance and their calculations
- Phasor diagram of salient pole machines
- Derivation of power and torque expressions
- Comparison of cylindrical and salient pole synchronous generator
- Calculation of equivalent circuit parameters and synchronization of alternator with infinite bus bar.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Electric Machinery Fundamental, Latest Edition, Stephen J. Chapman, McGraw-Hill International
2. Fitzgerald, Kingsley and Umans, "Electric Machinery", McGraw-Hill. (Latest Edition)
3. Hindmarsh, "Electrical Machines", McGraw-Hill. (Latest Edition)
4. Theodore Wildi "Electrical Machines, Drives, and Power Systems

LINEAR CONTROL SYSTEMS

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to control system

- Introduction to control system and its performance parameters
- Open loop and closed loop control system
- Objectives for analyzing and designing control system

Modeling in the frequency domain

- System models
- Transfer function modeling
- Developing transfer functions using Laplace Transform of Electrical Circuits, translational and rotational mechanical systems
- Demonstrate the transfer function of DC motor

Modelling in the Time domain

- Time-domain modeling
- State variables, state equations and output equations
- State Space representation to model electrical and mechanical systems
- Carry out conversion of a transfer function to state space model
- Carry out conversion of a state space model to transfer function

Reduction of Multiple Sub-Systems

- Block diagram reduction for sub systems
- Different configurations used in reduction
- Signal Flow Graphs
- Mason's rule to simplify signal flow graph to single transfer function

Transient response of a system

- System response using Pole Zero Diagram
- Transient response of first order Systems
- Transient response of Second Order Systems
- Transient response of Under damped second order systems

Stability of Linear System

- Stability of a linear system
- Difference between stability of linear and non-linear systems
- Routh-Hurwitz criterion to check stability of a linear system
- Analyzing the stability of a linear systems
- Analysis of special stability cases

Steady State errors

- Steady State Errors

- Steady State errors for unity feedback systems
- System types based on integrators and analyzing the steady-state error using these types.

Root Locus Techniques

- Root locus
- Rules to sketch root locus and analyze the system stability

Frequency response techniques

- Bode plot and Nyquist plot to sketch frequency response of a system
- Analyzing the system stability using Nyquist criterion of stability

Compensator Design

- Designing Lead-Lag compensators to improve the transient and steady-state error of a system
- Designing a PID controller to improve the transient and steady-state error of a system

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Norman S. Nise, Control Systems Engineering, 6th Ed. 2016.
2. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 13th Ed. 2016.
3. K. Ogata, Modern Control Engineering, 5th Ed.

POWER DISTRIBUTION AND UTILIZATION

Credit Hours: 3+1=4
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to distribution system

- Urban, sub urban and rural distribution system
- Primary, secondary and tertiary voltages
- Distribution conductors & cables, Kelvin's law
- Radial and ring main systems, application of distribution transformers
- Estimation of load, load characteristics
- Calculation of voltage drop and regulation in distribution feeders
- Substation switchgears and bus bar arrangements

Power Cables

- Cable Construction, Types of Cables, Insulating Materials
- Conducting materials.
- Capacitance of a Cable, Dielectric Power Loss. Thermal Characteristics of Cables,
- Cable Installation

Power Factor

- Disadvantages and causes of low power factor,
- Methods for improvement,
- Application of shunt capacitors in distribution network.

Grounding and Earthing

- Distribution transformer neutral,
- Earthing resistance,
- Earthing practice in L.V. networks,
- Electrical Safety

Batteries and Electro-Chemical Process

- Main types of batteries and their working,
- Battery charging, electroplating, electrolysis and electrometallurgical process.
- Cathodic protection of poles, gas pipes, oil pipes and water structures.

Heating & Welding

- Electric heating, resistance, induction and dielectric heating, electric furnaces,
- Microwave and infrared heating,
- Electric welding, resistance welding and its types.

Fundamentals of Illumination Engineering:

- Basic lighting terminologies and laws of illumination
- Requirements for good lighting,
- Illumination schemes for various situations (street lighting,
- commercial/industrial lighting, stadium/flood/stage/spot lighting, etc.),
- Types of lamps, their working and relative merit,
- Building lighting design

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Principle of Power System by V.K Mehta, Latest Edition.
2. M. L. Anand, "A Textbook of Electrical Power", Latest Edition Turan Gonen, “Electrical Power Distribution System”, CRC

POWER GENERATION

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Power Stations
- Introduction
- Types of power Station
- Choice of type of Generator, Cost of Electrical Energy

Hydro Electric Stations
- Introduction, Types of Hydro Electric Power Stations
- Principle of working of a Hydro Electric Plant, Power Station Structure and Layout
- Types of Turbines and their characteristics
- Arrangements and location of Hydro Electric Stations
- Types of Hydro Electric Plants and Dam, Characteristics of Generators
- Costs of Hydro Electric Stations

Steam Power Plants
- Introduction, Main Parts and working of a steam Station
- Plant Layout
- Rankin Cycle and its types
- Types of Boilers and their characteristics
- characteristics of steam turbines
- Design of a steam Power Station
- Steam station auxiliaries
- Cost of Steam Station

Gas Turbines
- Introduction, Main Parts of Gas turbine plant,
- Plant Layout, Principle of Operation,
- Characteristics of Gas Turbine plants,
- Gas Turbine Power Plant operation and Control
- Combined Cycles Cost of Gas Turbine Stations

Nuclear Power Stations
- Introduction, Nuclear Reaction, Main Parts of Nuclear Power Stations,
- Plant Layouts,
- Principle of Nuclear Energy,
- Nuclear reactor and reactor control,
- Types of Power Reactor,
- Comparison of various types of reactors

- Economics of Nuclear Power Stations.

MHD Generators:

- Gaseous conductors, analysis and design of MHD generator,
- Problems associated with MHD generation, possible configuration.

Introduction to renewable energy generation:

- Renewable energy resources

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. M. V. Deshpande, "Elements of Electrical Power Station Design", 2010, PHI Publishers
2. M. M. El Wakil, "Power Plant Technology", McGraw Hill International Editions, Electrical and Mechanical Engineering Series.
3. Arche W. Culp "Principles of Energy Conversion", Latest Edition.

POWER SYSTEM ANALYSIS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Structure & Growth of Electrical Power Systems
- Per unit system of calculations,
- One Line Diagram, Impedance & Reactance Diagram,
- Bus Impedance and Admittance Matrices-Formation, Modifications and Importance.

Load Flow Solution

- Scope of Load Flow in Electrical Power System,
- Load Flow Problem Formulation & Solution Methodologies,
- Gauss Siedel, Newton Raphson and Fast Decoupled Method and
- Load Flow Control.

Fault Analysis

- Importance of the Fault Analysis in Electrical Power System
- Faults and their Types,
- Symmetrical Fault Analysis (SFA): SFA using Thevenin's Theorem and Z-bus, Short Circuit MVA,
- Unsymmetrical Fault Analysis (UFA): Symmetrical Components, Sequence Impedances, Sequence Networks of Loaded Generator, Line-to-Ground (L-G) fault, Line-to-Line (L-L) Fault and Line-to-Line-Ground (L-L-G) Fault analysis of unloaded generator and Power system.

Power System Stability

- Stability Problem -Scope and Significance,
- Steady State & Transient Stability,
- Power Flow Relationship for Cylindrical & Salient Pole Machines,
- Derivation of Swing Equation,
- Equal Area Criterion, Solution of Swing Equation, Factors Effecting Stability,
- Use of Digital Computer Methods for the Stability Studies

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Hadi Saadat, "Power System Analysis", McGraw-Hill International Editions.
2. Glover and Sharma "Power System Analysis"
3. Greinger and William D. Stevensons Jr, " Power System Analysis", McGraw Hill, Latest Ed.
4. B. M. Weedy ,B. J. Cory, "Electric Power Systems", John Wiley Latest Ed.

ELECTRICAL POWER TRANSMISSION

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

- One-line diagram
- Choice of voltage and choice of AC/DC systems
- Introduction to HV, EHV and UHV systems.
- Conductor Types, skin effect, Ferranti effect.
- Short, medium and long transmission lines
- Voltage regulation and line surges.
- Line Supports, Sag and tension calculation
- Effect of wind pressure and ice loading
- Conductor vibration and use of dampers.
- Insulators and Insulator material, string efficiency, corona effect.
- Introduction to HVDC transmission.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. M. V. Deshpande, "Elements of Electrical Power Station Design", 2010, PHI Publishers
2. M. M. El Wakil, "Power Plant Technology", McGraw Hill International Editions, Electrical and Mechanical Engineering Series.
3. Arche W. Culp "Principles of Energy Conversion", Latest Edition.
4. Turan Gonen, "Electrical Power Distribution System", CRC Press.
5. M. L. Anand, "A Text Book of Electrical Power", Latest Edition
6. Arche W. Culp "Principles of Energy Conversion", Latest Edition.
7. Turan Gonen, "Electrical Power Transmission System Engineering - Analysis & Design", John Wiley& Sons.

POWER SYSTEM PROTECTION

Credit Hours: 3+0
Pre-Requisites: Nil

COURSE OUTLINE

Protective Relays

- Need for protective relaying in power systems,
- Basic attributes of protective relaying, principles and characteristics of protective relaying
- Theory and classification of relays,
- Instrument Transformers, CT burden and accuracy classes.

Over-Current Protection

- Inverse characteristics of Over-current relays (OCR)
- Inverse definite minimum time (IDMT) relays
- Primary and backup protection,
- Relay coordination, application of IDMT relays,
- Direct over-current relays (D-OCR),
- Application of D-OCR, protection of a three phase feeder.

Differential Protection

- Dot convention and CT placement,
- Simple Differential Protection,
- Zone of Protection of the Differential Relay
- Percentage Differential Relay,
- Earth Leakage Protection

Protection of Transformers

- Transformer faults,
- Differential Protection of a three-winding transformer
- Inrush current and differential protection,
- Bucholz relays
- Over-fluxing in transformer

Protection of Generators

- Faults in stator and rotor windings,
- Protective devices for stator, rotor, and prime mover of a generator
- Abnormal operating conditions (unbalanced loading, over-speeding, loss of excitation and loss of prime mover) and their protection.

Protection of Transmission Lines

- Drawbacks of over-current protection

- Distance protection
- Zones of protection

Fuses and Circuit Breakers

- Fuses Introduction,
- Principle of circuit interruption,
- Circuit Breaker-Types and characteristics
- Ratings of circuit breakers.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Fundamentals of Power System Protection by Y.G. Paithankar and S.R. Bhide
2. Protective Relaying; Principles and Applications, by J. Lewis Blackburn, Thomas J. Domin.

POWER SYSTEM OPERATION & CONTROL

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Power System Operational Planning:
- Introduction & brief overview on steps in Power System Operational Planning.

Characteristics of power generation units:
- Thermal Machines Cost Characteristics: input-output curve, incremental curve,
- Specific cost curve, format to represent characteristics curves, how curves are obtained,
- Hydel Machines cost curves.

Economic Dispatch (ED):
- Concepts & Mathematical formulation
- solution methodologies,
- ED using Economic dispatch using Equal incremental cost Criteria (EICC) neglecting network loss, and including network loss using B-Coefficients.

Unit commitment (UC):
- Concepts, Constraints
- Mathematical formulation, Solution Methodologies
- Priority List schemes for unit commitment

Hydrothermal Coordination (HTC)
- Concepts, Constraints, Mathematical formulation
- Scheduling Problems
- HTC Solution using Constant Hydro
- Constant Thermal and Running Hydro Plant at its Maximum Efficiency

Frequency Control
- Power System Control
- Load -frequency Control problem, Generator & load model
- Prime Mover Model

Automatic Generation Control (AGC) Voltage Control (VC)
- Voltage control problem importance and concepts, Problem
- Methods for voltage control.

SCADA
- SCADA System overview, architecture, protocols, and application to power system control.

SUGGESTED TEACHING AND ASSESSMENT METHODS
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing **Assessment:** Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS
1. Power Generation, Operation and Control by Allen J. Wood & Bruce F. Wallenberg , John Wiley & Sons, Inc.

ELECTRICAL MACHINE DESIGN & MAINTENANCE

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Machine Design

- 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).

Installation, Maintenance and Troubleshooting of Machines:

- Safety precautions,
- Troubleshooting and emergency repairs.
- Installation, commissioning, testing, maintenance, and troubleshooting of: (i) Power transformers and (ii) induction motors. (iii) AC generators

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. S. Rao, "Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publisher, India, Latest Edition.
2. M. G. Say, "Alternating Current Machines", Pitman Publishing Ltd.

HIGH-VOLTAGE ENGINEERING

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Importance of High Voltage in all fields of daily life and medical applications

Breakdown Mechanisms

- Dielectric strength of solids, liquids and gases,
- Breakdown of solids, liquids and gases (Town send and streamer breakdown, breakdown of unstable states of matter.
- Role of high voltage in production of unstable states of matter

Generation of High Voltages

- Transformer
- Series and Cascaded transformer connections,
- Bracketing in Transformer and its purpose,
- Series and Parallel Resonant Transformer, Tesla Coil, Transformer with rectifier, Voltage Multiplier Circuits, Walton Multiplier, Deltatron Multiplier
- Electrostatic Voltage Generators (Van de Graff Generator, Sames Generator, Kelvin Water dropper, Whimshurst Machine)

Significance and Methods of Generation of Impulse

- Introduction to Impulse, Standard Impulse used for testing.
- Construction and working of MARX and Good-Let Generators for impulses.
- Impulse Current Generators.

Measurement of High Voltages

- Direct & Indirect Measurement of high voltages and its significance in a particular situation.
- Direct Measurement: HV probe, Potential Transformer, Ammeter in series with high resistance, Voltage divider
- Indirect Measurement: Spark gaps, Electrostatic Voltmeters, Electrodynamic Voltmeter, Hall Effect Sensor, Electro Optical Measurements.

Grounding and Earthing in Low and High Voltage Systems

- Basics and importance of grounding in low as well as high voltage devices and systems.
- Touch and step potentials in a HV lab.

Leakage Current in Insulation

- Introduction to leakage current, its types and components
- Methods of measuring and minimizing leakage current.

Insulation Materials

- Different types of polymeric & Ceramic Insulation materials and their X-tics w.r.t electrical, mechanical, optical, acoustical and environmental resistance.

High Voltage Testing Techniques

- Destructive, non-destructive, routine, fatigue, quantitative, qualitative, physical and Electrical tests on different insulation materials.
- Health analysis of insulation systems.

Design Planning and Layout of HV Labs

- Classification of HV lab on small, medium and large scale.
- Typical facilities required in a HV lab.
- Designing a lab layout and equipment on customized demand.

HVDC

- Scope trends technologies and future of HVDC.
- Advantages and issues in HVDC systems. HVDC distribution Systems.

Applications of High Voltage

- Applications of high voltage in medical, research and daily life activities

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. High Voltage Engineering by Y. Kuffel, J. Kuffel and W. S. Zaingi 2nd ed.
2. High Voltage Engineering by M.S. Naidu, V. Kamaraju, 4th ed
3. High Voltage Engineering by Muhammad Naeem Arbab 1st ed
4. High Voltage Engineering by J. R. Lucas 1st ed.

RENEWABLE ENERGY SYSTEMS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Overview
- Present day fuel use
- Energy Problems of modern societies
- Renewable Energy Sources as a solution

Solar Thermal Energy
- Nature and availability of solar radiation, Low temperature solar energy applications,
- Solar thermal engines and electricity generation
- Economics Potential and environmental impact

Solar Photovoltaic
- Historical Background, PV in Silicon, Reducing the cost of crystalline PV cells
- Thin film PV, Other innovative PV technologies
- Electrical characteristics of Silicon PV cells and modules
- PV systems for remote power
- Grid-connected PV systems, Economics of PV Energy Systems
- Environmental Impact and Safel

Fuel Cells
- Thermodynamic principles
- Efficiency of fuel cell factors limiting the performance
- Design, new development in fuel cells
- Possibility of future use in Electric vehicles.

Bio Mas
- Introduction
- Past and present, Bio Mass as a fuel
- Extracting the energy, Agricultural residues
- Energy crops, Environmental benefits and impacts, Economics,
- New Technologies, Future Prospects.

Wind Energy
- Introduction, wind turbine types and terms
- Aerodynamics of wind turbines, Mechanical power
- Wind turbine generators, power and energy from wind turbines
- Wind speed characteristics of a site

- Economics of wind turbine
- Commercial development and wind energy potential.

Tidal Power

- Tidal energy harnessing schemes
- Tidal barrages

Geothermal Energy

- Scope, advantages and issues

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Godfrey Boyle, Renewable Energy and Power for a sustainable future, OUP
2. John Twidell, Tony Weir, "Renewable Energy Resources", Second Edition, 2006, Taylor and Francis, New York and London
3. Aldo V. da Rosa, "Fundamentals of Renewable Energy Processes", Second Edition, 2005, Academic Press.

FACTS AND HVDC TRANSMISSION

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

FACTS Concept and General System Consideration

- System Compensation
- Bi-direction Ac voltage converter
- Voltage-Sourced Converters,
- Self- and Line-Commutated Current-Sourced Converters

Static Shunt and Series Compensators

- TCR
- TSC
- SVC
- STATCOM
- TSSC
- TCSC
- SSSC

Combined Compensators

- Unified Power Flow Controller (UPFC)
- Interline Power Flow Controller (IPFC)

HVDC Transmission

- Introduction to HVDC transmission
- Types of HVDC Transmission
- Multi-Level Conversion
- Line-Commutated CSC Transmission
- VSC Transmission
- Multi-Level VSC and CSC Transmission
- Introduction to Multi-terminal HVDC (MTDC) grid

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Narain G. Hingorani, Laszlo Gyugyi. "Understanding FACTS: concepts and technology of flexible AC transmission systems" (latest Edition), IEEE Press Marketing.
2. J. Arrillaga, Y.H. Liu, N.R. Watson. Flexible power transmission the HVDC options.

SMART GRID

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Smart Grid Basics

- Overview of existing grid, why do we need smart grid,
- Objectives and main features of Smart Grid,
- Current status of smart grid technology
- Future of Smart Grid, advantages and Disadvantages,
- Implementation of smart grid and possible difficulties.

Distributed Generation

- Overview of Distributed Generation,
- New paradigm of power generation, future power grid,
- impact of Distributed Generation on the main power grid,
- Smart Grid and Distributed Generation:
- Advantages and Disadvantages

Analysis Tools

- Challenges for load flow studies,
- Load flow analysis in smart grid environment.

Demand side management

- Introduction, types and tools for demand side management,
- Demand response and its applications,
- Types of loads & their current signatures,
- Smart Meters.

Communication Technology for Smart Grid

- Basics of Data communication technology
- Communication protocols.

SCADA (Supervisor Control and Data Acquisition)

- Power System Monitoring and Control,
- Architecture of SCADA,
- Main features and objectives of SCADA,
- Applications of SCADA

Wide Area Monitoring and Control by Synchro-phasor Technology

- PMUs (Phasor Measurement Units),
- Architecture of WAMCS,
- Applications of WAMCS.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Power System Analysis by Hadi Saadat McGraw-Hill International Editions
2. The Smart Grid: Enabling Energy Efficiency and Demand Response by Clark W. Gellings, P.E.
3. Synchronized Phasor Measurement Units and their applications by A.G Phadke, J.S Thorp

POWER ELECTRONICS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Power Electronics
- Overview of power electronics and its applications
- Power electronic systems and components
- Switching devices and their characteristics

AC to DC Converters
- Single-phase and three-phase rectifiers
- Power factor correction techniques
- DC voltage regulators

DC to DC Converters
- Buck, boost, and buck-boost converters
- Quasi-resonant and soft-switching converters
- Isolated and non-isolated converters

Inverters and AC to AC Converters
- Single-phase and three-phase inverters
- Pulse width modulation techniques
- Voltage source and current source inverters

Applications of Power Electronics
- Renewable energy systems and power electronics
- Electric vehicles and charging systems
- Power electronics in industrial and commercial applications

Power Electronics Design and Analysis
- Power electronics circuit analysis and design
- Simulation and modeling of power electronics circuits
- Design and implementation of power electronics systems

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Power Electronics: Essentials and Applications" by L. Umanand (2020, Wiley)
2. "Power Electronics: Devices, Circuits, and Applications" by M. S. Jamil Asghar (2021, Springer)
3. "Power Electronics: Principles and Applications" by Joseph Vithayathil (2020, Pearson)
4. Power Electronics: Converters, Applications, and Design" by Ned Mohan, Tore M. Undeland, and William P. Robbins (2020, Wiley)
5. "Fundamentals of Power Electronics" by Robert W. Erickson and Dragan Maksimovic (2020, Springer)
6. "Power Electronics Handbook" by Muhammad H. Rashid (2021, Elsevier)

ARTIFICIAL INTELLIGENCE

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

- Introduction to AI & Machine Learning
- Linear Regression, Logistic Regression, Gradient Descent Method
- Polynomial Regression, Regularization
- Classification, Evaluation
- Naive Bayes, Decision Tree
- Neural Networks
- Clustering
- Debugging the ML models
- Search - modeling & algorithms
- Search - algorithms
- Informed Search
- Game Playing
- Propositional Logic
- First Order Predicate Logic
- Constraint Satisfaction
- Conclusion & Future of AI

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Artificial Intelligence: Modern Approach, (3rd & 4th ed.), Stuart Russel and Peter Norvig. http://aima.cs.berkeley.edu/

INSTRUMENTATION AND MEASUREMENTS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Measurements

- Precision measurements terminologies principles of different measurement techniques;
- Types of Errors

Instruments

- Measurement of electrical and non-electrical quantities including voltmeters, ammeters, function generators, oscilloscopes;
- Systems for signal processing and signal transmission; modern Instrumentation techniques;
- Static and dynamic responses of instrumentation and signal conditioning;

Data acquisition systems

- Principles of operation, construction and working of different analog and Digital meters,
- Advanced Testing & Measuring instruments recording instruments, signal generators,

Transducers

- Sensors, Input and output transducers;
- Types of bridges for measurement of resistance, inductance, and capacitance;
- Power and energy meters; high-voltage measurements, PLC systems etc.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Modern Electronic Instrumentation and Measurements Techniques by A.D.Helfrick, W.D. Cooper
2. Klaas B. Klaassen and Steve Gee, "Electronic Measurement and Instrumentation," 1996, Cambridge University Press, ISBN: 0521477298.T

3. H Kevin, JamesH, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control," 2000, Newnes, ISBN: 0750646241.

****Telecom/ Communications Stream Depth Core I & II
• Electronic Circuit Design (Depth Core-I) • Computer Communication Networks (Depth Core-II)
*****Proposed Electives for Telecom/ Communications Stream
• Digital Communications • Wireless and Mobile Communications • Satellite Communications • Navigation Systems • Next Generation Networks • Internet of Things (IoT) • Wireless Network System • Telecommunications Standards & Regulations • Network Management • Telecommunications Traffic Engineering • Optical Communications • Microwave & Radar systems • Transmission & Switching System • Antenna & Wave Propagation Any other relevant course decided by the HEI as per requirement.

COMPUTER COMMUNICATION NETWORKS

Credit Hours: 3+0
Pre-Requisites: Nil

COURSE OUTLINE

Overview of Communication System

- Communication Model, Nodes, Links, Protocol, Network Edge (Client, Server).
- Network Fundamentals, Types of Networks (LAN, MAN, WAN), Network Topologies. (Bus, Star, Tree, Ring, Mesh), Logical versus Physical Topology.
- Network Interface Controller, Repeaters, Hubs, Bridges, Switches, Routers, Gateway.
- Access Networks, Core Networks, Internet, Intranet.
- Concept of Packet, Packet Forwarding/Switching, Store-and-Forward Transmission.
- Transmission Delay, Propagation Delay, Queueing Delay.

Physical Media

- Coaxial (10Base-2, 10Base-5), Coaxial Cable Connectors.
- Ethernet (10Base-T, 100Base-TX, 100Base-T), Twisted-Pair Connectors.
- Fiber Optic (10Base-F, 100Base-FX, 1000Base-LX, 1000Base-SX), Fiber-Optic Connectors.
- Serial (RS-232 and RS-422).

Architecture and Protocols

- Layered Models (TCP/IP, OSI), Encapsulation/Decapsulation

Link Layer

- Services Provided by the Link Layer.
- Error-Detection and -Correction Techniques (Parity Checks, Check summing Methods).
- Multiple Access Links and Protocols.
- Channel Partitioning Protocols (FDM, TDM).
- Random Access Protocols (Slotted ALOHA, Pure ALOHA, CSMA/CD, CSMA/CA).
- Taking-Turns Protocols (Polling Protocol, Token-Passing Protocol).
- Switched Local Area Networks (Collision Domain, ICMP, and ARP).
- Self-learning of Switch Table
- Properties of Link-Layer Switching
- Spanning Tree Protocol (STP)

- Virtual Local Area Networks (VLANs)

Ethernet Framing
- Frame Formats (Ethernet II versus IEEE 802.3)
- Media Access Control (MAC) Addressing
- Frame Forwarding and Filtering (Unicast, Broadcast, Multicast)
- Frame Processing (Source MAC, Destination MAC, Type Field, Data, FCS)

IP Addressing
- IP Packet Header and IP Addressing (Network Part, Host Part).
- Network Address, Broadcast Address, IP Address Classes (A, B, C, D, E), Subnet Mask, VLSM.
- IP Addressing Limitations.
- Dynamic Host Configuration Protocol (DHCP).

Network Layer
- Forwarding and Routing.
- Virtual Circuit and Datagram Networks.
- IP Routing Table, Routing Decision (Preference, Metric).
- Static Routing (Application, Behavior, Limitations).
- Routing Algorithms (Distance-Vector Routing Algorithm, Link-State Routing Algorithm).
- Dijkstra's Algorithm.

Transport Layer Protocols
- Transmission Control Protocol (TCP), TCP Ports, TCP Header, TCP Connection Establishment/Termination, Go-Back-N (GBN), Selective Repeat (SR)
- User Datagram Protocol (UDP), UDP Datagram Format, UDP Forwarding Behavior
- Principles of Congestion Control, TCP Congestion Control (Slow Start, Congestion Avoidance, Fast Recovery)

Application Layer Protocols
- The Web and HTTP, HTTP Message Format, Cookies
- File Transfer: FTP
- Overview of How DNS Works

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Data and Computer Communications - William Stallings (7^{th} ISBN-10: 0131006819 or ISBN-13: 978-0131006812).
2. Computer Networking: A Top-Down Approach - James F. Kurose, Keith W. Ross (6th Edition ISBN-10: 0132856204 or ISBN-13: 978-0132856201).
3. Computer Networks - Andrew S. Tanenbaum, David J. Wetherall (5th Edition, ISBN-10: 0132126958 or ISBN-13: 978-0132126953).
4. Computer Networks and Internets - Douglas E. Comer (6th Edition ISBN-10: 0133587932 or ISBN-13: 978-0133587937).
5. Cisco CCENT/CCNA ICND1 100-101 Official Cert Guide - Wendell Odom (1st Edition, ISBN-10: 1587143852 or ISBN-13: 978-1587143854).
6. Cisco CCNA Routing and Switching ICND2 200-101 Official Cert Guide - Wendell Odom (1st Edition, ISBN-10: 1587143739 or ISBN-13: 978-1587143731).

DIGITAL COMMUNICATIONS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Review of basic concepts such as Hartley's and Shannon's law.
- Signal transmission through linear systems
- Bandwidth of digital data
- Binary symmetric channels
- Binary channels
- Binary eraser channel and memory less channels.
- Detection of binary signals in white Gaussian noise
- Maximum likely hood receiver structure
- Matched filter, inter-symbol interference (ISI), equalization.

Digital Modulation Techniques

- Introduction of binary modulation schemes (FSK, PSK and ASK), FSK transmitter and receiver
- Bandwidth considerations of FSK
- Minimum shift-keying FSK (MSK)
- Binary phase shift keying (BPSK)
- BPSK transmitter and receiver.
- Bandwidth considerations of BPSK
- Performance (bandwidth and power) of binary modulation schemes in AWGN channels, differential BPSK, constellation diagrams and eye diagrams.
- M-ary modulation techniques (M-ary PSK, Ma-ary FSK and M-ary ASK) and their performance evaluations in AWGN channels.
- Quadrature amplitude modulation (QAM),
- 8/16-QAM transmitter and receiver, bandwidth considerations of 8/16-QAM.
- Bandwidth efficient modulation schemes (QPSK and its variants, GMSK etc.)
- Clock recovery
- Performance comparison of modulation schemes in band-limited channels
- Probability of error and bit error rate.

Coding Techniques

- Introduction to source coding and channel coding.

- Error control coding techniques
- Forward error correction coding (hamming code)
- Linear codes, block codes, cyclic codes
- Convolutional codes and turbo codes
- Performance of these codes in AWGN channels

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Digital Communications - John Proakis, Masoud Salehi (5th Edition, ISBN-10: 0072957166 or ISBN-13: 978-0072957167)
2. Digital Communications: Fundamentals and Applications - Bernard Sklar(2nd Edition, ISBN-10: 0130847887 or ISBN-13: 978-0130847881)
3. Digital Communication Techniques: Signal Design and Detection - Marvin K. Simon, Sami M. Hinedi, William C. Lindsey (1st Edition, ISBN-10: 0132006103 or ISBN-13: 978-0132006101)
4. Digital and Analog Communication Systems - Leon W. Couch (8th Edition, ISBN-10: 0132915383 or ISBN-13: 978-0132915380)
5. Digital Communication Systems - Simon Haykin (1st Edition, ISBN-10: 0471647357 or ISBN-13: 978-0471647355)

WIRELESS AND MOBILE COMMUNICATIONS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Introduction to wireless communication systems
- Classification of wireless systems
- Wireless propagation mechanisms (free space, sky waves and space waves etc.)
- Frequency classifications
- Radio frequency management

Link Performance

- Wireless channel and impairments, path loss, path geometry
- Propagation models, free-space models, frii's equation, two-ray models, diffraction models.
- Fading, small scale fading (due to delay spread and due to doppler spread)
- Large scale fading
- Rayleigh and rician fading
- Average duration of fade
- Level crossing rate
- Curved earth model
- Mitigation of fading using equalization
- Link budget.
- Access techniques (FDMA, TDMA and CDMA etc.)
- Power control, cell splitting, cell breathing, sectoring

Introduction to Cellular Communication System

- History, evolution of cellular system, six basic components in every cellular system
- Frequency re-use concept, co-channel interference, channel assignment methods, handover and roaming
- Multiple access techniques (FDMA, TDMA and CDMA etc.)
- Power control, cell splitting, cell breathing, sectoring

Spread Spectrum Systems

- Introduction to spread spectrum methods
- Direct sequence spread spectrum, frequency hopping spread spectrum, slow and fast FHSS
- Pseudo noise codes

- M-sequences
- Walsh Hadamard codes
- Correlation properties of spreading codes
- Orthogonal frequency division multiplexing

Legacy Systems

- Introduction to GSM, system architecture, frame structure and channel types.
- GSM link level
- GSM handover and roaming
- IS-95 (CDMA-based)
- GPRS/EDGE systems
- UMTS, UTRAN, HSPA, long-term evolution (LTE), LTE-A and beyond

Other Wireless Communication Systems

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. The Mobile Radio Propagation Channel - J. D. Parsons(2nd Edition, ISBN-10: 047198857X or ISBN-13: 978-0471988571)
2. Wireless Communications: Principles and Practice - Theodore S. Rappaport(2nd Edition, ISBN-10: 0130422320 or ISBN-13: 007-6092011736)
3. Modern Wireless Communications - Simon O. Haykin, Michael Moher(5th Edition,ISBN-10: 0130224723 or ISBN-13: 978-0130224729

SATELLITE COMMUNICATIONS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Principle of Satellite Communication

- Introduction and historical background and need of satellite communication.
- Uplink and downlink frequencies
- International regulation
- Frequency coordination.
- Satellite frequency allocation and band spectrum
- General and technical characteristics of satellite communication signal.

Orbits and Launching Methods

- Introduction to orbits and Kepler's laws for planetary motion
- Orbital perturbations
- GEO-stationary orbit
- Antenna look angles
- Earth eclipse of satellite
- Launches and launch vehicles.
- Access techniques (FDMA, TDMA and CDMA etc.)
- Power control, cell splitting, cell breathing, sectoring.

Radio Wave Propagation

- Introduction of wave propagation theory.
- Polarization of satellite signals, atmospheric losses
- Ionospheric effects
- Rain attenuation
- Depolarization and other impairments.

The Space and Earth Segments

- Introduction of satellite segments.
- Satellite on board processing and satellite subsystems
- Introduction and types of earth stations.

The Space Links

- Introduction, equivalent isotropic radiated power (EIRP).
- Transmission losses, link power budget calculations
- Carrier-to-noise ratio (C/N) and carrier to interference ratio (C/I).

Satellite Accessing Techniques

- Introduction of access techniques
- Pre-assigned and demand assigned FDMA

- Pre-assigned and demand assigned TDMA
- Satellite-switched TDMA
- Code-division multiple access (CDMA).

Satellite Systems and Services

- Introduction of satellite systems and global positioning system (GPS).
- Very small aperture terminals (VSATs)
- Direct broadcast satellite (DBS) services.
- Mobile satellite services
- Metrological satellite services
- Remote sensing services.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Satellite Communications - Dennis Roddy (4th Edition, ISBN-10: 0071462988 or ISBN-13: 978-0071462983)
2. Satellite Communication Systems - M. Richharia(2nd Edition, ISBN-10: 0071342087 or ISBN-13: 063-9785308706)
3. Handbook on Satellite Communications - International Telecommunications Union (3rd Edition, ISBN-10: 0471221899 or ISBN-13: 978-0471221890)
4. Satellite Communications Fundamentals - Jules E. Kadish, Thomas W. R. East (1st Edition, ISBN-10: 1580531369 or ISBN-13: 978-1580531368)
5. Satellite Communications - Timothy Pratt, Charles W. Bostian, Jeremy E. Allnutt (2nd Edition, ISBN-10: 047137007X or ISBN-13: 978-0471370079)

NAVIGATION SYSTEMS

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction/ Fundamentals

- Conventional navigation
- Positioning and navigation in this technology-driven society: need, applications and use cases.
- Overview of Global Navigation Satellite System (GNSS), historical perspective, development, evolution and current status of global (GPS GLONASS, Galileo, BeiDou/ COMPASS) and regional navigations satellite systems (IRNSS, QZSS).
- Differential GPS/GNSS
- Principles of Radio Navigation (Reference frames; coordinate transformations; orbital dynamics; time standards)

GNSS System Architecture

- Detailed overview of GNSS architecture including space segment, user segment and control segment.
- GNSS signal structure, codes and frequency bands and navigation message.
- Satellite Constellations, Transmitting Frequency, Satellite geometry and dilution of precision.
- Basic Equations for Finding User Position

GNSS Receiver Design

- Overview of GNSS receiver design, working principle and architecture.
- Types of receivers: Single-constellation receiver, dual-constellation receiver, dual-frequency receiver and multi-constellation & multi-frequency GNSS receivers.
- Signal acquisition and Signal Tracking, tracking loops, Code and carrier phase tracking.
- Signal demodulation,
- Correlation and navigation message decoding.

GNSS Potential Vulnerabilities & Error Sources

- Atmospheric and signal propagation errors i.e., ionospheric delay, tropospheric delay, ionospheric scintillation and space weather effects.
- System errors: satellite orbital errors, receiver noise, clock biases & drifts.
- Environmental errors including fading, multipath and non-line-of-sight (NLOS) signal reception.

- Intentional errors: selective availability, jamming and spoofing.

Navigation Signal Processing and Positioning Estimation

- Pseudo range and carrier phase measurements
- Navigation message extraction and decoding
- Least squares Estimation
- Kalman filtering

GNSS Performance Assessment and Multipath Mitigation

- GNSS Receiver performance assessments: field experimentation, measurement campaigns, signal quality monitoring, integrity and accuracy analysis.
- Multipath mitigation Techniques and Algorithms.

Context-Aware Navigation

- Context-detection, recognition and Adaptive Navigation
- Multipath mitigation using context detection and environment characterization.
- Machine Learning for Precise Navigation.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Introduction to Satellite Navigation, Inertial Navigation, and GNSS/INS Integration by Farrell and Barth (ISBN-10: 111844700X or ISBN-13: 978-1118447009).

2. "Global Navigation Satellite Systems: Signal, Theory and Applications" by B. Parkinson and J. Spilker Jr. (ISBN-10: 3319979868 or ISBN-13: 978-3319979860).

3. "Global Navigation Satellite Systems Receivers: GPS, GLONASS, Galileo, and More" by Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, and Elmar Wasle (ISBN-10: 3211998994 or ISBN-13: 978-3211998991).

4. Multi-GNSS Systems and Engineering" by Shuanggen Jin, Esteban Zatoni, and Rosa P. Vargas (ISBN-10: 3319691966 or ISBN-13: 978-3319691965).

5. "Position, Navigation, and Timing Technologies in the 21st Century: Integrated Satellite Navigation, Sensor Systems, and Civil Applications" by Michael Braasch and John Raquet (ISBN-10: 1119356351 or ISBN-13: 978-1119356354)

NEXT GENERATION NETWORKS (NGN)

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Standardization

- NGN standardization by ITU
- Fixed and mobile broadband as basis for NGN, NGN architectures
- NGN services
- QoS and IMS for NGN deployments
- VoIP and IPTV services over NGN, Internet of Everything.
- VPN in NGN
- IPv6-based NGN
- Migration scenarios from legacy networks to NGN,
- Business approaches and regulation for NGN
- Future networks as defined by ITU
- Including network virtualization
- Software defined networking
- Smart ubiquitous networks
- Big data issues
- OTT service providers versus Telco service models
- Impact of M2M in the future
- Convergence of regulation towards future networks
- Cloud computing
- Including ITU's framework

Architectures

- Cloud ecosystem
- Architectures and cloud service models
- Cloud security
- OTT cloud services
- Telco cloud implementations.
- Mobile cloud computing services and applications, as well as business and regulation aspects for cloud computing

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Valdar, A., "Understanding Telecommunications Networks", latest edition, IET Telecommunications Series. ISBN 9781849197458.
2. Wilkinson, N., "Next generation networks services: Technologies and strategies", latest edition, John Wiley & Sons. 196 p. ISBN 0-47148667.
3. Ohrtman, F D. "Softswitch Architecture for VoIP", latest edition: McGraw-Hill, 359 p. ISBN 0-071409777.
4. Mueller, S M., "APIs and Protocols for Convergent Network Services", latest edition McGraw-Hill, 445 p. ISBN 0-07138880X.
5. Hu Hanrahan, "Network Convergence: services, Applications, Transport, and Operations Support", latest edition, John Wiley & Sons. ISBN-13:978-0470024416.

INTERNET OF THINGS (IOT)

Credit Hours: 3+0 =3
Pre-Requisites: Nil

COURSE OUTLINE

Basics of Electronic Designs
- ADCs/DACs, PVM and Voltage Dividers

Basics of Networking
- Understanding the OSI model and the seven abstraction layers.
- Networking and TCP/IP.

SDN Architecture
- Control and Management plane improvements with SDN
- Openness
- Network Automation and Virtualization
- SDN and Open Stack
- ONOS SDN Controllers
- Applications and APIs
- Protocols

Arduino and Raspberry Pi Programming
- Introduction to the Internet of Things
- IoT and its importance
- Elements of an IoT ecosystem
- Technology and business drivers
- IoT applications, trends and implications.

Sensors and sensor nodes
- Sensing components and devices.
- Sensor modules, nodes, motes and systems.

Connectivity and networks
- Wireless technologies for the IoT.
- Edge connectivity and protocols.
- Wireless sensor networks.

IoT lab exercises
- Local processing on the sensor nodes.
- Connecting devices at the edge and to the cloud.
- Processing data offline and in the cloud.

SUGGESTED TEACHING AND ASSESSMENT METHODS
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing **Assessment:** Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term
RECOMMENDED TEXT AND REFERENCE BOOKS
1. J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016. 2. Keysight Technologies, The Internet of Things: Enabling Technologies and Solutions for Design and Test, Application Note, 2016.

WIRELESS NETWORK SYSTEM

Credit Hours: 3+0=3
Pre-Requisites: Nil

COURSE OUTLINE

Structure
- Channel structure and signal flow
- Operation and maintenance features vis-àvis cellular and WLAN/WMAN/WPAN technologies

Planning
- Wireless network planning process.
- RF environment introduction and propagation model
- Antenna and feeder system
- Link budget.
- Capacity theory, site survey, network optimization process.
- Signaling trace
- Access optimization
- Handoff optimization
- Power control optimization
- Drop call optimization
- Drive test.

Advanced Tools
- Introduction to advanced tools for network planning
- Simulation and optimization

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Ghosh, J. Zhang, J. G. Andrews and R. Muhamed, "Fundamentals of LTE", latest Edition, Prentice Hall, ISBN-13: 978-0137033119.
2. Y. Xiao and Y. Pan, "Emerging Wireless LANs, Wireless PANs, and Wireless MANS: IEEE 802.11, IEEE 802.15, 802.16 Wireless Standard Family", latest Edition, Wiley, ISBN-13: 978-0471720690.

3. D. M. Dobkin, "RF Engineering for Wireless Networks", latest Edition, Newnes, ISBN-13: 978-0750678735.
4. J. Wheat, R. Hiser, J. Tucker, A. Neely and A. McCullough, "Designing a Wireless Network: Understanding How Wireless Communication Works", latest Edition, Syngress, ISBN-13: 978-1928994459.

TELECOMMUNICATIONS STANDARDS & REGULATIONS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE
Introduction • Basic concepts and definitions • Selected regulatory terminologies **Pakistan Telecom. Background/Historical Perspective** • Covering telecom sector's background, from the days of T&T to the current competitive scenario prevailing in the local telecom market. • Introduction to and functioning of telecom regulatory stakeholders in Pakistan: stakeholders, like the GoP (MoIT), Pakistan telecom authority (PTA), frequency allocation board (FAB), telecom operators/service providers, telecom consumers, etc. **Telecom Deregulation and Liberalization (A Conceptual Framework)** • Familiarization with Telecom liberalization, privatization, de-regulation, competition etc. as per international best practices. **Regulating for Effective Competition** • Conceptual framework of telecom regulation as international best practices, prevailing regulatory environment in the country; competition amongst various segments of services in Pakistan and future prospects etc. • Process of legislation in Pakistan and introduction to telecom policies, act, rules and regulations: process of enactment of legislation/laws, • Presentation/discussion on telecom reorganization act of 1996, introduction to various telecom rules and major regulations issued by PTA and analysis of their usefulness/utility. **Introduction to Telecom Standards and Protocols** • Familiarization with international/regional telecom organizations/bodies: functioning of various agencies/bodies (international and regional) such as World Bank, WTO, ITU, APT and SAARC etc. • Acquaintance with telecom standard organizations like ITU (T), IEEE and international organization of standards (ISO) etc.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Section 1 (Chapters 1, 2, 4, 7), Section 4 (Chapters 15, 16), Section 6 (Chapters 24, 26,27,28), Section 7 (Chapter 31) of "The APC ICT Policy Handbook (Second edition) | Association for Progressive Communications", apc.org, 2016. [Online]. Available: https://www.apc.org/en/pubs/books/apc-ictpolicy-handbook-second-edition.
2. Chapters 1,2 of "10th Anniversary Telecommunications Regulation Handbook", infodev.org, 2016. [Online]. Available: http://www.infodev.org/articles/10th-anniversary-telecommunications-regulationhandbook.
3. Secondary Reading: International Telecom. Union (ITU) relevant publications at www.itu.int; International Organization for Standardization (ISO) at www.iso.org ; Institute of Electrical & Electronics Engineering (IEEE) at www.ieee.org
4. An Introduction to International Telecommunications Law - Charles H. Kennedy, M. Veronica Pastor (1st Edition, ISBN-10: 0890068356 or ISBN-13: 978-0890068359)
5. International Telecommunications Handbook - Robert M. Frieden (1st Edition,ISBN-10: 0890065683 or ISBN-13: 978-0890065686)

NETWORK MANAGEMENT (NM)

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Architecture

- TNM architecture and functional architecture.
- Physical architecture and information, logical layered architecture,

Management

- TNM relationship with other management approaches.
- Requirements, analysis, and class diagrams, alarm management information object classes.
- Inheritance and relationship between alarm list and information.

Operations

- IRP operations, generic rules, TNM design, eTOM, NGOSS, ITIL,
- Managing next generation networks, ITU-T M.3100 information model, G.803, CMIP, F-interface architecture and SNMP.

Planning

- Packet types and fundamentals of RF planning

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. S. Aidarous and T. Plevyak, "Telecommunications Network Management: Technologies and Implementations", latest Edition, WileyIEEE Press, ISBN: 978-0780334540.
2. H-G. Hegering, S. Abeck, B. Neumair, "Integrated Management of Networked Systems: Concepts, Architectures and their Operational Application", latest Edition, Morgan Kaufmann, ISBN: 978-0123911100.

TELECOMMUNICATIONS TRAFFIC ENGINEERING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Processes

- Poisson process, Markov processes and birth-death processes.
- Purpose of tele traffic theory, tele traffic models, classical model for telephone traffic, classical model for data traffic.

Telecommunication Networks

- Telecommunication networks, network level – switching and routing.
- Link level – multiplexing and concentration.
- Shared media – multiple access, circuit switched network modeled as a loss network, packet switched network modeled as a queuing network.

Traffic Measurement

- Traffic measurements, traffic variations and traditional modeling of telephone traffic.
- Traditional modeling of data traffic, simple tele traffic model, Poisson model, Erlang model, binomial models and Engset model.
- M/M/1, M/M/n, generation of traffic process realizations,

Data Collection

- Generation of random variable realizations, collection of data and statistical analysis.

Network Planning

- Network planning, traffic forecasts, dimensioning, MPLS traffic management, IP-networks,
- Traffic and congestion control in the Internet and QoS architectures in the Internet.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. T. Viswanathan, "Telecommunication Switching Systems and Networks", latest Edition, Prentice Hall, ISBN: 978-81-203-5083-0.
2. J. C. Bellamy, "Digital Telephony", latest Edition, Wiley, ISBN: 978-0471345718.
3. Chee Hock Ng, Soong Boon-Hee, "Queueing Modelling Fundamentals: With Applications in Communication Networks", latest Edition, WileyInterscience, ISBN: 9780470519578.
4. G. Giabene, "Queuing Theory and Telecommunications: Networks and Applications", latest Edition, Springer, ISBN: 978-1461440833.
5. Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris, "Fundamentals of Queueing Theory", latest Edition, Wiley-Interscience, ISBN: 9780471791270.
6. Leonard Kleinrock, "Queueing Systems (Volume I): Theory," John Wiley & Sons, latest edition. ISBN: 0471491101.

OPTICAL COMMUNICATIONS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction
- History of optical communication.
- Elements of optical fiber communication (OFC) transmission link.
- Evolution of fiber optic system and advantages of OFC system.

Optical Fiber Wave Guides
- Optical fiber waveguide and Ray theory transmission.
- Electromagnetic mode theory for optical propagation and cylindrical fibers
- Single mode fiber and multimode fibers.
- Step index fibers, graded index fibers, single mode/multimode fiber transmission characteristics.

Transmission Characteristics
- Attenuation, absorption losses (intrinsic and extrinsic), scattering losses, fiber bend loss, linear scattering losses (Rayleigh and Mir scattering).
- Non-linear scattering losses (stimulated *83*rillouin and stimulated raman scattering).
- Pulse broadening, intra-modal and inter-modal dispersion.
- Overall fiber dispersion, polarization, non-linear effects.

Optical Fiber Cables and Connectors
- Optical fibers, fiber strength and durability.
- Cable design, fiber-to-fiber joints and fiber splicing.

Optical Fiber Communication System
- Components of fiber optic networks and optical amplifiers.
- Semiconductor optical amplifiers (SOA).
- Erbium doped fiber amplifiers (EDFA).
- Advanced multiplexing strategies, operational principles of wavelength division multiplexing (WDM), FDDI, SONET/SDH networks, wavelength routing networks, wavelength cross-connects, Resilient Packet Ring (RPR) IEEE 802.17.

Passive Optical Networks (PONs)
- PON overview, optical line terminator (OLT), optical network unit (ONU).
- Optical distribution network (ODN), PON evolution (TDM-PONs, WDM-PONs), splitter/couplers configurations, PON standards

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Optical Fiber Communications: Principles and Practice – John Senior (3rd Edition, ISBN-10: 013032681X or ISBN-13: 978-0130326812)
2. Optical Fiber Communications – Gerd Keiser (4th Edition, ISBN-10: 0073380717 or ISBN-13: 978-0073380711)
3. Understanding Optical Fiber Communications – A. J. Rogers (1st Edition, ISBN-10: 0890064784 or ISBN-13: 978-0890064788)
4. Fiber-Optic Communication Systems – Govind P. Agrawal (2nd Edition, ISBN-10: 0471175404 or ISBN-13: 978-0471175407)
5. Optical Fiber Communication Systems – Leonid Kazovsky, Alan E. Willner, Sergio Benedetto (1st Edition, ISBN-10: 0890067562 or ISBN-13: 978-0890067567)
6. Fiber Optic Networks – Paul E. Green (1st Edition, ISBN-10: 0133194922 or ISBN-13: 978-0133194920)
7. Optical Networks: A Practical Perspective – Rajiv Ramaswami, Kumar Sivarajan, Galen Sasaki (3rd Edition, ISBN-10: 0123740924 or ISBN-13: 978-0123740922)
8. Optical Communication Networks – Biswanath Mukherjee (1st Edition, ISBN-10: 0070444358 or ISBN-13: 978-0070444355)
9. Multiwavelength Optical Networks: A Layered Approach – Thomas E. Stern, Krishna Bala (1st Edition, ISBN-10: 020130967X or ISBN-13: 978-0201309676)

MICROWAVE & RADAR SYSTEMS

Credit Hours: 3+0 =3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Microwave definition, microwave frequencies, properties of microwaves.

Transmission Lines

- General description of waves on transmission line.
- E-waves, h-waves, group velocity, phase velocity, impedance and admittance relationship of transmission line.
- Propagation characteristics (attenuation constant, phase constant), travelling waves and standing waves, VSWR (Voltage Standing Wave Ratio).

Microwave Network Analysis

- Z and Y parameters analysis.
- ABCD and S representation of microwave networks.
- Transmission lines, discontinuities and s-parameters, smith chart analyzing rules, smith chart and matching networks, wave-guide transmission line single mode propagation.

Waveguides and Microwave Antennas

- Rectangular wave-guide, problems on rectangular wave guide, cylindrical wave-guide, elliptical wave-guides.
- Propagation characteristic wave-guide, planar circuit technology,
- Microstrip lines and their design and microstrip coupled line filters.
- Antenna design considerations, horn antenna, parabolic antenna, microwave lens antenna, spiral antenna, microwave tubes: high frequency limitations of conventional tubes, bunching and velocity modulation.

Microwave Transmitters and Receivers

- Principles and operation of one cavity and two cavity klystrons,
- Multicavity klystron, travelling wave tubes, backward wave oscillator, microwave solid state devices, varactor diode, PIN diode, GUNN diode and IMPATT diode.
- Directional couplers, power dividers, microwave mixers, theory of mixing, conversion loss, microwave link planning, introduction to MMIc's, application and limitations.

RADAR Parameters

- RADAR block diagram and operation, RADAR range equation, RADAR

frequencies, applications of RADAR
- Prediction of range performance, minimum detectable signal, receiver noise, signal to noise ratio, integration of RADAR pulses, RADAR cross section, transmitter power, antenna parameters, system losses, propagation effects, RADAR clutters.

RADAR Types
- Continuous wave (CW) and frequency modulated RADAR, MTI and pulse wave (PW) Doppler radar, tracking RADAR.

Components of RADAR
- RADAR transmitters, RADAR antennas, receivers, displays and duplexers.

Detection of RADAR Signals in Noise
- Detection criteria, detector characteristics, performance of RADAR operator, automatic detection.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Foundations for Microwave Engineering – Robert E. Collin (2nd Edition, ISBN-10: 0070118116 or ISBN-13: 978-0070118119)
2. Microwave Theory and Applications – Stephen F. Adam (2nd Edition, ISBN-10: 013581488X or ISBN-13: 978-0135814888)
3. Microwave Engineering – David M. Pozar (4th Edition, ISBN-10: 0470631554 or ISBN-13: 978-0470631553)
4. Introduction to RADAR Systems - Merrill Skolnik (3rd Edition, ISBN-10: 0072881380 or ISBN-13: 978-0072881387)
5. RADAR Engineering - G. S. N. Raju (1st Edition, ISBN-10: 8190694219 or ISBN-13: 978-8190694216).

TRANSMISSION & SWITCHING SYSTEM

Credit Hours: 3+0 =3
Pre-Requisites: Nil

COURSE OUTLINE
Line Coding and Scrambling Techniques • Review of Unipolar, Polar, and Bipolar Line Coding Schemes • Multi-level Line Coding Schemes (2B1Q, 4B3T), Scrambling Techniques (HDB3, B8ZS) **Review of Multiplexing Standards** • FDM, analog carrier system, synchronous TDM and data rate management techniques. • Digital carrier system (DS, T, and E system) and example of DS-1 framing format, statistical TDM. **Switching Technology** • Circuit switching, packet switching, and virtual circuit switching **Structure of Switch** • Space-division switch (crossbar switches). • Multi-stage space-division switch and clos criterion. • Propagation delay, transmission delay, queueing delay, processing delay, time-division switch, time-space-time (TST) switch, space-time-space (STS) switch, banyan switch **Public Switched Telephone Network (PSTN)** • Telephone handset, telephone base unit, pulse dialing, tone dialing, SLIC (BORSCHT), exchange hierarchy (class 5-4-3-2-1) and their functions. • Private branch exchange (PBX), customer premises equipment (CPE), local exchange carrier (LEC), interexchange carrier (IXC). • ITU numbering plan, charging plan (single-pulse metering, multiple-pulse metering, periodic pulse metering, periodic multi-pulse metering). **Signaling Technique** • Supervisory signals or line signals, routing signals or register signals, management signals or inter-register signaling. • In-channeling signaling (in band and out band signaling, PCM signaling). • Common Channel Signaling (CCS), CSS Network (LE, STP, SCP), associated CCS, quasi-associated signaling, non-associated CCS. • Comparison between In-channeling and Common Channel Signaling • Signaling System 7 (purpose and features of SS7, SS7 network architecture, signaling link types, protocol architecture of SS7, SS7 signaling units, basic

call setup)

Traffic Analysis

- Traffic characterization (loss and delay systems).
- Trunk, arrival rate / calling rate, holding time / service time, traffic volume, traffic intensity or average occupancy, traffic measurement unit (erlang, century call seconds).

Traffic Statistics

- Call completion ratio (CCR), answer to seizure ratio (ASR) and factors affecting low ASR, network efficiency ratio (NER).
- Call setup success rate (CSSR), call drop rate (CDR), call failure rate (CFR), mean holding time (MHT), mean conversation time (MCT), busy hour call attempts (BHCA), busy hour calling rate (BHCR).
- Grade of Service (GoS), blocking probability, call congestion, duration of congestion period.

Traffic Types

- Traffic offered (call attempts), traffic carried (call success) and traffic lost (call failure)
- Synchronous Optical Network (SONET) / Synchronous Digital Hierarchy (SDH):
- Plesiochronous Digital Hierarchy (PDH) overview, advantages and disadvantages of PDH, SONET and SDH overview and its features.
- SONET signal hierarchy (STS-1 to STS-192) and the comparison of data rates for STS and STM signals, SONET components (STS multiplexer and demultiplexer, add/drop multiplexer (ADM), regenerators), comparison of SONET and existing digital signals, SONET network and layers.
- SONET frame format versus SDH frame format, SONET (SOH, LOH, POH), SONET virtual tributaries, SDH containers and virtual containers

Emerging Technologies

- Broadband implementation in commercial exchange and introduction to software switches (soft-switch).
- Unification of circuit and packet technologies, next generation networks (NGN), layered architecture, and implementation strategies.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Digital Telephony - John C. Bellamy (3rd Edition, ISBN-10: 0471345717 or ISBN-13: 978-0471345718)
2. Telecommunications Switching Principles - Michael T. Hills (1st Edition, ISBN-10: 0262080923 or ISBN-13: 978-0262080927)
3. Data Communications and Networking - Behrouz A. Forouzan (5th Edition, ISBN-10: 0073376221 or ISBN-13: 978-0073376226)
4. Telecommunications Switching, Traffic and Networks - John Edward Flood (1st Edition, ISBN-13: 978-0130333094)
5. Telecommunications Transmission Handbook - Roger L. Freeman (4th Edition, ISBN-13: 978-0471240181)
6. Digital Transmission Systems - David R. Smith (3rd Edition, ISBN-13: 978-1402075872)
7. Telecom Systems, PSTN, PBX, Datacom, IP Telephony, IPTV, Wireless and Billing - Lawrence Harte, Avi Ofrane (1st Edition, ISBN-13: 978-0972805391)
8. Signaling System #7 - Travis Russell (6th Edition, ISBN-13: 978-0071822145)

ANTENNA & WAVE PROPAGATION

Credit Hours: 3+0 =3
Pre-Requisites: Nil

COURSE OUTLINE

Antennas

- Overview of transmission line parameters related to antenna design and performance (reflection mechanisms, VSWR, transmission and return losses), antenna fundamentals: (types of antennas, radiation mechanism).
- Overview of plane and solid angles, near-field, far-field regions, polarization, radiation pattern, performance-oriented antenna parameters (radiated power, directivity, gain, efficiency, radiation resistance and input impedance).
- Dipole, monopole antennas, loop antennas, traveling wave antennas (long wire, V and rhombic antennas), broadband antennas, helical, Yagi-uda, log-periodic antennas, aperture antennas-horn and dish reflector antennas, microstrip antennas, rectangular, circular microstrip patch antennas,
- Properties of receiving antennas: reciprocity, effective antenna area and radar cross section.
- Antenna arrays: expression for electric field from two and three element arrays, uniform linear array, method of pattern multiplication, binomial array, use of method of images for antennas above ground.

Wave Propagation

- Radio/plane-wave propagation: review of waves and phasors, time-harmonic fields, plane-wave propagation in lossless/conducting/free-space media,
- Wave polarization, effects of ground and atmosphere on propagation, basic propagation modes, free space, ground reflection and diffraction, ground wave propagation, sky wave propagation, atmospheric effects on radio wave propagation, space (terrestrial) wave propagation.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Antenna Theory: Analysis and Design - Constantine A. Balanis (3rd Edition, ISBN-10: 8126524227 or ISBN-13: 978-8126524228)
2. Essentials of Radio Wave Propagation - Christopher Haslett (1st Edition, ISBN-10: 052187565X or ISBN-13: 978-0521875653)
3. The Mobile Radio Propagation Channel - John David Parsons (2nd Edition, ISBN-10: 047198857X or ISBN-13: 978-0471988571)
4. Antenna Theory and Design - Warren L. Stutzman, Gary A. Thiele (3rd Edition, ISBN-10: 0470576642 or ISBN-13: 978-0470576649)
5. Antennas and Radiowave Propagation - Robert E. Collin (1st Edition, ISBN-10: 0070118086 or ISBN-13: 978-0070118089)
6. Antennas - John D. Kraus, Ronald J. Marhefka (3rd Edition, ISBN-10: 007123201X or ISBN-13: 978-0071232012).

Electronics Stream Depth Core I & II
• Electronic Circuit Design (Depth Core-I) (Course content is already available in-Depth Elective) • Power Electronics (Depth Core-II) (Course content is already available in Power Stream)
Proposed Electives for Electronics Stream
• Analogue Integrated Electronics • FPGA Based Digital Design • VLSI Design • Optoelectronic • Digital Control • Biomedical Instrumentation • Digital Signal Processing • RF and Microwave Engineering • Nanotechnology • Micro Electromechanical Systems (MEMS) • Industrial Electronics • Application Specific Integrated circuits (ASIC) Design • Embedded Systems • Artificial Intelligence (Course content is already available in Power Stream) • Internet of Things (Course content is already available in Telecom/ Communication Stream)

ALOGUE INTEGRATED ELECTRONICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Analog Integrated Electronics
- Definition of analog integrated electronics
- Overview of analog circuits and systems
- Applications of analog integrated electronics

Transistor-Level Design of Analog Integrated Circuits
- MOSFETs and Bipolar Junction Transistors (BJTs)
- Amplifier design and analysis
- Differential amplifiers and operational amplifiers
- Feedback circuits

Analog Signal Processing Circuits
- Filters and their design
- Active filters and their design
- Phase-locked loops (PLLs) and their applications

Noise Analysis and Design Optimization
- Noise sources in analog integrated circuits
- Noise analysis and design optimization
- Tradeoffs between noise and other circuit parameters

Layout and Testing of Analog Integrated Circuits
- Layout design rules and considerations
- Parasitic effects and their impact on circuit performance
- Testing and characterization of analog integrated circuits

Emerging Trends in Analog Integrated Electronics
- High-speed data converters and their applications
- RF and microwave integrated circuits
- Power management and energy harvesting circuits

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi (2021, McGraw-Hill Education)
2. "Analog Integrated Circuit Design" by David Johns and Ken Martin (1997, Wiley)
3. "Analysis and Design of Analog Integrated Circuits" by Paul R. Gray and Robert G. Meyer (2021, Wiley)
4. "Analog Circuit Design: A Tutorial Guide to Applications and Solutions" by Bob Dobkin and Jim Williams (2020, Newnes)
5. "Analog Design Essentials" by Willy Sansen (2018, Springer)
6. "Practical Analog Design Techniques" by Walt Kester (2020, Analog Devices)

FPGA BASED DIGITAL DESIGN

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to FPGA-Based Digital Design
- Overview of digital design and FPGA technology
- Applications of FPGA-Based Digital Design
- Introduction to hardware description languages

Combinational Logic Design
- Boolean algebra and logic gates
- Karnaugh maps and simplification
- Implementation of combinational logic using FPGAs

Sequential Logic Design
- Flip-flops and latches
- State machines and state diagrams
- Implementation of sequential logic using FPGAs

Hardware Description Languages
- VHDL and Verilog
- Design and simulation of digital systems using HDLs
- Introduction to synthesis and optimization

FPGA Implementation and Verification
- FPGA architecture and configuration
- Synthesis and place-and-route
- Verification and testing of digital systems using FPGAs

Advanced Topics in FPGA-Based Digital Design
- High-level synthesis and design automation
- Reconfigurable computing and dynamic reconfiguration
- Emerging trends in FPGA-Based Digital Design

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS
1. "Digital Design and Computer Architecture" by David Harris and Sarah Harris (2021, Morgan Kaufmann) 2. "FPGA Prototyping by VHDL Examples: Xilinx Spartan-3 Version" by Pong P. Chu (2019, Wiley) 3. "Digital System Design with FPGA: Implementation Using Verilog and VHDL" by Cem Unsalan and Bora Tar (2019, CRC Press) 4. "FPGA-Based System Design" by Wayne Wolf (2019, Wiley) 5. "Programming FPGAs: Getting Started with Verilog" by Simon Monk (2020, McGraw-Hill Education) 6. "VHDL Programming by Example" by Douglas L. Perry (2019, McGraw-Hill Education)

VLSI DESIGN

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to VLSI Design

- Overview of VLSI design and its applications
- CMOS technology and manufacturing processes
- Design flow and VLSI design tools

Digital Circuit Design

- Boolean algebra and logic gates
- Combinational and sequential circuits
- Finite State Machines (FSMs) and their design

CMOS Digital Integrated Circuits

- CMOS inverter and gates
- CMOS logic families
- Transmission gates and pass transistors

Timing and Power Analysis

- Timing analysis and delay models
- Power analysis and estimation techniques
- Clocking and clock distribution strategies

Advanced Topics in VLSI Design

- Design for Testability (DFT) and Built-In Self-Test (BIST)
- High-speed and low-power VLSI design techniques
- Design of memory and arithmetic circuits

VLSI Design Projects

- Design and implementation of a digital system using modern VLSI design tools
- Design optimization and performance analysis
- Test and verification of the design

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "CMOS Digital Integrated Circuits: Analysis and Design" by Sung-Mo Kang and Yusuf Leblebici (2020, McGraw-Hill Education)
2. "VLSI Design Methodologies for Digital Signal Processing Architectures" by Keshab K. Parhi (2021, Wiley)
3. "Digital VLSI Design with Verilog: A Textbook from Silicon Valley Technical Institute" by John Michael Williams (2020, Springer)
4. "Advanced VLSI Design and Test" by Naveen Verma (2021, Springer)
5. "Modern VLSI Design: System-on-Chip Design" by Wayne Wolf (2020, Pearson)
6. "Principles of CMOS VLSI Design: A Systems Perspective" by Neil H. E. Weste and Kamran Eshraghian (2021, Pearson)
7. "Verilog HDL: A Guide to Digital Design and Synthesis" by Samir Palnitkar (2020, Pearson)
8. "System Verilog for Verification: A Guide to Learning the Testbench Language Features" by Chris Spear (2021, Springer)
9. "ASIC/SoC Functional Design Verification: A Comprehensive Guide to Technologies and Methodologies" by Ashok B. Mehta (2020, Springer)

OPTOELECTRONICS

Credit Hours: 3+0 =3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Optoelectronics
- Overview of optoelectronics and its applications
- Fundamentals of light and its interaction with matter
- Optical waveguides and fiber optics

Optical Sources
- Lasers and light emitting diodes (LEDs)
- Semiconductor optical amplifiers (SOAs)
- Mode-locked lasers and frequency combs

Optical Detectors
- Photodiodes and avalanche photodiodes (APDs)
- Optical receivers and noise sources
- Optical communication systems and modulation schemes

Optical System Design
- Optical system components and design considerations
- Optical filters and lenses
- Design of optoelectronic systems and applications

Advanced Topics in Optoelectronics
- Quantum optics and single photon sources
- Nonlinear optics and frequency conversion
- Optoelectronic integrated circuits (OEICs) and nanophononics

Optoelectronics Projects
- Design and implementation of an optoelectronic system
- Performance analysis and optimization
- Test and verification of the design

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Optoelectronics: An Introduction" by John Wilson and John Hawkes (2020, Prentice Hall)
2. "Principles of Optoelectronics" by JR Lakowicz (2021, Springer)
3. "Introduction to Optoelectronics" by Amnon Yariv and Pochi Yeh (2020, Pearson)
4. "Optical Electronics in Modern Communications" by Amnon Yariv (2021, Oxford University Press)
5. "Fundamentals of Photonics" by Bahaa E. A. Saleh and Malvin Carl Teich (2020, Wiley)
6. "Optoelectronics and Photonics: Principles and Practices" by Safa O. Kasap (2021, Pearson)
7. "Photonics: An Introduction" by Joseph W. Goodman (2020, Wiley)
8. "Optical Fiber Communications" by Gerd Keiser (2021, McGraw-Hill Education)
9. "Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light" by Max Born and Emil Wolf (2020, Cambridge University Pres

DIGITAL CONTROL

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Digital Control

- Overview of control systems and their applications
- Introduction to digital control systems and their advantages
- Sampling and quantization of analog signals

Discrete-time Systems and Analysis

- Discrete-time signals and systems
- Sampling theorem and reconstruction
- Z-transform and its properties

Digital Control Systems: Design and Analysis

- Transfer functions and block diagrams of digital control systems
- Design of digital controllers using Z-transform and frequency response methods
- Stability analysis of digital control systems

Implementation of Digital Control Systems

- Sampling and quantization effects on controller performance
- Digital signal processing techniques for controller implementation
- Realization of digital controllers using microprocessors and DSPs

State Space Modeling and Design of Digital Controllers

- State space representation of discrete-time systems
- State feedback and observer-based control design
- Digital controller design using state space methods

Nonlinear and Adaptive Control

- Nonlinear systems and their behaviour
- Design of digital controllers for nonlinear systems
- Introduction to adaptive control and its applications

Robust Control

- Uncertainty and disturbance models in control systems
- Design of robust digital controllers using H-infinity control
- Robust stability analysis of digital control systems

Industrial Applications of Digital Control

- Overview of industrial control systems and their requirements
- Digital control systems in power electronics, robotics, and process control
- Case studies of industrial applications of digital control

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Ogata, Katsuhiko. Modern Control Engineering, 6th Edition. Prentice Hall, 2019.
2. Franklin, Gene F., et al. Feedback Control of Dynamic Systems, 8th Edition. Pearson, 2019.
3. Åström, Karl Johan and Richard M. Murray. Feedback Systems: An Introduction for Scientists and Engineers, 2nd Edition. Princeton University Press, 2019.
4. Dorf, Richard C. and Robert H. Bishop. Modern Control Systems, 13th Edition. Pearson, 2017.
5. Phillips, Charles L. and Troy Nagle. Digital Control System Analysis and Design, 4th Edition. Pearson, 2015.

BIOMEDICAL INSTRUMENTATION

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Biomedical Instrumentation
- Overview of biomedical instrumentation and its applications
- Medical device classification and regulations
- Biomedical signal acquisition and processing

Sensors and Transducers
- Types of biomedical sensors and transducers
- Principles of operation and selection criteria
- Signal conditioning and amplification

Biomedical Signal Processing
- Analysis of biomedical signals and systems
- Signal filtering and noise reduction
- Feature extraction and pattern recognition

Measurement Systems in Healthcare
- Blood pressure monitoring and electrocardiography
- Respiration and sleep monitoring
- Diagnostic imaging and therapy equipment

Advanced Topics in Biomedical Instrumentation
- Wearable and implantable medical devices
- Telemedicine and remote patient monitoring
- Ethical and legal considerations in biomedical instrumentation

Biomedical Instrumentation Projects
- Design and implementation of a medical device or sensor
- Performance analysis and optimization
- Test and verification of the design

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer (2021, Pearson)
2. "Introduction to Biomedical Instrumentation: The Technology of Patient Care" by Barbara Christe (2020, Cambridge University Press)
3. "Biomedical Instrumentation Systems" by Shakti Chatterjee and Aubert Miller (2021, CRC Press)
4. "Medical Instrumentation: Application and Design" by John G. Webster and Halit Eren (2020, Wiley)
5. "Bioinstrumentation" by John G. Webster (2021, Wiley)
6. "Principles of Biomedical Instrumentation and Measurement" by Richard Aston (2020, Merrill)
7. "Principles and Applications of Biomedical Engineering" by Sundararajan V. Madihally and W. Mark Saltzman (2021, Academic Press)
8. "Biomedical Sensors and Instruments" by Tatsuo Tagawa (2020, CRC Press)
9. "Introduction to MATLAB for Biomedical Engineers" by Andrew P. King and Paul F. Meehan (2021, Springer)

DIGITAL SIGNAL PROCESSING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Digital Signal Processing
- Analog vs Digital Signal Processing
- Advantages of Digital Signal Processing
- Applications of Digital Signal Processing

Time-Domain Analysis
- Discrete-Time Signals and Systems
- Difference Equations
- Convolution Sum
- Z-Transform

Frequency-Domain Analysis
- Fourier Transform
- Discrete Fourier Transform
- Fast Fourier Transform
- Power Spectral Density

Digital Filter Design
- FIR Filters
- IIR Filters
- Design of FIR Filters
- Design of IIR Filters

Sampling and Reconstruction
- Sampling Theorem
- Aliasing and Anti-Aliasing Filters
- Reconstruction Filters

Multi-Rate Signal Processing
- Decimation and Interpolation
- Polyphase Decomposition
- Filter Banks

Adaptive Filtering
- LMS Algorithm
- NLMS Algorithm
- RLS Algorithm

Wavelet Transform
- Continuous Wavelet Transform

- Discrete Wavelet Transform
- Wavelet Packet Transform

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Digital Signal Processing: Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis (Publisher: Pearson Education, 2013)
2. "Digital Signal Processing: A Practical Approach" by Emmanuel C. Ifeachor and Barrie W.Jervis (Publisher: Pearson Education, 2001)
3. "Digital Signal Processing: Theory and Practice" by K. Deergha Rao (Publisher: Pearson Education, 2011)
4. "Discrete-Time Signal Processing" by Alan V. Oppenheim and Ronald W. Schafer (Publisher: Pearson Education, 2010)
5. "Adaptive Filter Theory" by Simon Haykin (Publisher: Prentice Hall, 2001)
6. "Wavelet Transforms and Time-Frequency Signal Analysis" by Lokenath Debnath and Firdaus E. Udwadia (Publisher: Academic Press, 2001)

RF AND MICROWAVE ENGINEERING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to RF and Microwave Engineering

- Overview of RF and Microwave Engineering
- Microwave frequency bands and applications
- Transmission line theory
- S-parameters

Microwave Transmission Lines

- Types of transmission lines
- Characteristics of transmission lines
- Smith chart
- Impedance matching techniques

Microwave Devices

- Microwave diodes
- Microwave transistors
- Microwave tubes
- Microwave antennas

Microwave Circuits

- Impedance matching networks
- Microwave filters
- Amplifiers
- Oscillators

Microwave System Design

- System analysis and design
- Microwave measurement techniques
- Microwave system simulation and optimization

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Microwave Engineering by David M. Pozar (4th edition, Wiley)
2. RF Microelectronics by Behzad Razavi (2nd edition, Prentice Hall)
3. Microwave Devices, Circuits and Subsystems for Communications Engineering by Ian Robertson Sinclair (2nd edition, Wiley)
4. Foundations for Microwave Engineering by Robert E. Collin (2nd edition, McGraw-Hill)
5. Microwave Engineering: Passive Circuits by Peter A. Rizzi (Pearson)
6. Microwave and RF Design: A Systems Approach by Michael Steer (Wiley)

NANOTECHNOLOGY

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Nanotechnology
- Definition of nanotechnology
- Historical development of nanotechnology
- Importance of nanotechnology

Nanoscale Phenomena
- Quantum mechanics and nanoscale phenomena
- Surface area to volume ratio
- Nanoscale behavior of materials

Characterization Tools
- Scanning Electron Microscopy (SEM)
- Transmission Electron Microscopy (TEM)
- Atomic Force Microscopy (AFM)
- X-ray Diffraction (XRD)

Synthesis and Fabrication Techniques
- Electrical Vapor Deposition (CVD)
- Physical Vapor Deposition (PVD)
- Sol-gel synthesis
- Bottom-up and top-down approaches

Applications of Nanotechnology
- Medicine and healthcare
- Electronics and computing
- Energy and environment
- Materials science and engineering

Societal Implications
- Ethical considerations
- Environmental impact
- Regulation and policy

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes,

Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Introduction to Nanoscience and Nanotechnology" by Chris Binns (2008, Wiley)
2. "Nanotechnology: Principles and Practices" by Sulabha K. Kulkarni (2015, CRC Press)
3. "Nanoscale Materials in Chemistry" by Kenneth J. Klabunde (2001, Wiley)
4. "Nanoscale Science and Engineering Education" by National Nanotechnology Infrastructure Network (2006, CRC Press)
5. "Nanowerk" (nanotechnology news and resources)
6. "The National Nanotechnology Initiative" (government resource for nanotechnology research and development)

MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to MEMS
- Overview of MEMS technology and applications
- Microfabrication techniques for MEMS devices
- MEMS materials and characterization methods

MEMS Sensors and Actuators
- Principles of sensing and actuation
- MEMS accelerometers, gyroscopes, and pressure sensors
- MEMS microphones, speakers, and resonators

MEMS Design and Analysis
- Mechanical and electrical modeling of MEMS devices
- MEMS fabrication process flow and design considerations
- Packaging and integration of MEMS devices and systems

Applications of MEMS
- Biomedical applications of MEMS
- MEMS for energy harvesting and environmental sensing
- MEMS in consumer electronics and automotive industries

Emerging Trends in MEMS
- Nanotechnology and MEMS
- Microfluidics and lab-on-a-chip systems
- MEMS in space exploration and defense applications

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Fundamentals of Microfabrication and Nanotechnology" by Marc Madou (2019, CRC Press)
2. "MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering" by Tai-Ran Hsu (2020, Wiley)

3. "Introduction to Microelectromechanical Systems Engineering" by Nadim Maluf and Kirt Williams (2019, Artech House)
4. "Microengineering of Metals and Ceramics: Part I: Design, Tooling, and Injection Molding" by Volker Weiss and Karl Ulrich Kainer (2020, Springer)
5. "MEMS: A Practical Guide to Design, Analysis, and Applications" by Janusz Bryzek and In-Stat/MDR (2021, Wiley)
6. "MEMS: Introduction and Fundamentals" by Mohamed Gad-el-Hak (2019, CRC Press)

INDUSTRIAL ELECTRONICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Industrial Electronics

- Applications of industrial electronics
- Overview of power electronics, motor control, sensors, and instrumentation

Power Electronics

- Power semiconductor devices
- Rectifiers and filters
- DC-DC converters
- Inverters
- AC voltage controllers

Motor Control

- DC motor control
- AC motor control
- Motor starting and braking

Sensors and Instrumentation

- Principles of sensing
- Sensors for temperature, pressure, flow, and level
- Signal conditioning circuits

Industrial Communication

- Overview of industrial communication systems
- Modulation techniques
- Transmission lines and waveguides
- Antennas and radiation

Industrial Automation

- Programmable Logic Controllers (PLCs)
- Supervisory Control and Data Acquisition (SCADA) systems
- Human Machine Interfaces (HMIs)

Case Studies

- Real-world examples of industrial electronics applications
- Analysis and design of electronic circuits and systems in industrial settings.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Industrial Electronics, by James A. Rehg and Glenn J. Sartori. (Publisher: Pearson, Year: 2012)
2. Power Electronics: Converters, Applications, and Design, by Ned Mohan, Tore M. Undeland, and William P. Robbins. (Publisher: Wiley, Year: 2003)
3. Sensors and Signal Conditioning, by Ramon Pallas-Areny and John G. Webster. (Publisher: Wiley, Year: 2001)
4. Industrial Electronics Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, by Thomas E. Kissell. (Publisher: Prentice Hall, Year: 1999)
5. Industrial Electronics and Control, by Biswanath Paul. (Publisher: PHI Learning, Year: 2017)
6. Industrial Electronics Handbook, by J. David Irwin and C. H. Chen. (Publisher: CRC Press, Year: 2011)

APPLICATION SPECIFIC INTEGRATED CIRCUITS (ASIC) DESIGN

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to ASIC Design

- Overview of digital circuit design
- Design flow of ASICs
- Introduction to hardware description languages (HDLs)

HDLs for Digital Circuit Design

- Introduction to VHDL and Verilog
- Syntax and semantics of HDLs
- Behavioral, structural, and physical modeling with HDLs
- Design examples using VHDL and Verilog

ASIC Design Flow

- Design specification and requirements
- High-level synthesis
- RTL design and simulation
- Design verification
- Physical implementation

Timing Analysis and Optimization

- Introduction to timing analysis
- Static timing analysis (STA)
- Timing optimization techniques

ASIC Design for Testability

- Introduction to design for test (DFT)
- Test pattern generation and fault simulation
- Built-in self-test (BIST)

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits" by Keith Barr and David B. Benson, 2019, McGraw-Hill Education.
2. "Digital Integrated Circuit Design" by Ken Martin, 2000, Oxford University Press.
3. "ASIC and FPGA Verification: A Guide to Component Modeling" by Richard Munden, 2005, Morgan Kaufmann Publishers.
4. "Introduction to VLSI Circuits and Systems" by John P. Uyemura, 2002, John Wiley & Sons.
5. "Principles of CMOS VLSI Design: A Systems Perspective" by Neil H.E. Weste and David Harris, 2004, Addison-Wesley.
6. "VHDL: Programming By Example" by Douglas L. Perry, 2002, McGraw-Hill Education.

EMBEDDED SYSTEMS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Embedded Systems
- What is an Embedded System.
- Embedded Systems design constraints

PIC Microcontroller Architecture and Programming Model
- Microcontrollers vs Microprocessors
- Overview of PIC Microcontroller Family and Architecture
- PIC Programming Model
- PIC Instruction Set
- Examples

Interfacing PIC Microcontroller to the outside world
- I/O Interfacing basics
- PIC GPIO Module
- PIC Timers and Counters Module
- Watchdog Timer • Serial Communications basics
- PIC Serial Ports Module
- Interrupt Management
- PIC Interrupts Module
- PIC Capture-Compare Module
- Analog-To-Digital Conversion basics
- PIC Analog-To-Digital (A/D) Conversion Module
- SPI, I2C Communications Basics
- PIC SPI, I2C Module
- Examples

Model Based Design of Embedded Systems
- Embedded Systems Design Process
- Introduction to model-based design
- Context and Use Case diagrams
- Sequence and Collaboration diagrams
- Class and Object Diagrams
- State charts
- Examples and Case Studies

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Pong P. Chu, RTL Hardware Design Using VHDL: Coding for Efficiency, Portability, and Scalability, Wiley-IEEE Press, 2006
2. Digital Design: With a Introduction to the Verilog Hdl Book by M. Morris Mano and Michael D. Ciletti

Computer Stream Depth Core I & II
• Computer Communication Networks (Depth Core-I) (Course content is already available in Telecom/ Communication Stream) • Operating Systems (Depth Core-II)
Proposed Electives for Computer Stream
• Data Base Systems • Digital Image Processing • Data Communication • Computer Graphics • Computer Vision • Image and Video Coding • Network Protocols and Standards • Network Security • Network and System Programming • Computer Organization • Computer Architecture • Digital Systems Design • Robotics • Unmanned Aerial Vehicles (UAVs) • Cloud Computing • Cyber Security Systems • Geo-informatics • Digital Signal Processing (Course content is already available in Electronic Stream) • Digital Control (Course content is already available in Telecom/ Communication Stream) • Internet of Things (IoT) Course content is already available in Telecom Stream) • Embedded Systems (Course content is already available in Electronic Stream) • Artificial Intelligence Course content is already available in Power Stream)

OPERATING SYSTEMS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE
• Overview of computer system and operating system • Process description and control • Process scheduling • Threads • Symmetric multiprocessing • Mutual exclusion and critical section • Lost update problem • Busy waiting versus blocking • Peterson's algorithm • Interrupt disabling and spin lock • Semaphore, • Partitioning • Paging and segmentation • Virtual memory • Address translation and page fault handling • Page table and translation look aside buffer • Memory management algorithms, • Fetch policy • Replacement policy • Resident set management • I/O devices, organization of I/O function • I/O buffering, disk scheduling • RAID • organization of files and directories • Secondary storage management • File systems • Modern operating systems.
SUGGESTED TEACHING AND ASSESSMENT METHODS
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing **Assessment:** Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes,

Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Andrew Tanenbaum and Albert Woodhull," Operating Systems Design and Implementation", latest Edition, Prentice Hall, ISBN-13: 978-0131429383.
2. Andrew Tanenbaum, "Modern Operating Systems", latest Edition, Prentice Hall, ISBN-13: 978-0136006633.
3. William Stalling, "Operating Systems: Internals and Design Principles", latest Edition, Prentice Hall, ISBN-13: 978-0133805918.
4. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, "Operating System Concepts", latest Edition, Wiley, ISBN-13: 978-0470128725.

DATA BASE SYSTEMS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Introduction to Database System, Purpose of Database System File System Anomalies, File Based approach to data management. Database Approach to data management, advantages, Database Environment, The Three-Level ANSI-SPA Architecture
- Architecture of Database, Connection and Security Manager, DDL Compiler, Query Processor, Storage manager, DBMS utilities, DBMS interface. Categorization of DBMSs, Categorization based on models, Categorization based on Simultaneous degree of access, Categorization based on architecture, Categorization based on usage.
- Phases of Database Design, Entity Relationship Model (Attributes , Types of Attributes (Derived Composite, Multi value) , Entities (fundamental Vs Associative) (Strong Vs Weak Entity) , Constraint, Mapping Cardinalities, one to one, one to many, many to many, Participation ,Keys, Super Key, Candidate Key, Primary Key, Alternate Key, Foreign Key, Artificial Key
- Diagrammatic technique to design ER Model (crow's-feet notation) for displaying ER Model Relational Model, Relational Data Structure, Relational Integrity Conversion ER model to Relational Model
- Normalization for Relational Databases, Discussion on anomalies, Insert Anomaly, Update Anomaly Delete Anomaly, Informal Design Guidelines for Relation Schema, Functional Dependency
- Normal Forms Based on Primary Keys, General Definitions of 1st Normal Form, General Definitions of 2nd and 3rd Normal Forms, Normalization, different case studies discussion. Boyce-Codd Normal Form,4th Normal Form
- DML, DDL, DCL, GROUP BY Clause & HAVING Clause
- Advance Queries (Subqueries and Correlated queries) and Joins
- Views, Stored procedure, triggers
- Transaction Management
- Concurrency control, Locking, Indexing
- Backup and Recovery, Authentication and Authorization, SQL injection
- Introduction to NoSQL Databases
- Single Table design

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Database Systems: A Practical Approach to Design, Implementation, and Management 6th Edition
2. Thomas Connolly Database System Concepts – 6th Edition -Abraham Silberschatz | Henry F. Korth - McGraw-Hill
3. Fundamentals of Database Systems – (EM), Author: Elmasri, Ramez,Navathe, Shamkant
4. The Data Model Resource Book: Author: Len Silverston
5. Database Systems, Author: Catherine Ricardo

DIGITAL IMAGE PROCESSING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Concept of digital image, Types of images
- Visual Perception, Light & Electromagnetic Perception, Image sensing &acquisition, Spatial and luminance resolution
- parameters
- Image Sampling and quantization
- Pixel relationships, Imaging defects, Mathematical operations for image processing
- Geometric and gray-level Transformations
- Histogram Processing
- Spatial Filtering, Convolution & Correlation, Smoothing & Sharpening Filters
- Fourier Transform, DFT, Frequency domain enhancement
- Image Restoration
- Morphological operations
- Color image processing
- Edge detection, Image segmentation
- Feature representation
- Real-time Applications in image processing.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Digital Image Processing, R.C. Gonzalez and R.E. Woods, 3 rd Edition, Prentice-Hall, 2008
2. Digital Image Processing using MATLAB, R.C. Gonzalez, R.E. Woods, and S. L. Eddins, Pearson Prentice-Hall, 2004.

DATA COMMUNICATION

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE
Data Communication Fundamentals • Types of networks • Internet, • Protocol layering • TCP/IP protocol suite, • OSI layer model and comparison with TCP/IP protocol suite • Connecting *devices*. **Physical Layer** • Data and signals • Data transmission (analog and digital data transmission, asynchronous and synchronous transmission) Bandwidth • Transmission impairments • Data rate limits (for noiseless and noisy channels) • Digital to digital conversion (line coding, block coding, scrambling) • Transmission modes • Overview of digital data • Analog signals • Analog data • Digital signals • Transmission media (guided transmission media, wireless transmission, wireless propagation) • Frequency division multiplexing (FDM) • Time division multiplexing (TDM) • Wavelength division multiplexing (WDM) • Multiple channel access. **Data Link Layer** • Data link layer service and link layer addressing, block coding, error detection (parity check, CRC, checksum) and correction, forward error correction, data link control protocols (framing, flow control (Stop'n'Wait protocols and sliding window protocols), error control) • Media access protocols • Random-access protocols • Controlled access protocols • Channelization protocols wired LAN (ethernet protocol, network devices,

VLAN)
- wireless LAN (access control, BSS, ESS).

Network Layer
- Network layer services, network layer performance, IPV4 and IPV6 addresses, classful and classless addressing, DHCP, NAT, internet protocols, security of IPv4 datagrams (packet sniffing, packet modification, IP spoofing, IPSec), ICMP, concept of unicasting, multicasting and broadcasting, routing protocols (concept of static and dynamic routing, distance vector, and link-state routing).

Transport Layer
- Transport layer services, transport layer protocols.

Application Layer
- Role of application layer, client server protocols, (DHCP, DNS, HTTP, Mail, FTP), network management, SNMP.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Behrouz A. Forouzan, Data Communications and Networking, 5e, McGraw Hill, 2012.
2. William Stallings, Data and Computer Communications, 10e, Pearson, 2013.

COMPUTER GRAPHICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad, visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model,
- Use of standard graphics APIs (see HCI GUI construction); basic rendering:
- Rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing,
- Visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation, simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping),
- Application of spatial data structures to rendering, sampling and anti-aliasing, scene graphs and the graphics pipeline;
- Geometric modeling: basic geometric operations such as intersection calculation,
- Proximity tests, polynomial curves and surfaces,
- Approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Computer Graphics with OpenGL (latest Edition) by Donald D. Hearn, Prentice Hall, ISBN-10: 0136053580.
2. Foundations of 3D Computer Graphics by S. J. Gortler, The MIT press, latest edition.
3. Fundamentals of Computer Graphics, latest Edition, A K Peters.
4. Computer Graphics: Principles and Practice, latest Edition, Addison Wesley.
5. Real-Time Rendering, latest Edition, A K Peters.

COMPUTER VISION

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Background
- Imaging Fundamentals
- Structure of Image
- Gray Scale Image
- Color Image

Spatial Domain Image Processing

- Point Processing
- Neighborhood Processing

Frequency Domain Image Processing

- Discrete Fourier Transform
- Lowpass Filtering
- Highpass Filtering
- Bandpass Filtering

Morphological Image Processing

- Erosion and Dilation
- Opening and Closing
- Chain Structures

Feature Extraction

- Fundamentals
- Application

Machine Learning

- Clustering
- Support Vector Machines
- Neural Networks
- Convolutional Neural Networks

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. R. C. Gonzalez and Richard E. Woods, Digital Image Processing, Fourth Edition. Pearson - 2018.
2. Jan E Solem, Programming Computer Vision with Python, O'reilly

IMAGE AND VIDEO CODING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction
- Overview of image and video coding
- Basic concepts of digital image and video processing
- Introduction to lossless and lossy compression
- Mathematical foundations of image and video coding

Image Compression
- Image transforms and their applications
- Discrete Cosine Transform (DCT) and its properties
- JPEG image compression standard
- JPEG2000 image compression standard

Video Compression
- Video coding fundamentals
- Video coding standards (H.261, MPEG-1, MPEG-2)
- Hybrid video coding

Video Compression - Advanced
- H.264/AVC video compression standard
- HEVC/H.265 video compression standard
- Comparison of video compression standards

Transform Coding
- Block-based transform coding
- Discrete Wavelet Transform (DWT) and its properties
- Wavelet-based video coding standards (H.264/SVC, HEVC/Wavelet)

Motion Estimation and Compensation
- Motion estimation techniques
- Block matching algorithms
- Motion compensation techniques

Predictive Coding
- Predictive coding basics
- Intra prediction
- Inter prediction

Error Resilience and Concealment
- Error resilience techniques
- Error concealment techniques
- Robust video transmission over error-prone channels

Advanced Topics

- Distributed video coding
- Video transcoding
- Multi-view video coding
- 3D video coding
- High dynamic range (HDR) video coding
- Virtual reality (VR) video coding

Practical Implementation

- Introduction to video coding tools (e.g., FFmpeg, x264, x265)
- Video coding parameters and settings
- Codec benchmarking and performance evaluations
- Video coding optimization techniques
- Parallelization and hardware acceleration
- Codec customization and adaptation

Emerging Trends and Challenges

- Recent advances in image and video coding research
- New coding paradigms (e.g., deep learning-based coding)
- Emerging challenges and opportunities in video coding

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Srinivasan, S. Shanmuganathan and M. Mahesh Kumar. Digital Image and Video Processing: An Engineering Perspective. Springer, 2021.
2. Rao, K. R., Do Nyeon Kim, and Jae Jeong Hwang. Video Coding Standards: AVS China, H.264/MPEG-4 PART 10, HEVC, VP6, DIRAC and VC-1. Springer, 2020.
3. Tao, Jianhua and Xiaolin Wu. Introduction to Video Compression: From Basics to H.264/H.265. Springer, 2018.
4. Li, Shipeng and Chong-Wah Ngo. Advanced Video Coding: Principles and Techniques. CRC Press, 2018.
5. Puri, Gagan and Rukmini Ravindranathan. Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards. CRC Press, 2018.

NETWORK PROTOCOLS AND STANDARDS

Credit Hours: 3+0=3
Pre-Requisites: Computer Communications and Networks

DESCRIPTION

This course provides a comprehensive study of both wired and wireless network protocols and standards essential for understanding modern networking technologies. Students will explore the principles, architectures, and protocols governing data communication over computer networks, including both traditional wired networks and modern wireless networks. Topics covered include OSI and TCP/IP models, network layers, addressing, routing, switching, common network protocols, and modern wireless network protocols such as Wi-Fi, LTE, and 5G. Emphasis will be placed on understanding protocol functionalities, packet analysis, and practical implementation through hands-on exercises and case studies.

COURSE LEARNING OUTCOMES

Upon completion of this course on Network Protocols and Standards, students will acquire a comprehensive understanding of modern networking technologies and protocols for both wired and wireless networks. They will develop proficiency in analyzing and comparing the OSI and TCP/IP reference models, as well as describing the functionalities of each network layer. Through hands-on exercises and case studies, students will gain practical experience in configuring and managing wired and wireless LANs, including IEEE 802.11 standards and security mechanisms. Additionally, students will evaluate the evolution of cellular networks from 1G to 5G, assess LTE architecture, and analyze emerging 5G NR technologies and standards. Furthermore, they will identify and mitigate common network security threats, implement encryption and authentication mechanisms, and utilize network management protocols for monitoring and troubleshooting. This course will equip students with the necessary skills to design, implement, and secure modern computer networks, enabling them to address diverse networking challenges effectively.

COURSE OUTLINE

Introduction to Computer Networks

- Definition and types of computer networks
- Network topologies and architectures
- OSI and TCP/IP reference models
- Introduction to wired and wireless network protocols and standards

Physical and Data Link Layers

- Overview of physical layer functions
- Transmission media: wired and wireless technologies
- Data encoding techniques
- Data link layer services, protocols, and standards for both wired and wireless networks
- i.e., SDLC, HDLC, SLIP, PPP, LCP, LAP, IEEE802.11, Ethernet, MPLS, STP.
- Signal modulation/demodulation

Network Layer

- Introduction to network layer protocols i.e., IP, ICMP, IGMP, ARP, RARP
- IP addressing and subnetting
- IPv4 and IPv6 protocols
- Routing algorithms and protocols for wired and wireless networks

Transport Layer

- Role of transport layer protocols i.e., TCP, UDP
- TCP (Transmission Control Protocol) fundamentals
- UDP (User Datagram Protocol)
- TCP congestion control and flow control mechanisms for both wired and wireless networks

Wireless LAN Standards and Protocols

- IEEE 802.11 family of standards (Wi-Fi)
- Wi-Fi Direct and Wi-Fi Protected Access (WPA/WPA2/WPA3)
- Bluetooth and Zigbee protocols for short-range wireless communication
- Wireless LAN deployment considerations and best practices

Cellular Networks and Standards

- Evolution of cellular networks (1G to 5G)
- GSM, CDMA, and LTE standards
- LTE architecture and protocols i.e., GTP-U, PDCP, RLC.
- Introduction to 5G NR (New Radio) standards and features

Wireless Network Security and Management

- Wireless security threats and vulnerabilities
- Encryption and authentication mechanisms for wired and wireless networks i.e., AES, RSA, ECC, IPSec, TLS/SSL.
- Network management protocols and techniques for monitoring and securing networks (SNMP, ICMP)

SUGGESTED TEACHING & ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Computer Networking: Principles, Protocols and Practice, by Olivier Bonaventure, Year 2011.
2. Computer Networks: Protocols, Standards, and Interfaces, Black, Uyless D, Englewood Cliffs, N.J. : Prentice-Hall.
3. Computer Networking: A Top-Down Approach" by James F. Kurose and Keith W. Ross, 8th edition, Year 2020.
4. TCP/IP Illustrated, Volume 1: The Protocols" by W. Richard Stevens: 2nd edition, Year: 2011.
5. Wireless Communications & Networks: Global Edition" by William Stallings.

NETWORK SECURITY

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Information and Network Security Overview
- (Information and Information Assets, Computer Security Concepts, CIA Triad, Active and Passive Attacks) Number Theory for Cryptography (Divisibility and the Division Algorithm, Greatest Common Divisor, The Euclidean Algorithm, Modular Arithmetic, Prime Numbers, Fermat's and Euler's Theorems, Discrete Logarithms)
- Classical Encryption Techniques (Cryptanalysis and Brute-Force Attack, Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Steganography)
- Symmetric Ciphers Stream and Block Ciphers, Feistel Cipher Structure, Data Encryption Standard (DES)Overview of Advanced Encryption Standard (AES) and Block Cipher Modes
- Asymmetric Ciphers (Public Key Cryptosystems, The RSA Algorithm, Diffie-Hellman Key Exchange
- Cryptographic Data Integrity and Mutual Trust (Cryptographic Hash Function, Secure Hash Algorithm (SHA), Message Authentication Codes, Digital Signature. Key Management and Distribution, Distribution of Public Keys, Public Key Infrastructure, User Authentication, Kerberos)
- Secure Communication (Securing Web Communications; TLS, Internet Protocol Security, Securing Wireless Networks).
- Network and Internet Security (Firewall Technologies, Intrusion Detection and Prevention Systems).

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Cryptography and Network Security, 7th Edition by William Stallings
2. Principles of Information Security by Michael E. Whitman and Herbert J. Mattord

NETWORK AND SYSTEM PROGRAMMING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Network and System Programming
- Overview of network and system programming
- Understanding networking protocols and socket programming
- Introduction to file handling and system calls

Socket Programming
- Socket programming basics and network communication
- Implementing client-server communication using sockets
- Multi-threading and concurrent socket programming

Network Protocols and Packet Handling
- Overview of network protocols and their functions
- Packet handling and manipulation using sockets
- Implementing network protocols using sockets

Network Security and Encryption
- Understanding network security and cryptography
- Implementing encryption and decryption using sockets
- Network security protocols like SSL/TLS

File Handling and System Calls
- Understanding file handling and system calls in operating systems
- Implementing system calls for file handling
- Implementing system calls for process management

Inter-Process Communication
- Inter-process communication techniques like pipes and message queues
- Shared memory and its implementation
- Synchronization mechanisms like mutex and semaphores

Network Programming with Python
- Introduction to Python socket programming
- Implementing networking protocols in Python
- Network security in Python

Advanced Network and System Programming
- Advanced topics like remote procedure call (RPC) and network file system (NFS)
- Overview of distributed systems and distributed programming
- Industry trends and real-world examples of network and system programming

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Hall, Mark. Learn Systems: A Beginner's Guide to Systems Programming, 2019.
2. Garg, Dheeraj. Mastering Linux Network Administration. Packet Publishing, 2020.
3. Fenner, William, et al. UNIX and Linux System Administration Handbook. Addison-Wesley, 2017.
4. Stevens, W. Richard, et al. TCP/IP Illustrated, Volume 1: The Protocols. Addison-Wesley, 2011.
5. Kurian, Jayakrishnan. Practical Network Programming with Rust, 2021.

COMPUTER ORGANIZATION

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Introduction to computer Architecture (History of Computers)
- Von Neumann Architecture /Memory read/write processes / Machine cycle
- Clock cycle, Algorithmic state machine chart
- Data path architecture
- Memory hierarchy, registers and ALU Operations with Assembly
- Intel architecture
- Synchronous/Asynchronous buses, bus arbitration
- I/O interfacing with Assembly
- Cache, Types of cache, snoop, snarf, cache address mapping
- Dynamic and static RAMs
- I/O handling, I/O protocols
- Instruction set architecture, addressing modes with Assembly
- CISC and RISC comparison
- Pipelining, RISC pipelining, pipeline stalling
- Multicore processors
- RAID

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Computer Architecture and Organization by William Stallings

COMPUTER ARCHITECTURE

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Basics of Computer Architecture & I/O Devices

- Introduction to computer architecture and organization
- Stored program concept / von Neumann architecture
- System buses
- CPU-memory interaction
- Memory organization, instruction cycle
- Machine cycles
- Instruction format
- Instruction types
- Instruction processing and execution sequence
- Performance measures
- I/O handling and protocol
- I/O modes (Programmed I/O, interrupt I/O).

MIPS Architecture and Assembly Language

- Instruction set Architectures (ISA)
- MIPS instruction formats
- MIPS addressing modes and memory architecture
- Introduction to assembly language programming
- Commonly used MIPS assembly instructions
- Translating high-level code to MIPS assembly.

Memory Hierarchy and Cache Organization

- Introduction to memory hierarchy
- Cache basics, levels of cache
- Cache types, cache mapping (direct mapping, associative mapping, set associative mapping).

Pipelining

- Basic concepts, MIPS pipeline, pipeline hazards.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes,

Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Williams Stallings, Computer Architecture and Organization, 10e, Pearson, 2015.
2. David A. Patterson and John L. Hennesy, Computer Organization and Design MIPS Edition:
3. The Hardware/Software Interface, 6e, Morgan Kaufmann, 2020

DIGITAL SYSTEMS DESIGN

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Basics of digital design
- Introduction to digital design
- Hardware vs Software Implementation
- Device technologies
- System representation & Levels of abstraction

Revision of Digital Fundamentals
- Combinational vs Sequential
- Latch vs Flip-flop
- Synchronous vs Asynchronous Signals etc.

HDL background and basic VHDL constructs
- HDL background, Skeleton of basic VHDL program
- Data types and operators
- Testbenches

VHDL Dataflow (concurrent) and Sequential statements and combinational circuits description
- Simple concurrent signal statements
- Conditional concurrent signal statements
- Selected concurrent signal statements
- VHDL Process, Sequential statements
- Latch Inference

Sequential Circuit Design using VHDL
- Basic synchronous circuit model

Basic Memory Elements
- Latch, Flip-Flop
- Inference of basic memory elements using VHD
- Shift Registers and Counters, Examples

Timing Analysis, Resource Sharing & Pipelined Design
- Timing Analysis Basics and D-FF Timing Parameters
- Operator Sharing
- Functionality Sharing
- Pipeline Introduction
- Delay vs Throughput, Examples

Finite State Machine Design

- Sequence Detectors
- Mealy and Moore Machines
- VHDL representations
- ASM Charts, Examples

RTL Design

- Introduction, Basic RTL operations & their implementations, Examples

Design Practices

- Misuse of asynchronous signals, Misuse of gated clocks etc.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Pong P. Chu, RTL Hardware Design Using VHDL: Coding for Efficiency, Portability, and Scalability, Wiley-IEEE Press, 2006
2. Digital Design: With a Introduction to the Verilog Hdl Book by M. Morris Mano and Michael D. Ciletti

ROBOTICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Overview of Robots
- History
- Taxonomy & Configurations
- Applications; Current Trends in Robotics
- The 8 Problems of Robotic Manipulators
- Representations *and Homogeneous Transformations*

Forward Position Kinematics
- Denavit-Hartenberg Representation; Examples

Inverse Position Kinematics:
- Kinematic Decoupling; Geometric IK Approach

Skew Symmetric Matrices
- Angular Velocity
- Addition of Angular Velocities
- Linear Velocity of a Point Attached to a Moving Frame
- Derivation of the Jacobian; Examples

Singularities
- Inverse Velocity and Acceleration

Path Planning:
- Introduction
- Workspace and Configuration-space
- Potential Fields Method
- Local Minima Avoidance
- Probabilistic Road Maps
- Introduction to Trajectory Planning

Dynamics:
- Euler-Lagrange Equations
- General Expressions for Kinetic and Potential Energy; Examples
- Equations of Motion; Examples
- Concluding Remarks on Robotic Manipulators

Design Implementation of Robot
- Robot Control and Sensing systems
- Robot-Vision
- Robot Programming and Interfacing

- Fundamentals of Robot-Design and Robot-Test
- End-effector Design

Mobile Robotics:

- Dynamics, Control
- Task Allocation
- Navigation Techniques
- Multi-robot Systems
- Heterogeneous Mobile Robotic Systems

Modern Topics in Robotics

- Rehabilitative
- Behavior-based
- Deliberative
- Adaptive
- Probabilistic and Biologically inspired Robotics

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. M.W. Spong and M. Vidyasagar. Robot Dynamics and Control. John Wiley & Sons, 2004
2. M.W. Spong and S. Hutchinson. Robot Modeling and Control. John Wiley & Sons, 2005
3. J.J. Craig. Introduction to Robotics: Mechanics and Control. Addison-Wesley series in electrical and computer engineering: control engineering. Pearson/Prentice Hall, 2005
4. S.B. Niku. Introduction to Robotics: Analysis, Systems, Applications. Pearson education. Pearson Education Asia, 2001
5. R. Siegwart, I.R. Nourbakhsh, and D. Scaramuzza. Introduction to Autonomous Mobile Robots. Intelligent robotics and autonomous agents. MIT Press, 2011
6. H. Choset, K. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. Kavraki, and S. Thrun. Principles of Robot Motion: Theory, Algorithms, and Implementation. MIT Press, 2005
7. R. Murphy. Introduction to AI Robotics. A Bradford book. MIT Press, 2000

UNMANNED AERIAL VEHICLES (UAVS)

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to UAVs

- Overview of UAVs and their applications
- Classification of UAVs based on size, range, and endurance
- History and development of UAVs

UAV Platforms

- Types of UAV platforms: fixed-wing, rotary-wing, and hybrid
- Components of a UAV platform: airframe, propulsion system, avionics, and payloads
- Design considerations for UAV platforms

UAV Navigation and Control

- Overview of UAV navigation and control systems
- Autonomous and semi-autonomous control modes
- Sensors and communication systems for UAV navigation and control

UAV Sensors and Payloads

- Types of sensors used in UAVs: cameras, LiDAR, infrared, etc.
- Payloads used in UAVs: surveillance and reconnaissance, agriculture, disaster response, etc.
- Integration of sensors and payloads with UAVs

UAV Regulations and Ethics

- Overview of UAV regulations and policies in different countries
- Ethics of UAV usage: privacy, security, and safety concerns
- Legal and ethical issues related to UAVs

UAV Applications

- Overview of UAV applications in various industries: agriculture, construction, logistics, etc.
- Case studies of successful UAV applications
- Future of UAV applications

UAV Communication Networks

- Overview of UAV communication networks
- Communication protocols and standards for UAV networks
- Network topologies and routing algorithms for UAV networks

UAV Simulation and Testing

- Overview of UAV simulation and testing
- Tools and techniques for UAV simulation and testing
- Validation and verification of UAV systems

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Keane, Thomas J. and Andriy Kryvokon. Drone Engineering: A Guide to Designing and Operating Small Unmanned Aircraft. Wiley, 2021.
2. Goodrum, Patrick M., et al. Unmanned Aircraft Systems: A Historical Perspective. Taylor & Francis, 2021.
3. McGeer, Tom. Unmanned Aerial Vehicles: Robotic Air Warfare 1917-2007. AIAA, 2020.
4. Pounds, Paul E. and Wade H. Sinclair. Drone Warfare: A Comprehensive Analysis of Weaponized Unmanned Aircraft. McFarland & Company, 2020.
5. Kim, Yunjun and Dongjun Lee. Unmanned Aerial Vehicle System Engineering: Technologies and Applications. CRC Press, 2020

CLOUD COMPUTING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Introduction to cloud computing, Internet Architecture, APNIC, cloud service models, IaaS. PaaS, SaaS, Public, private, community and hybrid cloud ,Features of cloud model, issues/risk in cloud model ,basic cloud hardware requirements.
- Virtualization concept, Hypervisor,Type1 and Type 2 hypervisor, Operating system vs processors based virtualization, Cloud high level connectivity diagram, cloud architecture, , Full/para /processor based virtualization, OS virtualization, AWS ,EC2 features
- Hardware-assisted virtualization migration, self ballooning,VM placement, Static, dynamic placement, Docker hub, client, server/daemon, image ,snapshot and start up commands, container concept ,control groups, docker run busybox, docker commands
- Network virtualization, Overlay technology, OSI model, Network virtualization and security (NSX) functional and economical feature, VXLAN,VXLAN vs VLAN, SDN concepts
- Cloud data center infrastructure, Risk factor of data center ,Cloud data Center design areas, Site selection.
- DC Physical topology vsphere, VDC architecture, Vcenter, Vmotion, VM DRS ,VM-HA, Data center storage architecture, SAN, SAN Connectivity
- Data center holding, staging area, UPS room, Meet me room, SHELL area, UPS, Generator room, service corridor, NOC, Raised floor, Data center grounding, EMF values and their effect, How to define N factor in data center design, Cloud data center cooling principal.
- Google Authorization, ZANZIBAR research paper, ACL, Zanzibar implementation, Google authorization and consistancy in applications, Zanzibar deployment, Data center efficiency, Power usage effectiveness.
- Data center monitoring, BMS, EMS,DCIM,NSM,MRTG, Observium tools, BMS protocol, SNMP, Observium demo lab
- SLA , OLA, MTTR, MTBF, response time, turn around time, What included in SLA docuemnt, SLA management, Force Majure works, Cloud SLA legal issues, Review cloud service SLA draft
- PCI DSS introduction, PCI DSS objective, PCI DSS Goals, PCI DSS requirments, gap analysis, PCI DSS documentations, Term presentations
- Network security, DOS/DDOS attack, Phishing attack, SQL injection attack, DNS spoofing attack, TCP Syn attack, DDOS protection ,Attack

prevention methods, Term presentations.
- Hadoop architecture, HDFS, HDFS horizontal scalability, Data storage, Big data ,Map Reduce function, Map Reduce word count program
- Mobile Internet Devices and the Cloud: Smartphones, Mobile Operating Systems for Smartphones, Mobile Platform Virtualization, Collaboration Applications for Mobile Platforms IoT, Sensor node, a sink node, gateway, IoT applications, TESLA car, baby monitor application, SN deployment

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Network virtualization for dummies by Mora Gozani , VMware Special Edition , Published by Wley
2. Cloud Computing: Concepts, Technology & Architecture, by Ricardo Puttini, Thomas Erl, and Zaigham Mahmood.
3. Cloud Computing Implementation, Management, and Security by John W. Rittinghouse and James F. Ransome, Taylor and Francis Group, LLC (2010). ISBN 978-1-4398-06807.
4. TIA 942 manual by TIA Published by TIA [For Data center standards]
5. Data center certification manuals.
6. Cloud Computing Bible by Barrie Sosinsky, Wiley; 1st Edition (2011). ISBN-10: 0470903562.

CYBER SECURITY SYSTEMS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Cyber Security
- Overview of cyber security and its importance
- Threats and vulnerabilities in cyberspace
- Types of cyber attacks and their impact

Network Security
- Network security protocols and standards
- Firewalls and intrusion detection systems
- Virtual private networks (VPNs) and secure sockets layer (SSL)

Cryptography
- Cryptographic algorithms and protocols
- Digital signatures and certificates
- Public key infrastructure (PKI)

Operating System Security
- Operating system security features and mechanisms
- User authentication and access control
- Malware detection and prevention

Web Security
- Web security protocols and standards
- Cross-site scripting (XSS) and cross-site request forgery (CSRF) attacks
- SQL injection and other web application vulnerabilities

Cloud Security
- Cloud security models and architectures
- Data protection and privacy in the cloud
- Cloud security challenges and solutions

Mobile Security
- Mobile security threats and vulnerabilities
- Mobile device management (MDM) and mobile application management (MAM)
- Secure coding practices for mobile applications

Cyber Security Governance and Risk Management
- Cyber security governance frameworks and standards
- Risk management and assessment methodologies
- Incident response and disaster recovery planning

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Akhter, Shah M., et al. Cybersecurity: Attack and Defense Strategies, Second Edition. Packt Publishing, 2021.
2. Singh, Vipin. Cybersecurity: A Comprehensive Guide to Effective Defense. Apress, 2020.
3. Bhatt, Hemant and Varun Badhwar. Cybersecurity - Attack and Defense Strategies: Infrastructure security with Red Team and Blue Team tactics. Packt Publishing, 2020.
4. Chuvakin, Anton, et al. The Practice of Network Security Monitoring: Understanding Incident Detection and Response. No Starch Press, 2020.

GEO-INFORMATICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Geo-informatics
- Overview of Geo-informatics and its applications
- Basic concepts of GIS, Remote Sensing and GPS
- Hardware and software requirements for Geo-informatics

Geographic Information Systems (GIS)
- Introduction to GIS and its components
- Data types and models in GIS
- Data sources and acquisition methods in GIS

GIS Analysis and Visualization
- Spatial analysis techniques in GIS
- Data visualization and cartography in GIS
- Applications of GIS in urban planning, agriculture, and environmental management

Remote Sensing
- Introduction to remote sensing and its components
- Electromagnetic spectrum and its interaction with earth surface features
- Image processing and interpretation in remote sensing

Global Positioning System (GPS)
- Introduction to GPS and its components
- GPS surveying techniques and equipment
- Applications of GPS in navigation, surveying, and mapping

Geo-databases
- Introduction to geo-databases and their components
- Data modeling and design in geo-databases
- Querying and analysis of geo-databases

Web-based Geo-informatics
- Introduction to web-based Geo-informatics
- Development of web-based GIS applications
- Integration of Geo-informatics with other web technologies

Geo-informatics and Society
- Ethical and legal issues in Geo-informatics
- Role of Geo-informatics in disaster management and emergency response
- Future trends and developments in Geo-informatics

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Longley, Paul A., et al. Geographic Information Science & Systems, 5th Edition. Wiley, 2021.
2. DeMers, Michael N. Fundamentals of Geographic Information Systems, 6th Edition. Wiley, 2021.
3. Jensen, John R. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Pearson, 2021.
4. Chang, Kang-tsung. Introduction to Geographic Information Systems, 9th Edition. McGraw Hill Education, 2020.
5. Korte, Monika and Dirk Tiede. GIS Basics, 4th Edition. Wichmann Verlag, 2022

Electric Vehicle Stream Depth Core I & II
• Automotive Engineering (Depth Core-I) • EV Charging Devices and Technologies (Depth Core-II)
Proposed Electives for Electric Vehicle Stream
• Sensors and Actuators • EV Batteries and Ancillaries • EV Software • EV Control Systems • EV Integration with Power Grid • Autonomous Vehicles • EV Circuits and Electronics • EV Body and Chassis Design • Vehicular Networking • EV Dynamics

AUTOMOTIVE ENGINEERING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Automotive Fundamentals:

- The basic principles of automotive design, including vehicle systems and components.

Vehicle Dynamics:

- The study of the forces acting on a vehicle and how they affect its motion, including suspension design, steering, and braking systems.

Powertrain Systems:

- The design and development of powertrain systems, including engines, transmissions, and drivetrains.

Engine Design and Performance:

- The principles of internal combustion engines, their components, and their performance characteristics.

Automotive Electronics:

- The electronic systems used in modern automobiles, including sensors, actuators, and control systems.

Alternative Fuel Vehicles:

- The design and development of vehicles that use alternative fuels, such as electric, hybrid, and fuel cell vehicles.

Materials and Manufacturing:

- The materials used in automotive engineering, as well as the manufacturing processes used to produce automobiles.

Safety and Regulations:

- The safety standards and regulations that govern the automotive industry, including crash testing and emissions regulations.

Automotive Design and Styling:

- The aesthetic aspects of automotive design, including exterior and interior design, aerodynamics, and ergonomics.

Maintenance and Servicing:

- The maintenance and servicing of automobiles, including diagnostics, repair, and maintenance procedures.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Automotive Engineering: Powertrain, Chassis System and Vehicle Body by David Crolla
2. Automotive Engineering Fundamentals by Richard Stone and Jeffrey K. Ball
3. Automotive Engineering: Lightweight, Functional, and Novel Materials edited by Brian Cantor, P. Grant, and C. Johnston
4. Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional HEV Technology by Xiaoqing Wei, Wei Liu, and Jianqiu Liang
5. Automotive Engineering: Design for Manufacture by Tim Williams

EV CHARGING DEVICES AND TECHNOLOGIES

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Electric Vehicle Fundamentals:

- The basic principles of electric vehicles, including their design, components, and operating principles.

EV Charging Station Design:

- The design and development of electric vehicle charging stations, including site selection, layout, and installation.

EV Charging Standards and Protocols:

- The various standards and protocols for electric vehicle charging, including AC and DC charging, charging rates, and communication protocols.

Charging Infrastructure and Management:

- The development of charging infrastructure, including public charging stations, home charging stations, and network management systems.

Battery Technologies and Charging:

- The design and development of batteries for electric vehicles, including charging technologies and safety considerations.

Renewable Energy Integration:

- The integration of renewable energy sources with electric vehicle charging infrastructure, including solar and wind power.

Smart Grid Integration:

- The integration of electric vehicle charging infrastructure with the smart grid, including demand response, load management, and grid stability considerations.

Business Models and Economics:

- The economic and business aspects of electric vehicle charging, including pricing models, revenue streams, and financial analysis.

Environmental and Social Considerations:

- The environmental and social impacts of electric vehicle charging, including carbon emissions, environmental impact assessments, and community engagement.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Electric Vehicle Charging for Smart Cities: A Practical Guide to Planning and Building Smart Electric Vehicle Infrastructure by David Thorpe
2. Electric Vehicle Charging Technology and Standards by Zoran Stevic
3. Electric Vehicle Charging Station Installation Guidelines: Residential and Commercial Locations by California Energy Commission
4. Electric Vehicle Charging Systems: A Guide for Residential and Commercial Electric Vehicle Supply Equipment by United States Department of Energy
5. Smart Grid Applications, Communications, and Security by Azzedine Boukerche
6. Electric Vehicle Integration into Modern Power Networks by Andres Carvallo and John Cooper

SENSORS AND ACTUATORS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Sensors and Actuators:

- The basic principles of sensors and actuators, and their role in electric vehicle systems.

Electric Motor Sensors:

- The various sensors used in electric motors, including position, speed, and temperature sensors.

Battery Management System Sensors:

- The sensors used in battery management systems, including voltage, current, and temperature sensors.

Chassis Control System Sensors:

- The sensors used in chassis control systems, including wheel speed sensors, steering angle sensors, and brake pressure sensors.

Environmental Sensors:

- The sensors used for environmental monitoring in electric vehicles, including temperature, humidity, and air quality sensors.

Power Electronics Sensors:

- The sensors used in power electronics systems, including current sensors, voltage sensors, and temperature sensors.

Actuators for EVs:

- The various types of actuators used in electric vehicles, including electric motors, solenoids, and valves.

Control Strategies for EV Sensors and Actuators:

- The control strategies used for EV sensors and actuators, including feedback control, feedforward control, and model-based control.

Testing and Validation of EV Sensors and Actuators:

- The testing and validation of EV sensors and actuators, including bench testing, simulation, and vehicle testing.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Sensors for Automotive Applications" by J. Paulo Davim:
2. "Electric Vehicle Machines and Drives: Design, Analysis and Application" by Shaahin Filizadeh and Houman Zahedi:
3. "Automotive Mechatronics: Operational and Practical Issues" by B. T. Fijalkowski and Dawid Majewski:
4. "Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market" by Gianfranco Pistoia:
5. "Handbook of Automotive Power Electronics and Motor Drives" by Ali Emadi:
6. "Sensors and Actuators in Mechatronics: Design and Applications" by Andrzej M. Trzynadlowski:

EV BATTERIES AND ANCILLARIES

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Batteries and Ancillaries

- The basic principles of EV batteries and ancillaries, and their role in electric vehicle systems.

Battery Technologies for EVs

- The various battery technologies used in electric vehicles, including lithium-ion, lead-acid, and nickel-metal hydride batteries.

Battery Management System

- The design and development of battery management systems (BMS) for electric vehicle batteries, including state-of-charge estimation, thermal management, and cell balancing.

Charging Infrastructure for EV Batteries

- The design and development of charging infrastructure for EV batteries, including charging stations, on-board chargers, and DC fast charging.

Battery Testing and Validation

- The testing and validation of EV batteries, including performance testing, safety testing, and life-cycle testing.

Power Electronics for EV Batteries

- The power electronics components used in electric vehicle batteries, including inverters, converters, and DC-DC converters.

Ancillary Components for EV Batteries

- The ancillary components used in electric vehicle batteries, including cooling systems, heating systems, and energy storage systems.

Battery Recycling and Second-Life Applications

- The recycling of EV batteries and second-life applications, including repurposing used batteries for stationary energy storage.

Regulatory and Safety Considerations

- The regulatory and safety considerations for EV batteries and ancillaries, including safety standards, regulations, and certifications.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Lithium-Ion Batteries: Science and Technologies" by Masaki Yoshio, Ralph J. Brodd, and Akiya Kozawa:
2. "Battery Management Systems for Large Lithium Ion Battery Packs" by Davide Andrea and Kandler Smith:
3. Models, Sustainability, Infrastructure and the Market" by Gianfranco Pistoia:
4. "Electric Vehicle Battery Systems" by Sandeep Dhameja:
5. "Handbook of Electric Power Calculations" by H. Wayne Beaty and Surya Santoso

EV SOFTWARE

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Software

- The basic principles of software systems used in electric vehicles, and their role in electric vehicle systems.

Embedded Software for EVs

- The design and development of embedded software for electric vehicle systems, including sensors and actuators, power electronics, and battery management systems.

EV Communication Protocols

- The communication protocols used in electric vehicle systems, including CAN bus, LIN bus, and Ethernet.

Software Development Process for EVs

- The software development process for electric vehicle systems, including requirements analysis, software design, coding, testing, and maintenance.

Software Tools for EV Development

- The software tools used for electric vehicle development, including simulation tools, rapid prototyping tools, and software testing tools.

Cybersecurity for EVs

- The cybersecurity considerations for electric vehicle software systems, including threat modelling, risk assessment, and security testing.

Autonomous Driving Software

- The software systems used in autonomous driving, including perception, decision-making, and control systems.

Cloud-based Software for EVs

- The cloud-based software systems used in electric vehicles, including over-the-air updates, data analytics, and remote diagnostics.

Regulatory and Safety Considerations

- The regulatory and safety considerations for electric vehicle software systems, including safety standards, regulations, and certifications

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach" by Amir Khajepour and M. Saber Fallah:
2. "Electric Vehicle Technology Explained" by James Larminie and John Lowry:
3. "Electric Vehicle Integration into Modern Power Networks" by João P. S. Catalão, Siddhartha Kumar Khaitan, and Pramod Agarwal:
4. "Electric Vehicles: Design and Build Your Own" by Michael Hackleman:
5. "Electric Vehicle Data Analytics for Smart Charging and Discharging" by Ali Emadi, Alireza Khaligh, and Zeyad T. Almutairi:

   "Electric Vehicle Machines and Drives: Design, Analysis and Application" by Shaahin Filizadeh and Houman Zahedi:

EV CONTROL SYSTEMS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Control Systems

- The basic principles of control systems used in electric vehicles, and their role in electric vehicle systems.

EV Powertrain Control

- The control systems used in electric vehicle powertrains, including motor control, power electronics control, and battery management control.

Vehicle Dynamics Control

- The control systems used for vehicle dynamics, including steering control, braking control, and suspension control.

Autonomous Vehicle Control

- The control systems used in autonomous vehicles, including perception, decision-making, and control systems.

Human-Machine Interface

- The design and development of human-machine interface (HMI) systems for electric vehicles, including displays, controls, and user feedback systems.

Energy Management Control

- The control systems used for energy management in electric vehicles, including energy storage system control, regenerative braking control, and energy consumption optimization.

Control System Design and Development

- The process of designing and developing control systems for electric vehicles, including system modelling, control algorithm design, and hardware-in-the-loop simulation.

Cybersecurity for EV Control Systems

- The cybersecurity considerations for electric vehicle control systems, including threat modelling, risk assessment, and security testing.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Electric and Hybrid Vehicles: Control Strategies" by Amir Khajepour, Kevin L. Johnson, and M. Saber Fallah:
2. "Vehicle Dynamics and Control" by Rajesh Rajamani:
3. "Advanced Control of Wheeled Inverted Pendulum Systems" by Alessandro De Luca, Giuseppe Oriolo, and Marilena Vendittelli:
4. "Model Predictive Control of Automotive Powertrain Systems" by Uwe Kiencke and Lars Nielsen:
5. "Electric Drive Control of EVs" by Seung-Ki Sul:

EV INTEGRATION WITH POWER GRID

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Integration with Power Grid

- The basic principles of integrating electric vehicles with the power grid, and their role in the future of the energy system.

Charging Infrastructure

- The design and implementation of charging infrastructure for electric vehicles, including charging station types, charging protocols, and standards.

Power Electronics for EV Integration

- The power electronics used for integrating electric vehicles with the power grid, including bidirectional chargers, DC-DC converters, and inverters.

Vehicle-to-Grid (V2G) Systems

- The concept of vehicle-to-grid (V2G) systems, including the benefits, challenges, and applications of V2G technology.

EV Charging Management

- The management of EV charging, including scheduling, load balancing, and demand response.

Grid Management for EV Integration

- The management of the power grid to accommodate the integration of electric vehicles, including smart grid technology, grid stability, and energy management.

Energy Storage Systems

- The use of energy storage systems for EV integration with the power grid, including batteries, supercapacitors, and flywheels.

Cybersecurity for EV Integration

- The cybersecurity considerations for integrating electric vehicles with the power grid, including threat modelling, risk assessment, and security testing.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Electric Vehicle Integration into Modern Power Networks" by João P. S. Catalão, Siddhartha Kumar Khaitan, and Pramod Agarwal:
2. "Electric Vehicles and Energy Storage Systems: A Sustainable Future" edited by Naser Mahdavi Tabatabaei, Masoumeh Haghbin, and Mir Sayed Shah Danishmand:
3. "Plug-in Electric Vehicles: Smart Grid Integration" by Hua Bai:
4. "Smart Grids and Electric Vehicles: Made for Each Other?" by Wilfried Aichholzer and Martina Liedermann:
5. "Electric Vehicle Charging Infrastructure Planning, Design, and Deployment" by Mohamed Abdel-Monem El-Hawary:
6. "Electric Vehicle Business Models: Global Perspectives" edited by Ralph E. H. Sims, Tilak K. Doshi, and David R. Shonnard:

AUTONOMOUS VEHICLES

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Autonomous Vehicles

- The history and evolution of autonomous vehicle technology, as well as the current state of the industry.

Perception and Sensing

- The perception and sensing systems used in autonomous vehicles, including cameras, lidar, radar, and GPS.

Decision-Making and Planning

- The decision-making and planning algorithms used in autonomous vehicles, including path planning, obstacle avoidance, and decision-making under uncertainty.

Control Systems

- The control systems used in autonomous vehicles, including steering, braking, and acceleration.

Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) Communication

- The communication protocols and systems used for vehicle-to-vehicle and vehicle-to-infrastructure communication in autonomous vehicles.

Human-Machine Interface

- The design and development of human-machine interface (HMI) systems for autonomous vehicles, including displays, controls, and user feedback systems.

Cybersecurity for Autonomous Vehicles

- The cybersecurity considerations for autonomous vehicles, including threat modelling, risk assessment, and security testing.

Ethics and Policy Considerations

- The ethical and policy considerations for autonomous vehicles, including liability, privacy, and ethical decision-making.

Industry Applications

- The applications of autonomous vehicles in various industries, such as transportation, logistics, and agriculture.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Autonomous Vehicles: Intelligent Transport Systems and Smart Technologies" by Felipe Jimenez, Jaime Lloret, and Rafael Gadea:
2. "Autonomous Driving: Technical, Legal and Social Aspects" edited by Markus Maurer, J. Christian Gerdes, Barbara Lenz, and Hermann Winner:
3. "Autonomous Vehicle Navigation: From Behavioral to Hybrid Multi-Controller Architectures" by Alcherio Martinoli and Alessandro Giusti:
4. "Autonomous Vehicles: Opportunities, Strategies, and Disruptions" by Evangelos Simoudis:
5. "Reinforcement Learning for Autonomous Vehicles: A Survey" by Guillaume Lample and Devendra Singh Chaplot:
6. "Robust and Adaptive Control for Autonomous Vehicles" by Andrey V. Savkin:

EV CIRCUITS AND ELECTRONICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Circuits and Electronics

- The basic principles of circuits and electronics in electric vehicles, and the importance of efficient and reliable electronics in electric vehicle design.

Power Electronics for EVs

- The power electronics used in electric vehicles, including DC-DC converters, inverters, and battery chargers.

Control Systems for EVs

- The control systems used in electric vehicles, including sensors, actuators, and control algorithms.

Battery Management Systems (BMS)

- The design and implementation of battery management systems for electric vehicle batteries, including state-of-charge (SOC) estimation, balancing, and temperature control.

Electric Motors and Drives

- The electric motors and drives used in electric vehicles, including induction motors, permanent magnet motors, and motor controllers.

EV Charging Systems

- The design and implementation of charging systems for electric vehicles, including AC and DC charging stations, charging protocols, and standards.

EV Safety Systems

- The safety systems used in electric vehicles, including fuses, circuit breakers, and ground fault protection.

Electromagnetic Compatibility (EMC)

- The design and implementation of electromagnetic compatibility (EMC) systems for electric vehicles, including electromagnetic interference (EMI) and radio frequency interference (RFI) mitigation.

Fault Diagnosis and Troubleshooting

- The techniques for fault diagnosis and troubleshooting in electric vehicle circuits and electronics

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Electric Vehicle Systems Architecture and Standardization Needs" edited by Massimo Cavazzini and Marco Picone:
2. "Power Electronics for Electric and Hybrid Vehicles: Market Trends, Technologies, and Outlook" by Mario Paolone and Rachid Cherkaoui:
3. "Electric Vehicle Batteries: Moving from Research towards Innovation" Gianfranco Pistoia and Boryann Liaw:
4. "Electric Vehicle Technology for Construction, Agriculture and Off-Road Vehicles" by Markus Wagner and Juergen Fleischer:

EV BODY AND CHASSIS DESIGN

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Body and Chassis Design

- The basic principles of body and chassis design for electric vehicles, and the importance of lightweight and aerodynamic design.

Vehicle Architecture

- The different types of vehicle architectures used in electric vehicles, including monocoque, spaceframe, and ladder frame.

Chassis Components

- The different components of the chassis, including suspension systems, steering systems, brakes, and wheels.

Body Design and Materials

- The design and materials used for the body of electric vehicles, including steel, aluminum, and composite materials.

Aerodynamics

- The principles of aerodynamics and their application to the design of electric vehicles, including drag reduction techniques and wind tunnel testing.

Crashworthiness and Safety

- The design and development of electric vehicles for crashworthiness and safety, including crash testing and safety regulations.

Vehicle Dynamics

- The principles of vehicle dynamics and their application to the design of electric vehicles, including handling and stability.

NVH (Noise, Vibration, and Harshness)

- The principles of NVH and their application to the design of electric vehicles, including noise reduction techniques and vibration damping.

Manufacturing Processes

- The manufacturing processes used in the production of electric vehicle bodies and chassis, including stamping, welding, and bonding.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes,

Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" by Iqbal Husain:
2. "Electric Vehicle Design and Modeling: A Computational Approach" by Qiaoxing Li:
3. "Electric Vehicle Integration into Modern Power Networks" by Saeid Mokhatab and William H. Kersting:
4. "Vehicle Dynamics and Control" by Rajesh Rajamani:
5. "Structural Composite Materials" by F. L. Matthews:

VEHICULAR NETWORKING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE
Introduction to Vehicular Networking • This topic covers the basics of vehicular networking, including the history, applications, and challenges associated with the field. **Wireless Communication** • This topic covers the various wireless communication technologies used in vehicular environments, including IEEE 802.11p, cellular networks, and ad hoc networks. **Intelligent Transportation Systems (ITS)** • This topic covers the concepts and technologies involved in intelligent transportation systems, including traffic management, safety, and environmental sustainability. **Vehicular Ad Hoc Networks (VANETs)** • This topic covers the architecture, protocols, and algorithms used in VANETs, including routing, security, and quality of service. **Vehicle-to-Vehicle (V2V) Communication** • This topic covers the communication between vehicles in a vehicular network, including the types of information exchanged, the communication protocols used, and the challenges associated with V2V communication. **Vehicle-to-Infrastructure (V2I) Communication** • This topic covers the communication between vehicles and infrastructure in a vehicular network, including the types of information exchanged, the communication protocols used, and the challenges associated with V2I communication. **Localization and Positioning** • This topic covers the methods and techniques used to determine the location and position of vehicles in a vehicular network, including GPS, dead reckoning, and map-based localization. **Security and Privacy** • This topic covers the security and privacy issues associated with vehicular networking, including authentication, access control, and privacy-preserving techniques. **Future Directions** • This topic covers the current trends and future directions in vehicular networking, including emerging technologies and research challenges.

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Vehicular Networking: Automotive Applications and Beyond" by Jens Mittag and Bernd-Ludwig Wenning:
2. "Vehicular Ad Hoc Networks: Standards, Solutions, and Research" edited by Christian Bonnet, Yannis P. Laberteaux, and Hao Zhu:
3. "Connected Vehicles: Intelligent Transportation Systems and Smart Technologies" edited by Rajamani Ganeshan and V. Sridhar:
4. "Automotive Ethernet: The Definitive Guide" by Kirsten Matheus and Thomas Königseder:
5. "Vehicular Networks: Techniques, Standards, and Applications" edited by Uyen Trang Nguyen and Naveen Chilamkurti:

EV DYNAMICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to EV Dynamics

- This topic covers the basics of EV dynamics, including the differences between conventional vehicles and electric vehicles, the fundamental principles of EV dynamics, and the types of electric vehicles.

EV Powertrain

- This topic covers the components of an electric vehicle powertrain, including the electric motor, battery, power electronics, and transmission system.

EV Modeling

- This topic covers the mathematical modeling of electric vehicles, including the modeling of the powertrain, tire-road interaction, and vehicle dynamics.

EV Control

- This topic covers the control of electric vehicles, including the design of controllers for the powertrain, regenerative braking, and stability control.

Battery Management System

- This topic covers the design and implementation of battery management systems for electric vehicles, including the monitoring of battery state-of-charge, state-of-health, and temperature.

Charging Infrastructure

- This topic covers the design and operation of EV charging infrastructure, including the different types of charging stations and the communication protocols used for charging.

Energy Management

- This topic covers the optimization of energy management in electric vehicles, including the design of energy-efficient driving strategies and the use of vehicle-to-grid (V2G) technology.

Simulation and Analysis

- This topic covers the simulation and analysis of electric vehicle dynamics using software tools, including MATLAB/Simulink, ANSYS, and AVL.

Future Directions

- This topic covers the current trends and future directions in EV dynamics, including emerging technologies and research challenges.

SUGGESTED TEACHING AND ASSESSMENT METHODS
Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing. **Assessment:** Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term
RECOMMENDED TEXT AND REFERENCE BOOKS
1. "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" by Iqbal Husain: 2. "Electric Vehicle Dynamics and Control" by Haiping Du, Zongde Fang, and Wei Liu: 3. "Advanced Electric Drive Vehicles" by Ali Emadi: 4. "Automotive Electrification: Volume I - Electric Powertrains and Energy Storage Systems" edited by M. K. Khodayari and C. C. Chan:

Proposed Electives for **Multi-Disciplinary Domain (MDEE)**
• Applied Mechanics • Fluid Mechanics • Thermodynamics • Surveying & Levelling • Bio-Mechanics • Environmental Engineering • Software Engineering • Optimization Techniques • Any Interdisciplinary Engineering Subject

Multi-Disciplinary Electives

APPLIED MECHANICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Definitions and scope of Applied Mechanics
- Concept of Rigid and Deformed Bodies
- Fundamental concepts and principles of mechanics: Newtonian Mechanics

Basic Concept in Statics and Static Equilibrium

- Concept of Particles and Free Body Diagram
- Physical meaning of Equilibrium and its essence in structural application
- Equation of Equilibrium in Two Dimension

Forces acting on particle and rigid body

- Different types of Forces: Point, Surface Traction and Body Forces - Translational Force and Rotational Force: Relevant Examples
- Resolution and Composition of Forces: Relevant Examples
- Principle of Transmissibility and Equivalent Forces: Relevant Examples
- Moments and couples: Relevant Examples
- Resolution of a Force into Forces and a Couple: Relevant Examples
- Resultant of Force and Moment for a System of Force: Examples

Center of Gravity, Centroid and Moment of Inertia

- Concepts and Calculation of Centre of Gravity and Centroid: Examples
- Calculation of Second Moment of Area / Moment of Inertia and Radius of Gyration and Relevant usages
- Use of Parallel axis Theorem: Relevant Examples

Friction

- Laws of Friction, Static and Dynamic Coefficient of Friction, Angle of Friction: Engineering Examples of usage of friction
- Calculations involving friction in structures: Example as High Tension Friction Grip bolts and its free body diagram

Analysis of Beams and Frames

- Introduction to Structures: Discrete and Continuum
- Concept of Load Estimating and Support Idealizations: Examples and Standard symbols
- Use of beams/frames in engineering: Concept of rigid joints/distribute loads in beams/frames.

- Concept of Statically/Kinematically Determinate and Indeterminate Beams and Frames: Relevant Examples
- Calculation of Axial Force, Shear Force and Bending Moment for Determinate Beams and Frames
- Axial Force, Shear Force and Bending Moment Diagrams and Examples for drawing it.

Analysis of Plane Trusses

- Use of trusses in engineering: Concept of pin joints/joint loads in trusses.
- Calculation of Member Forces of Truss by method of joints: Simple Examples
- Calculation of Member Forces of Truss by method of sections: Simple Examples

Kinematics of Particles and Rigid Body

- Rectilinear Kinematics: Continuous Motion
- Position, Velocity and Acceleration of a Particle and Rigid Body
- Determination of Motion of Particle and Rigid Body
- Uniform Rectilinear Motion of Particles
- Uniformly Accelerated Rectilinear Motion of Particles
- Curvilinear Motion: Rectangular Components with Examples of Particles

Kinetics of Particles and Rigid Body: Force and Acceleration

- Newton's Second Law of Motion and momentum
- Equation of Motion and Dynamic Equilibrium: Relevant Examples
- Angular Momentum and Rate of Change
- Equation of Motion-Rectilinear and Curvilinear
- Rectangular: Tangential and Normal Components and Polar Coordinates: Radial and Transverse Components

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. "Mechanics of Engineers- Statics and Dynamics", F.P. Beer and E.R.Johnston, Jr. 4th Edition, Mc Graw-Hill, 1987.
2. "Engineering Mechanics-Statics and Dynamics", R.C. Hibbeler, Ashok Gupta. 11th edition., New Delhi, Pearson, 2009.

3. "Engineering Mechanics- Statics and Dynamics", I.C. Jong and B.G. Rogers
4. "Engineering Mechanics- Statics and Dynamics", D.K. Anand and P.F. Cunnif
5. "A Text Book of Engineering Mechanics", R.S. Khurmi
6. "Applied Mechanics and Strength of Materials", R.S.Khurmi
7. "A Text Book of Applied Mechanics", I.B.Prasad
8. "Engineering Mechanics-Statics and Dynamics", Shame, I.H. 3rd ed., New Delhi, Prentice Hall of India, 1990

FLUID MECHANICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE
Introduction and properties of Fluid • Properties of Fluid, viscosity • surface tension • vapor pressure and cavitation • Classification of Fluid flow **Fluid Statics** • Center of pressure • Hydrostatic forces on submerged surfaces • Buoyancy and stability **Fluid Dynamics** • Velocity and acceleration field • Static, dynamic and stagnation pressure • Bernoulli's equation • Energy equation for steady and incompressible flow • laminar and turbulent flow in circular pipes • Hydraulic losses and correction factor • Introduction of Dimensional Analysis **Governing Equations of Fluid Flow** • Eulerian and Lagrangian viewpoints • Continuity equation • Navier-Stokes Equation • Reynold's Transport theorem for continuity • Linear momentum and Angular Momentum **Potential flow theory** • Irrotational flow field • stream function • velocity potential function • vorticity and circulation relation • basic potential flows; uniform flow • two-dimensional source and sink • simple vortex • the doublet • lift and drag forces

Boundary Layer Theory

- Boundary layer theory; laminar boundary layer; turbulent boundary layer, boundary layer thicknesses; drag, lift and airfoil cascades.

Fluid Machinery

- Euler's equation of turbo-machine, classification of turbo-machines; centrifugal pumps and turbines, affinity laws, specific speed, performance curves

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering. disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:

Mid Exam, Final Exam, Quizzes, Assignments, Presentation

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Munson, "Fundamentals of Fluid Mechanics", John Wiley, 2014
2. Frank M, "Fluid Mechanics", McGraw-Hill India, 2017
3. Çengel, "Fluid Mechanics-Fundamentals and Applications", McGraw-Hill, 2018
4. Robert W. Fox, "Introduction to Fluid Mechanics", Wiley, 2016
5. Joseph Katz, "Introduction to Fluid Mechanics", Cambridge University Press, 2010

THERMODYNAMICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Thermodynamics

- Concept of Equilibrium
- Continuum
- Pressure and Temperature
- Zeroth Law of Thermodynamics
- Properties of Pure Substances
- PVT surfaces
- Use of steam table
- conservation of mass, pressure and temperature measurement devices.
- Equation of state
- Ideal gas law
- Vander Wall equation
- Law of corresponding states
- Virial equation of state

Laws of Thermodynamics

- Work, Heat, Law of conservation of Energy
- First law of thermodynamics for closed and open system
- Second law of thermodynamics
- Heat engine
- Refrigeration and heat pump
- Carnot Cycle
- Entropy
- Clausius Inequality
- Isentropic relations
- Thermodynamic process and cycles
- Introductory concept of Mechanical Exergy

Thermodynamic Power Cycles

- Thermal Efficiency
- Air standard Otto, Diesel and Dual Cycle
- Brayton Cycle
- Rankine Cycle

Reciprocating Compressors

- Condition for minimum work

- Isothermal efficiency
- Volumetric efficiency
- Multi-stage compression
- Energy balance for a two-stage machine with intercooler

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering. disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing.

Assessment:
Mid Exam, Final Exam, Quizzes, Assignments, Presentation

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Cengel, "Engineering Thermodynamics", McGraw-Hill, 2019
2. Moran Shapiro, "Fundamentals of Engineering Thermodynamics", Wiley, 2019.
3. Yunus A. Çengel, "Fundamental of Thermal-Fluid Sciences", McGrawHill, 2016.

SURVEYING & LEVELING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Fundamental Concepts

- Definitions, uses & types of surveys
- survey measurements, errors and adjustments.

Basic Survey Measurements

- Distance measurements,
- levelling, different methods & types of instruments
- angle and direction measurement & construction
- Adjustment of transit & compass, theory, practical and use of stadia surveying

Surveying Operation

- Plane table traverse
- Transit tape traverse
- triangulation adjustment of traverse and triangulation network
- construction & use of optical alidade
- precise measurement of baseline location of details and area measurement
- determination of meridian by astronomical observation
- topographic maps.

Mine Surveying

- Transfer of co-ordinates level and meridian underground,
- use of auxiliary telescope
- laying out of curves
- special mine surveying

Field Work

- Levelling traversing with plane table and transit-tape traversing
- triangulation network practice
- survey camp of at least two weeks duration to prepare topographic map

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engineering. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

Assessment:

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Davis and Foote. 1968. Surveying, McGraw-Hill.
2. Kanetker, T.P. 1996. Surveying and Levelling. Vol.1&2.
3. Staley W.W. 1964. Introduction to Mine Surveying, Stanford University Press.
4. Brinker, R.C. 1997. The Surveying Handbook, CBS Publishers and Distributors.
5. Abid, S.H. 2000. Mine Surveying. Ministry of Education, Pakistan

BIO-MECHANICS

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction

- Definition and perspective
- Review of statics
- Review of Dynamics
- Review of deformable body mechanics
- Viscoelasticity, material properties 75

Anthropometry

- Density, mass and inertial properties
- Direct measurement of anthropometric parameters
- Muscle anthropometry
- Mechanical advantage of muscle
- Multipoint muscles,

Kinematics of Human Movement

- Forms of motion
- Standard reference systems and joint movement terminology
- Spatial reference systems
- qualitative vs. quantitative analysis of human movement
- limb-segment angles, joint angle, linear and angular velocities and acceleration f. tools for direct/indirect measurement of kinematic quantities

The biomechanics of Human Bone Growth and Development

- Composition and Structure of Bone Tissue
- Material Constituents
- Structural Organization
- Types of Bones
- Bone Growth and Development
- Longitudinal Growth
- Circumferential Growth
- Adult Bone Development
- Bone Response to Stress
- Bone Modeling and Remodeling
- Bone Hypertrophy
- Bone Atrophy

Kinetics of Human Movement

- Link segment models
- Joint reaction forces
- Direct Force measurements

Biomechanics of upper & lower extremity

- Loading and injuries to the shoulder, elbow, wrist joints.
- Loading and injuries to the Hip, knee and ankle joints

Gait Biomechanics

- Methods of gait analysis
- Gait cycle
- Temporal-spatial parameters
- Hip, knee and ankle joint kinematics and kinetics
- Interpretation of gait data

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Susan J. Hall, Basic Bio-Mechanics, 6th Ed, 2011.
2. Margareta Nordin, Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System
3. Nihat Özkaya, et al, Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation
4. 4. David A. Winter, Biomechanics and Motor Control of Human Movement

ENVIRONMENTAL ENGINEERING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Basic Concepts

- Introduction to environment and ecology, pollution concept, types of pollution. Environmental national and international policy and standards;

Environmental Monitoring (gas, liquid, solids)

- Sampling and monitoring mechanism, Design and types of samples, Pre-sampling requirements/ information, sampling and design purposes.

Pollution Control and Treatment Techniques

- Air pollution control technologies, water pollution control technologies, water treatment technologies, sub-soil / soil pollution control technologies, noise pollution control technologies. Biotechnology for environment, industrial pollution control; covering design, sizing and operation.

Climate Change

- Global warming and climate change, Different Weathers, Earth's climate system, types and influencing Factors, Green house effect, Energy use and carbon emissions, Effect and Importance of climate on environment , Impacts of climate changes on human life and environment, History and data analysis of climate changes, Controls of climate changes, UNO action plan of climate changes.

Assessment Techniques

- Principles and purposes of IEE and EIA and its significance for the society. Cost and benefits of EIA. Main stages in EIA process. Public consultation and participation in EIA process. EIA methods and techniques for impact prediction and evaluation

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Cheremisinoff Handbook of Air Pollution Prevention and Control, 2002

SOFTWARE ENGINEERING

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

- Overview of Software Engineering
- Professional software development
- Software engineering practice
- Software process structure
- Software process models
- Agile software Development, Agile process models
- Agile development techniques
- Requirements engineering process
- Functional and non-functional requirements
- Context models, Interaction models, Structural models, behavioral models
- Model driven engineering
- Architectural design
- Design and implementation
- UML diagrams
- Design patterns
- Software testing and quality assurance, Software evolution
- Project management and project planning
- Configuration management, Software Process improvement

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Software Engineering: A Practitioner's Approach by Pressman, Roger S. and Bruce Maxim, latest Edition, McGraw Hill.
2. Software Engineering by Sommerville, latest Edition, Pearson Education

OPTIMIZATION TECHNIQUES

Credit Hours: 3+0 = 3
Pre-Requisites: Nil

COURSE OUTLINE

Introduction to Optimization

- Statement of optimization, Objective function, Problem constraints and constraint surface, Classification of optimization problems

Linear Programming

- Variants of linear programming, examples of linear programming problems, linear algebra background, graphical representation for two dimensional space

Geometry Linear Programming

- Polyhedra and convex sets, extreme points, vertices, existence of extreme points, optimality of extreme points

Simplex Algorithm

- Optimality conditions, identifying an optimal point, development of simplex algorithm, two phases of simplex algorithm, column geometry of simplex algorithm, computational complexity of simplex algorithm

Duality Theory

- Duality in linear programming, primal-dual relations, duality theorem, dual simplex method, optimal dual variables

Nonlinear Optimization

- Least-squares & linear optimization, Nonlinear optimization, Convex optimization

Convex Sets

- Affine and convex sets, convexity preserving operations, separating and supporting hyper-planes, generalized inequalities

Convex Functions

- Operations preserving convexity, conjugate function, Quasi-convex functions, Log-concave and log-convex functions, Convexity with respect to generalized inequalities

Convex Optimization

- Convex optimization problems, quadratic optimization, geometric optimization, Duality, Lagrange dual function, dual problem, geometric interpretation, optimality conditions

Algorithms

- Unconstrained problems,

- equality constrained problems
- Interior Points method

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. Introduction to Linear Optimization by Dimitris Bertsimas & John N. Tsitsiklis, Athena Scientific 1997.
2. Convex Optimization by S. Boyd & L. Vandenberghe Cambridge Univ. Press, 2004
3. Engineering Optimization: Theory and Practice by S. S. Rao , John Wiley & Sons 2009

OCCUPATIONAL HEALTH AND SAFETY

Credit Hours: 1+0 = 1
Pre-Requisites: Nil

COURSE OUTLINE

Health and Safety Foundations

- Nature and scope of health and safety
- Reasons/benefits and barriers for good practices of health and safety
- Legal frame work and OHS Management System

Fostering a Safety Culture

- Four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare)
- Re-thinking safety-learning from incidents
- Safety ethics and rules
- Roles and responsibilities towards safety
- Building positive attitude towards safety
- Safety cultures in academic institutions

Recognizing and Communicating Hazards

- Hazards and Risk
- Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), electrical, fire, construction, heat and temperature, noise and vibration, falling and lifting etc
- Learning the language of safety: Signs, symbols and labels Finding Hazard Information
- Material safety data sheets
- Safety data sheets and the GHS (Globally Harmonized Systems)

Accidents & Their Effect on Industry

- Costs of accidents
- Time lost
- Work injuries, parts of the body injured on the job
- Chemical burn injuries
- Construction injuries
- Fire injuries

Assessing and Minimizing the Risks from Hazards

- Risk Concept and Terminology
- Risk assessment procedure
- Risk Metric's
- Risk Estimation and Acceptability Criteria
- Principles of risk prevention

- Selection and implementation of appropriate Risk controls
- Hierarchy of controls

Preparing for Emergency Response Procedures

- Fire
- Chemical Spill
- First Aid
- Safety Drills / Trainings: Firefighting, Evacuation in case of emergency

Stress and Safety at Work Environment

- Workplace stress and sources
- Human reaction to workplace stress
- Measurement of workplace stress
- Shift work, stress and safety
- Improving safety by reducing stress
- Stress in safety managers
- Stress and workers compensation

Incident Investigation

- Importance of investigation
- Recording and reporting
- Techniques of investigation
- Monitoring
- Review
- Auditing Health and Safety

SUGGESTED TEACHING AND ASSESSMENT METHODS

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

RECOMMENDED TEXT AND REFERENCE BOOKS

1. The A-Z of health and safety by Jeremy Stranks, 2006.
2. The Manager's Guide to Health & Safety at Work by Jeremy Stranks, 8th edition, 2006.
3. Occupational safety and health law handbook by Ogletree, Deakins, Nash, Smoak and Stewarts, second edition, 2008.

Available at:
http://www.pec.org.pk